Monday
6:30AM - 3:00PM
Palais des congrès de Montreal, 220d

Education Exhibits (Print) - Adult Brain
EdE-32

6:30AM - 9:00PM

A Teaching Guide to Flutemetamol F18 and Florbetapir F18, New Neuroimaging Agents for Evaluation of Dementia of the Alzheimer’s Type (DAT).

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Purpose
Flutemetamol F18 is the latest PET brain imaging probe approved by the Food and Drug Administration (FDA) in October 2013 for evaluation of cognitive decline. It is the second agent for this indication; 18-F Florbetapir was approved in April 2012. High affinity binding of these probes to neuritic β-amyloid plaques estimates plaque localization and density, aiding the diagnosis of Dementia of the Alzheimer's type (DAT). An FDA-required, company-sponsored training program is mandatory for image interpretation. Imaging data sets require binary categorization of images as positive or negative. As an adjunct to clinical diagnosis, imaging results facilitate in vivo visualization of amyloid plaque held responsible for neuronal death and degeneration leading to symptoms of DAT. This educational exhibit reviews the latest approved PET probes in amyloid imaging, including methodology, interpretative guidelines and clinical case studies.

Materials and Methods
This educational poster will compare F-18 labeled Flutemetamol and Florbetapir under the following sections: 1. Technical aspects and probes used in PET amyloid imaging; 2. Interpretative criteria and clinical significance of imaging studies; 3. Advantages and pitfalls of amyloid imaging.

Results
¹¹C-Pittsburgh compound-B (¹¹C-PiB), a derivative of a fluorescent amyloid staining dye, Thioflavin T, is the gold standard among amyloid imaging probes. Its high affinity to β-amyloid plaques has been confirmed at autopsy in DAT cases. However, the longer half-life of newer fluorinated agents, 110 minutes (compared with 20 minutes for ¹¹C-PiB) make them ideal for clinical use. Flutemetamol F18, a fluorinated derivative of Thioflavin T, is structurally similar to ¹¹C-PiB; its cortical uptake/retention and β-amyloid plaque affinity also conforms with ¹¹C-PiB across the entire spectrum of DAT. The lower degree of nonspecific white matter uptake, color scale reading and slightly lower radiation dose are added advantages compared to the previous probe, 18-F Florbetapir, a stilbene derivative. A multi-society group recently has formulated appropriate use criteria to guide the clinical practitioner in optimal imaging indications. While a diagnosis of DAT can be made tentatively with positive results (greater than average cortical uptake) in conjunction with a strong clinical suspicion, a positive scan also may be observed with other neurologic conditions and normal aging. Negative imaging results decrease the likelihood
of dementia due to DAT. Although amyloid imaging at the present time is not approved to predict future dementia or monitor therapeutic response, this may be the greatest future potential of the amyloid-seeking agents.

**Conclusions**

PET amyloid imaging is gaining momentum with FDA approval of Flutemetamol F18 and similar agents. This poster seeks to disseminate the basic concepts of β-amyloid imaging to enable its clinical use in suitable patients and explore the diagnostic relevance of these agents. Further clinical trials will be needed to better understand the impact on patient outcome. Future availability of anti-amyloid disease modifying therapies is expected to significantly change the clinical utility of this new class of radiopharmaceuticals.

**KEYWORDS:** Alzheimer Disease, PET, Plaque Imaging

**EdE-02**

6:30AM - 9:00PM

**Advanced Neuroimaging Tools for Planning/Guiding Occipital Lobe Surgery**

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**Purpose**

The complexity of evolving MR imaging (MRI) technologies and the wealth of new information they provide can make it difficult for clinicians to stay abreast of the latest developments and applications. This educational poster reviews clinically relevant aspects of functional MRI (fMRI) and diffusion tensor imaging (DTI) methods and their use in mapping the visual system to aid diagnosis of vision-related CNS pathology and to assist treatment planning, delivery and follow up. A unique focus is the use of novel methods to provide information that augments conventional brain image data. This permits better appreciation of the relationships among brain activation patterns, a site of operable pathology and the potential impact of invasive treatment on the patient's vision capacities/deficits.

**Materials and Methods**

A complete clinical workflow used at Froedtert Hospital/Medical College of Wisconsin and collaborating institutions for guiding surgical treatment of brain tumors, arteriovenous malformations and epilepsy is reviewed. Unique features of data acquisition, analysis and display are highlighted including the integration of neuroimaging and behavioral data into Functional Field Maps (FFMaps). FFMaps display brain activation patterns in the format of visual field maps highlighting the relationships between brain activation and visual sensation, and permitting presurgical estimation of potential postsurgical vision deficits. Case studies illustrating the advantages of this approach are reviewed.

**Results**

Functional MRI and DTI mapping of vision-related brain structures for clinical use requires interpretation of the imaging data in terms of the diagnostic/treatment goals and the patient's existing and post-treatment visual abilities, taking into account potential deficits that may be caused by the treatment procedures themselves. A substantial loss of portions of a patient's visual field may be acceptable in cases of life threatening illness though, even then, preserving critical foveal vision may be possible. However, when brain tissue is distorted due to tumor mass effects,
physical malformation or previous injury/surgery, then identification of eloquent tissue may be
difficult or impossible without fMRI mapping. Moreover, individual variation in the size of
primary and extrastriate visual areas and their positions relative to sulcal or gyral landmarks can
be considerable and avoidance of postoperative deficits may depend on careful surgical resection
to within millimeters of key structures. The occurrence of debilitating visual agnosias such as
prosopagnosia, alexia and akinetopsia are associated with lesions of specific extrastriate visual
areas whose locations or functionality are difficult to define for individual patients without
functional imaging. It also is becoming apparent that, without fMRI, it may not be possible to
fully diagnose/differentiate certain vision pathologies such as attention-related visual neglect
versus sensory field loss, and this can have important consequences for surgical planning and
outcomes.

Conclusions
Together, fMRI, DTI and behavioral tests can map visual system pathways and their 3-
dimensional configuration relative to a site of operable brain pathology. Yet, there is a significant
gap between the complexity and sophistication of the information that neuroimaging can provide
and its clinical use in comparably sophisticated ways. To maximally benefit patients, this
advanced knowledge must be conveyed to physicians at the forefront of daily medical practice.

KEYWORDS: Brain, Neoplasm, Treatment Assessment

EdE-22
6:30AM - 9:00PM

Age-Based Approach to Pineal Region/Gland Lesions with Follow-Up Recommendations

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Purpose
Pineal gland lesions commonly are identified on brain imaging, with 25\% of normal human
subjects having an incidental pineal cyst and up to 40\% identified histologically at autopsy. The
diagnostic dilemma for the radiologist is to determine which patients need imaging of the entire
neuroaxis or continued follow up, with the purpose of avoiding unnecessary diagnostic imaging
and invasive testing. Pineal lesions are categorically presented by age of presentation, as specific
etiologies are clustered around different ages.

Materials and Methods
Malignant and benign lesions arising from the pineal region and gland are presented by patient
age, 0-10 years, 10-20 years, and greater than 20 years. Teaching points include key histological,
pathological, and imaging differences and similarities between the lesions. Information is
presented in pictorial format with lesions discussed individually, separated by age and
characteristics. Comparisons then are made between lesions to reinforce similarities and
differences to help the clinician narrow their differential diagnosis. The etiology,
pathophysiology, key characteristics and imaging findings, and clinical management are
included. Special emphasis is placed on management of benign pineal cysts by summarizing
recently published long-term epidemiological studies.

Results
The broad spectrum of pineal lesions will be presented by age and tissue of origin, with CT
and/or MR imaging (MRI) case examples. Lesions presenting in the 0-10 age group include pineoblastoma, trilateral retinoblastoma, germ cell tumors (germinoma, choriocarcinoma, teratoma, embryonal, and yolk sac), vein of Galen aneurysm/AVM, papillary tumor, pineal parenchymal tumor of intermediate differentiation (PPTID), lipoma, tectal glioma, and dermoid. Lesions presenting in the 10-20 age group include pineal cyst, germ cell tumors, papillary tumor, PPTID, lipoma and dermoid cyst (congenital). Lesions presenting in the 20 year old and beyond group include pineal cyst, meningioma, pineocytoma, papillary tumor, PPTID, metastatic disease, lipoma and epidermoid (congenital).

Conclusions
Pineal region and gland lesions represent a challenging group of lesions for the diagnostic radiologist. Understanding the key histologic differences and imaging characteristics is invaluable for differentiating benign from malignant lesions. Increasing the specificity of the differential diagnosis and providing the referring provider appropriate management recommendations is of utmost importance. Accurate identification of pineal lesions allows for entire imaging of the neuroaxis to be recommended for or against. Awareness of results of long-term robust studies can allow for radiologists to justify recommending against follow up for pineal cystic lesions up to 2 cm in size.

KEYWORDS: Pineal Gland
Pineal Germinoma

![Image](TCT_EdE-22_PinealGerminoma.jpg)

Heterogeneously enhancing 3.7 cm lobulated mass projects into the left lateral ventricle and 3rd ventricle with cerebellar mass effect. TIWI pre (left) and post contrast (right).

- **Etiology**
  - Male >>> Female. 90% in the first 2 decades of life. Majority in pineal region vs. suprasellar (3rd ventricle).
  - Derive from ectopic rests, transformation of nascent germ cells, or late migration.
- **Pathophysiology - MALIGNANT**
  - Histology resembles ovarian dysgerminoma & testicular seminoma. Large pleomorphic nuclei.
  - Well circumscribed. Solid ± cystic components.
  - No capsule- can be locally invasive! CSF dissemination is possible – evaluate entire neuroaxis!
  - ± syncytiotrophoblastic cells (14%) - more likely to secrete hCG.
- **Imaging characteristics**
  - CT: Hyperattenuation due to hypercellularity. Engulfs pineal calcifications. 100% calcified.
  - T1WI: iso- to hyperintense to gray matter
  - T2WI: iso- to hyperintense to gray matter
  - Enhancement on post contrast images
  - DWI: restricted diffusion due to hypercellularity
- **Management**
  - Biopsy with immunostaining. Sensitive to chemotherapy and radiation.
  - Prognosis 75-95% 5-10 year survival. Syncytiotrophoblastic types have poorer prognosis.

(Filename: TCT_EdE-22_PinealGerminoma.jpg)

**EdE-14**

6:30AM - 9:00PM

**Cerebral Venous Thrombosis: State of the Art Diagnosis and Management**

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**Purpose**

The purpose of this educational exhibit is to review the pathophysiology, clinical presentation, and neuroimaging of cerebral venous thrombosis (CVT). Different approaches for diagnosis of CVT including CT, MRI, US, and DSA will be discussed and the reader will become acquainted with imaging findings as well as limitations of each modality. Lastly, this exhibit will review the standard of care for CVT treatment including the use of neurorventional procedures.
Materials and Methods
The exhibit will consist of a basic overview of cerebral venous anatomy and pathophysiology, clinical presentation of CVT, and imaging findings suggestive of CVT on nonenhanced head CT (NECT). Thereafter, advanced imaging of CVT with CT venography as well as MRI/MRV will be discussed providing a comparative discussion of strengths and pitfalls of each modality. The use of US in the pediatric population will be discussed briefly. This will be followed by an overview of treatment options for CVT, including neurointerventional techniques, with cases illustrating reversibility of brain abnormalities after successful treatment.

Results
The presentation of CVT is often nonspecific, and requires a high index of clinical suspicion. The radiologist plays a key role by recognizing potential signs and patterns suggestive of CVT on NECT and confirming the diagnosis using more advanced neuroimaging techniques. Signs of CVT on NECT can be divided into indirect signs (edema, parenchymal hemorrhage in certain patterns and locations, subarachnoid hemorrhage, and rarely subdural hematomas) and less commonly direct signs (visualization of dense thrombus within a vein or cord sign, or within the cerebral venous sinuses such as dense triangle sign in the superior sagittal sinus). Confirmation is performed with CTV, directly demonstrating the thrombus as a filling defect, or MRI/MRV, which also provides superior characterization of parenchymal abnormalities. However, one must be familiar with pitfalls of each technique (e.g., variable density of thrombus on CT depending on thrombus age) and ancillary MRI sequences helpful for detection and confirmation of thrombi which will be discussed using case examples. General pitfalls and anatomical variants including hypoplastic sinus, bifid sinus, and arachnoid granulations as well as MR artifacts mimicking thrombus also will be discussed. Lastly, treatment algorithms including indications for the use of catheter-directed thrombolysis or thrombectomy in select cases will be reviewed.

Conclusions
Cerebral venous thrombosis (CVT) is a relatively uncommon phenomenon, and frequently overlooked at initial presentation. Familiarity with imaging features and diagnostic workup of CVT will help in providing timely diagnosis and therapy which can significantly improve outcome and diminish the risk of acute and long-term complications, optimizing patient care.

KEYWORDS: Stroke, Venous Anatomy, Venous Sinus Thrombosis
Classification of Glial Tumors in the Deep White Matter and Corpus Callosum

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Purpose
To match the contrast enhancement pattern of gliomas of corpus callosum and deep white matter with the deep medullary vein territories defined by venous susceptibility maps.

Materials and Methods
One thousand untreated gliomas of the cerebral hemispheres were reviewed retrospectively. This sample contained seven primary enhancing gliomas in the corpus callosum and 50 deep white matter enhancing gliomas which touched to the lateral ventricular walls. The latter group included four un-operated cases with serial imaging of the enhancement pattern. The tumors were sorted into seven deep medullary venous territories each of which eventually drains into vein of Galen. These territories were defined by using previously published postmortem venography and ten normal venous susceptibility maps as the gold standard.

Results
Contrast-enhanced MR imaging of gliomas of the deep white matter and corpus callosum demonstrated pathognomonic intratumoral venous thrombosis and dilation of the normally invisible deep medullary veins due to intratumoral capillary shunting. Shape and location of enhancing gliomas in the deep white matter and corpus callosum matched seven deep venous territories: 1. the septal which drains the corpus callosum and frontal pole (BA 10), 2. the thalamostriate (terminal) vein which drains the upper part of the basal ganglia and the white matter of the posterior frontal and the anterior parietal lobes, 3. the anterior cerebral vein drains the undersurface of the rostrum of the corpus callosum and the adjacent orbitofrontal gyri (BA11), 4. the dorsal callosal vein drains the splenium and adjacent cingulate gyrus, 5. the basal vein of Rosenthal drains the medial and inferior parts of the occipital and temporal lobe and the insula, 6. the inferior ventricular vein of temporal horn drains the lateral part of the anterior temporal lobe and 7. the veins of occipital horn drain the lateral part of the posterior temporal lobe and the occipital lobe). In addition, there were three cases of internal radial patterns consistent with classic appearance of the deep white matter venous convergence arcs as defined by postmortem venography. The enhancement pattern in the corpus callosum included the adjacent cingulate cortex which was consistent with the territory of the paired septal veins which drain the corpus callosum through the roofs of the lateral ventricles. The previously documented dilatation of the valveless medullary veins in the normal white matter surrounding gliomas was seen in tumors. Case 1: Glioblastoma in septal venous territory. Sagittal and companion coronal postcontrast T1-weighted imaging demonstrates enhancement in the corpus callosum and adjoining left medial cerebral hemisphere. Capillary shunting within the tumor enlarges the deep medullary veins.

Conclusions
Contrast enhancement of gliomas in the corpus callosum and deep white matter can be used to
assign tumors to one of seven venous territories thereby providing a much needed classification which can stratify patients for clinical trials and genetic mapping.

KEYWORDS: Corpus Callosum, Glioma

EdE-19

Clinical Applications of Dynamic Contrast-Enhanced Magnetic Resonance Imaging Permeability in Brain Tumors

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Purpose
Permeability of blood vessels in brain tumors provides valuable information about blood-brain barrier (BBB) integrity, vascular morphology, nature of neovascularization, and tumor pathophysiology, and prognosis. Here we discuss the clinical applications of T1-weighted dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) permeability in brain tumors.

Materials and Methods
The most widely applied and accepted MR technique for permeability evaluation is DCE-MRI. During T1-weighted DCE-MRI, contrast agent accumulation results in T1-shortening and positive enhancement. Through pharmacokinetic modeling of contrast agent accumulation into the extravascular-extracellular space (EES), a number of parameters can be determined including: transfer constant (Ktrans or vascular permeability) that is a combination of capillary wall permeability surface area product per unit volume of tissue (PS) and capillary blood flow.
volume of the EES (Ve) and fractional blood-plasma volume (Vp). We use a dedicated T1-weighted DCE sequence as part of our standard protocol for assessment of intracranial mass lesions. All studies were performed on 1.5T and 3.0T MR systems and automated postprocessing was performed on a Versavue server® (iCad, Nashua, NH). Regions of interest (ROIs) were manually delineated avoiding areas of necrosis or hemorrhage and the higher values of Ktrans, Ve and Vp were considered for our study.

Results
Ktrans in metastases was higher than in glioblastoma (GB), however higher Ve was found in GB probably related to a higher degree of neovascularization. In contrast to GB, neovascularization was absent in primary central nervous system lymphoma which tended to have relatively low perfusion and permeability compared with GB. We found that permeability Ktrans was able to discriminate low- from high-grade gliomas, probably related to presence of immature and permeable vessels in high-grade gliomas. Differentiation between GB and abscess was also possible. In our study GB had higher perfusion and lower Ktrans compared to abscess. Radiation necrosis showed decreased perfusion and Ktrans with a very slow rate of enhancement whereas tumor recurrence resulted in high perfusion and permeability. Patients on antiangiogenic therapeutic such as thalidomide and bevacizumab demonstrated decrease in the enhancing volume, perfusion, and vascular permeability as a response to treatment.

Conclusions
Current clinical applications of DCE-MRI microvascular permeability in brain tumors include differential diagnosis, tumor grading, and therapeutic monitoring.

KEYWORDS: Brain Metastases, Brain Neoplasms, Permeability MR Imaging

EdE-11

Common and Uncommon Encephalitis Syndromes: Imaging Findings and Differential Diagnosis

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Purpose
Imaging evaluation of patients presenting with encephalopathy syndromes can be challenging because of variable clinical presentation, patient's inability to provide a reliable history, and wide range of potential abnormalities seen on neuroimaging. However, there are key features and patterns on imaging that can help suggest and in certain cases diagnose the specific entity. As such, the radiologist plays an essential role in appropriate diagnosis and management of these patients. The objective of this pictorial essay is to provide an overview of imaging features and patterns encountered in the more common and uncommon but important encephalitis syndromes and differential diagnoses.
Materials and Methods
To provide an overview of (1) general imaging findings and patterns suggesting an encephalopathy syndrome with particular focus on MRI, and (2) to review specific examples of relatively common and uncommon infectious, metabolic, toxic and miscellaneous encephalitis syndromes with case-based differential diagnoses. The exhibit will include infectious etiologies: herpes simplex encephalitis, acute necrotizing encephalitis, acute disseminated encephalomyelitis, progressive multifocal leukoencephalopathy; Prion disease: Creutzfeldt-Jacob disease; metabolic and toxic syndromes: posterior reversible encephalopathy syndrome, osmotic myelinolysis syndrome, Wernicke's encephalopathy, hypoglycemic encephalopathy, drug-induced toxic leukoencephalopathy, metronidazole-induced encephalopathy; and miscellaneous and rare entities such as Cree encephalitis. Important variants of same disease (for example, hemorrhagic herpes encephalitis mimicking subarachnoid hemorrhage), and differential diagnoses (for example for herpes simplex encephalitis: PCA territory infarct, limbic encephalitis, astrocytoma involving the medial temporal lobe) will be illustrated and discussed.

Results
MR imaging (MRI) is the mainstay modality for characterization and diagnosis of encephalopathy syndromes. On MR imaging, T2/FLAIR, diffusion-weighted images (DWI), and occasionally contrast-enhanced images are the key sequences used for characterization and diagnosis. Encephalitis syndromes are characterized by different patterns of abnormal hyperintensity on T2 and FLAIR images depending on the specific pathology. Diffusion-weighted imaging (DWI) is important for distinction of vasogenic edema from cytotoxic edema and occasionally the abnormalities may be more evident on DWI than T2 or FLAIR images. The first step in recognition of an encephalitis syndrome is to distinguish the abnormalities from incidental nonspecific white matter changes and large or small vessel ischemic infarction. Some clues for distinction from the latter are (1) abnormality may not correspond to a typical vascular distribution, (2) mixed diffusion characteristics within a small area or between the cortex and subcortical white matter, (3) mass effect, earlier than would be expected with an acute stroke, (4) abnormalities may be partially reversible, (5) presence of normal or increased perfusion, and (6) occasionally gyral or leptomeningeal enhancement earlier than would be expected for an acute infarct. If focal, these must be distinguished from intracranial masses and venous thrombosis. As is often the case, a concise and proper clinical evaluation often can help narrow and focus the differential diagnosis. Specific examples of encephalitis syndromes, as outlined above, important variants, and their differential diagnoses will be illustrated and discussed.

Conclusions
Encephalitis syndromes can have complex and variable presentations. This exhibit will provide an overview of the more common and uncommon encephalitis syndromes and their differential diagnoses and mimics. Familiarity with the imaging patterns of these syndromes will help early recognition of these important entities and optimize patient management.

KEYWORDS: Encephalitis, Encephalopathy

EdE-04

Demystifying the Subcortical U-Fibers: Spectrum of their Neuroimaging Findings with Reference to Underlying Mechanisms of White Matter Disease
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Purpose
U-fibers are white matter short association fibers connecting cerebral cortex of a particular region with that of adjacent gyri, thus forming discrete U-shaped bands immediately below the sixth (multiform) cortical layer. In neuroradiologic interpretation, the involvement of subcortical U-fibers by white matter pathologic processes, or their sparing, is an important feature in the imaging differential diagnosis of both inherited leukencephalopathies and acquired white matter diseases. In the current neuroradiologic literature there is, however, scant explanation of potential mechanisms of this differential involvement. It would be highly pertinent and useful for neuroradiologists to be familiar with these theories for better understanding of imaging findings and their significance when encountering U-fiber abnormalities.

Materials and Methods
We review the available data on mechanisms that underpin the involvement of U-fibers in pathologic processes in adjacent white matter, or their relative resistance to these perturbations. We present neuroimaging patterns of diseases typically involving or sparing the U-fibers, with neuropathologic microscopic correlation.

Results
There is evidence that U-fibers are the slowest myelinating fibers in the central nervous systems with myelination extending well into adulthood. Therefore, diseases that affect myelin degradation and recycling (turnover) rather than myelin synthesis tend to spare the U-fibers in which myelin turnover is very slow. Inherited metabolic defects of this kind include metachromatic leukodystrophy (MLD), globoid cell leukodystrophy (Krabbe's disease), and X-linked adrenoleukodystrophy. In contrast, in diseases affecting myelin synthesis or in which there is toxic damage to myelin, U-fibers are equally vulnerable as the remaining white matter (for example in Canavan, Alexander, van Der Knapp, or Pelizaeus-Merzbacher diseases). Mechanisms of toxic damage to myelin also probably apply to acquired demyelinating disorders such as multiple sclerosis, some cases of acute disseminated encephalomyelitis (ADEM) or progressive multifocal leukoencephalopathy (PML). Similarly, U-fibers are affected in cerebral amyloid inflammatory vasculopathy (CAIV) in which there is a combination of vasculopathy and inflammation, in keeping with the observation of their involvement in other inflammatory processes. Conversely, sparing of U-fibers by most arterial diseases may be explained by the microvascular architecture of the cortico-medullary junction. In addition to long penetrating medullary vessels, short pial vessels supply the interface of the white matter and the adjacent cortex. Thus, U-fibers are typically spared by white matter lesions caused by small vessel disease, CADASIL, and cerebral amyloid angiopathy (CAA). This double vascular supply may also explain U-fiber sparing in carbon monoxide poisoning and delayed hypoxic encephalopathy (Grinker myelinopathy), as well as their preservation in venous infarction due to dural sinus occlusion.

Conclusions
Resistance of U-fibers to pathological process in adjacent white matter may depend on different myelination rates and the vascular microarchitecture of the gray-white matter interface. U-fibers are, however, equally vulnerable to processes affecting myelin directly. This pictorial and
educational display will clarify the several possible underlying mechanisms of involvement of U-fibers in white matter diseases and the resulting neuroimaging findings.

KEYWORDS: Leukodystrophy, White Matter Tracts

EdE-23

From Baseball to the OR

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Purpose
To explore the implications of a commonly encountered phenomenon in presurgical mapping of brain tumors using advanced imaging, mainly diffusion tensor imaging (DTI).

Materials and Methods
The "ball-in-glove" configuration of brain tumor and white matter fibers is presented using illustrations as well as images from clinical presurgical brain mapping studies. Discussion of presurgical DTI interpretation in the setting of clinical cases introduces and reinforces concepts of common yet critical functional systems. Implications of the "ball-in-glove" configuration and presurgical DTI for the neurosurgeon then are explored through examination of preoperative considerations, intraoperative techniques and assessments, and postoperative outcomes. Intraoperative photographs and postoperative imaging from clinical cases are used.

Results
The recently described "ball-in-glove" configuration in presurgical brain mapping commonly is encountered. The majority of presurgical brain mapping cases are performed for gliomas, white matter-based lesions. Because gliomas often are round, they tend to displace tracts about their periphery. The configuration is similar to a baseball within a glove, with the lesion mimicking the ball and the white matter tracts mimicking the palm and finger extensions of a baseball glove. This visualization can help the neurosurgeon, especially if specific tract border designations are described. An accurate description and visualization of high risk lesion borders will impact surgical planning as well as intraoperative assessments, allowing the neurosurgeon to test specific functions as the tumor is dissected along specific borders. This approach results in improved postoperative outcomes, maximized tumor resection and minimized postsurgical deficits.

Conclusions
Presurgical brain mapping for tumors has had a profound impact on patients. Diffusion tensor imaging has been critical in this process as it allows the neurosurgeon a better understanding of surgical risks and also how to avoid postoperative deficits. It is vital for the neuroradiologist to understand the commonly encountered "ball-in-glove" configuration and how to approach it during DTI interpretation.

KEYWORDS: DTI, Functional Brain Mapping, Functional Networks

EdE-07

6:30AM - 9:00PM
From Bench to Bedside: Inclusion of Magnetization-Transfer-Imaging into Routine MR Imaging in Multiple Sclerosis: Can Patient Management Benefit from Consecutive Monitoring of the Magnetization-Transfer-Ratio?

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Purpose
When judging longitudinal MR imaging in multiple sclerosis (MS) beyond counting lesions and gadolinium enhancement, markers of myelin integrity are of additional value. As all applicable methods are considered costly in terms of scan time and postprocessing facilities, our aim was to test whether or not a routine approach in everyday conditions is at all feasible and beneficial for practical disease monitoring.

Materials and Methods
Based upon a neurological out-patient practice with a 1.5 T "workhorse" (Philips Intera-Achieva) we took an old-fashioned approach using Magnetization Transfer (MT): A PDW SE sequence before and after an off-resonance MT pulse (TR = 1710 ms, TE = 30 ms, NSA = 1, scan time 3:09 min) was added to our standard MS protocol, thus routinely providing both additional PDW image information and the opportunity for gathering data on myelin integrity in all patients and disease stages. We used the FDA approved software package nordicICE® for image segmentation, calculation of the Magnetization-Transfer-Ratio (MTR) and consecutive MTR histograms of the whole brain as well as FLAIR and gadolinium enhancing lesions. Statistical analysis was performed with STATA 12 using tests for (i) differences in mean MTR (ANOVA) and (ii) equality of distributions (Kolmogorov-Smirnov and Mann-Whitney tests).

Results
Our still ongoing (by its nature retrospective) study covers approximately 1200 patient years, and the longitudinal MTR registration proves to be valuable in monitoring disease activity of MS. We present as a "pars pro toto" three examples with the specific results of consecutive MTR monitoring and the corresponding MR images in (i) early failure of first line and following success of escalation therapy in aggressive tumefactive MS, (ii) development and course of Natalizumab associated progressive multifocal leukoencephalopathy in relapsing-remitting MS (RRMS), and (iii) patient surveillance in RRMS after therapy discontinuation on patient's request facing bothersome side effects of interferon treatment. During the monitoring period over up to 4 years, all presented cases showed gradual and significant (p<0.0001) changes in mean MTR and shifts of MTR histograms respectively. These always did precede the relevant clinical events - both to the worse and the better, and in our Natalizumab associated PML case even several months!

Conclusions
Longitudinal databases for consecutive monitoring of the MTR can be created for individual MS patients with reasonable effort, and the technique seems suitable for routine MR imaging procedures. Concerning scan time, addition of a PDW sequence before and after an off-resonance MT pulse (3:09 min @ 1.5 T) should be feasible in any clinical environment. The method itself is robust and reliable, and it seems valuable in predicting both lurking danger and trends to the better during the course of the disease. It thus can contribute to an improved clinical surveillance of MS patients and risk assessment of MS therapy. Limitations definitely arise from
the retrospective character of our still ongoing study and from restricted manpower for
postprocessing in a routine clinical setting without research funds. Vendors should make efforts
to incorporate "push-button" MTR procedures in their user interfaces; national societies should
develop and negotiate reimbursement schemes.

KEYWORDS: Magnetization Transfer Imaging, Multiple Sclerosis

EdE-08

Half-a-Dozen Reasons to Map the Motor Cortex Presurgically

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Purpose
To demonstrate vital applications of presurgical fMRI localization of motor cortex, beyond that
afforded by anatomical landmarks.

Materials and Methods
Six distinct applications of presurgical fMRI localization of motor cortex are presented, and
illustrated with clinical cases. Critical clinical questions answered by presurgical fMRI as well as
postsurgical outcomes are reported. Functional MRI paradigms and strategies to localize the
motor cortex in a variety of clinical settings where anatomical landmarks alone are insufficient
are discussed. Adverse consequences associated with failure to map the motor cortex are
demonstrated and discussed as well.

Results
The precentral gyrus and motor cortex can be localized with sulcal and gyral landmarks in the
vast majority of patients without the need for presurgical mapping. Some practitioners believe
that motor fMRI is altogether unnecessary. However, there are critical circumstances requiring
presurgical mapping of the motor cortex, where anatomical landmarks are insufficient to answer
clinical questions that may impact surgical decision-making. Applications include multiplanar
localization, lesion-induced distortion of anatomical landmarks, homunculus localization,
congenital brain anomalies, informing DTI interpretations, and localization of nonvisible targets.
Preoperative and intraoperative surgical decision-making can be impacted by presurgical motor
mapping. This includes resectability, surgical trajectory, establishing functional resection
boundaries, and surgical target localization.

Conclusions
Presurgical mapping of the motor cortex is a vital service in institutions where perirolandic
surgeries are performed. Neuroradiologists should be versed in motor mapping to support
neurosurgical services and minimize postoperative motor deficits.

KEYWORDS: FMRI, Motor Cortex

EdE-10

High Resolution Black Blood Imaging of Atherosclerotic Disease in the Carotid Bulb
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Purpose
Atherosclerotic disease of the carotid bulb is a major cause of morbidity and mortality in the form of stroke. Current treatment guidelines are based on NASCET type carotid bulb stenosis. Black blood imaging has developed into a major tool in the characterization of diseases that affect the vessel wall. This exhibit will describe the imaging characteristics of carotid bulb atherosclerotic disease as depicted by black blood MRI.

Materials and Methods

Results
Black blood imaging is able to detect complicated atherosclerotic plaques of the carotid bulb which have an increased risk of stroke. This may be used in the future as a surrogate marker to decide for more aggressive medical or even surgical management.

Conclusions
The objective of this exhibit is to depict how atherosclerotic plaques of the carotid bulb can be characterized using high resolution black blood MRI.

KEYWORDS: Atherosclerosis, Black-Blood Technique, Black-Blood Vessel Wall

EdE-12

Hypertrophic Olivary Degeneration: Anatomy and Imaging

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Purpose
The aim of this presentation is to provide a comprehensive review of hypertrophic olivary degeneration (HOD) through correlation of the normal anatomy with imaging abnormalities detected on MR imaging.

Materials and Methods
We describe, explain and illustrate the spectrum of imaging abnormalities encountered in HOD.

Results
Hypertrophic olivary degeneration is a rare entity and a form of trans-synaptic degeneration resulting from an insult to the triangle of Guillain and Mollaret. This pathway connects the dentate nucleus of the cerebellum, the red nucleus of the midbrain and the inferior olivary nucleus of the medulla. Using different diagrammatic illustrations and MR images (MRI), we will explain the relationship between the primary lesion and the resulting radiological appearances. We also include the three distinct MRI stages encountered in HOD.

Conclusions
It is important for radiology residents to recognize the imaging features and patterns of HOD.
This exhibit provides a detailed review of the imaging features with emphasis on the normal anatomy of the Guillian and Mollaret triangle.

KEYWORDS: Adult Brain, Degenerative, Olivary Degeneration

EdE-29

Imaging of Penetrating Traumatic Brain Injuries - Providing Added Value in Emergency Evaluation

J Johnson1, B Millard-Hasting2, G Punch3, S Stalcup4, M Huang3, J Romero4, J Talbott3
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Purpose
Penetrating wounds of the brain represent a small but significant segment of traumatic brain injuries seen in both civilian and in military settings. Both clinical treatment and imaging paradigms require unique considerations beyond algorithms used in blunt traumatic brain injuries. Purpose: 1. To review types of penetrating traumatic brain injuries along with pathophysiological considerations. 2. To illustrate the imaging findings in a variety of penetrating head injury mechanisms. 3. To discuss imaging and interpretation strategies focused on optimizing clinical decision making in the emergency and sub-acute setting.

Materials and Methods
Subcategories of penetrating head trauma will be reviewed using selected cases along with original medical illustrations. Imaging anatomy of the various pathophysiology of injury will be reviewed. Illustrated cases of the various patterns of injury will be reviewed using different imaging algorithms to demonstrate goal-oriented imaging evaluation.

Results
Penetrating head trauma represents a small proportion of the overall traumatic brain injury population; however, it is a unique clinical population with potential for high morbidity and mortality and requires unique considerations compared to the more common blunt head injury. This exhibit reviews the types of penetrating head injury using various imaging strategies focused on goal-oriented interpretation schemes.

Conclusions
After reviewing this exhibit, the reader will be familiar with the subtypes of penetrating head wounds and pathophysiologic considerations for these types of traumatic brain injuries. The imaging features and strategies for a broad spectrum of penetrating wounds are reviewed and discussed in the context of optimizing imaging strategies to assist in optimal clinical decision making.

KEYWORDS: Penetrating, TBI, Traumatic Brain Injury

EdE-16

6:30AM - 9:00PM
Intracranial Contrast Extravasation during CT Angiography in Acute Trauma Settings: A Pictorial Presentation

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Purpose
Recent reports have indicated that intracranial contrast extravasation during CT angiography (CTA) predict poor outcome and prognosis. The purpose of this presentation is to demonstrate different types of intracranial contrast extravasations.

Materials and Methods
From our clinical data we identified trauma patients with intracranial contrast extravasation on CTA. We present cases that demonstrate different type of hematomas in which contrast extravasation was present with technical and practical tips.

Results
We present intracranial contrast extravasation into epidural hematoma, subdural hematoma, hemorrhagic contusion and parenchymal hematoma. Setting an appropriate window level and scrutiny of the hematoma site are essential for correct identification of intracranial contrast extravasation. In some cases, hematoma growth can be depicted between noncontrast head CT and CTA.

Conclusions
Intracranial contrast extravasation can be detected during CTA in acute trauma settings. This imaging finding has significant clinical implications for patient care and Neuroradiologists should be familiar with it.

KEYWORDS: Contrast Extravasation, CT Angiogram, Traumatic Brain Injury

EdE-06

Intracranial Findings in Patients with IgG4-Related Disease

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Purpose
Manifestations of IgG4-related disease have been reported in nearly every organ system. The purpose of this education exhibit is to describe imaging features seen in several patients with intracranial manifestations of IgG4-related disease.

Materials and Methods
In this series, we identified four patients with biopsy proven IgG4-related disease of the head and neck and intracranial involvement by imaging. Patient 1 is a 66-year-old female who presented to our Neurology department for further evaluation after an abnormal MRI of the head, performed elsewhere, for left-sided facial and ear pain. The patient has since been treated with steroids and rituximab, with resolution of her symptoms. Patient 2 is a 42-year-old female who presented to our Hematology department for "orbital pseudotumor." Her initial workup began secondary to a right-sided headache, intermittent right orbital swelling, and diplopia. The patient
was treated initially with steroids, and now has been transitioned to rituximab. Her symptoms have resolved. Patient 3 is an 82-year-old male who presented to our Endocrinology department for evaluation of proptosis. He was treated with steroids for several years, and then transitioned to rituximab. His proptosis has resolved. Patient 4 presented to our Hematology department in 1998 with proptosis. Steroids, rituximab, and radiation provided no symptom relief. He passed away in 2013 at the age of 52 secondary to end stage liver disease.

Results
Patient 1's initial MRI demonstrated dural thickening and enhancement centered at the left tentorium. The most recent MRI examination demonstrated moderate decrease in these findings. Patient 2's initial MRI demonstrated an enhancing mass in the right cavernous sinus. This had resolved on the most recent MRI. Patient 3's initial CT and MRI examinations demonstrated enhancing masses involving the bilateral cavernous sinuses and anterior Meckel's caves. Intracranial disease had resolved on the most recent CT. Patient 4's initial MRI demonstrated an enhancing mass involving the anterior right cavernous sinus. This lesion progressed after several years. A new enhancing mass was seen in the left cavernous sinus on subsequent examinations.

Conclusions
Intracranial involvement in IgG4-related disease can present in varying locations. In this small series, three of four patients presented with masses in the cavernous sinus, one of which extended to Meckel's caves. One of four patients presented with dural thickening and enhancement. The neuroradiologist should be aware of intracranial IgG4-disease, and include it in the differential diagnosis for these findings when appropriate.

KEYWORDS: IgG4 Related Disease
Magnetic Resonance Spectroscopy Patterns in Adult Intra-Axial Brain Tumors

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Purpose
Magnetic resonance imaging (MRI) is the best diagnostic tool in patients with central nervous system tumors with an excellent yield and cost/benefits ratio being consider as the gold standard for diagnosis and follow up. Conventional sequences (T1, T2 and FLAIR) and the use of paramagnetic contrast agents allow a precise diagnosis and detailed analysis in most cases, with
great anatomical resolution and real impact in initial therapeutic approach. In the last years we face various technologic advances in tumor diagnosis and treatment and it is a necessary multidisciplinary approach of the affected patient, where the radiologist plays a key role. At the present time MRI allows morphologic study and functional analysis of tumors using different techniques like diffusion, perfusion and magnetic resonance spectroscopy (MRS). MR spectroscopy is an imaging technique that allows to obtain noninvasive metabolic mapping of brain lesions with an excellent performance in patients with brain tumors. MR spectroscopy allows not only to mainly establish a more precise diagnosis of tumor kind, but in addition to evaluate regional extension, discard alternative diagnoses and a complete post-therapeutic evaluation and follow up. Our goal was to evaluate the contributions of MRS in central nervous system tumors and the main metabolic patterns in most frequent primary and secondary tumors in adult population.

Materials and Methods
To achieve our goal we analyzed the magnetic resonance images obtain in 300 patients over five years (2008-2013), with initial diagnosis of tumor, in which conventional MRI and MRS were acquired. MR spectroscopy were obtained in a closed field 1.5 T MRI unit, using PRESS technique, with both monovoxel lecture, TE 35 ms, and 2D or 3D multivoxel acquisition, TE 144 ms. In multivoxel acquisition tumoral and peritumoral areas were included. The authors performed a spectrum analysis with special attention to levels of n-acetyl-aspartate (NAA), choline (Ch), creatine (Cr), myo-inositol (mI) and lipids/lactate (Lip/Lac) in comparison with the same levels in the normal parenchyma contralateral to the lesion in each particular patient. Metabolic ratios of Ch/NAA, Ch/Cr, mI/Cr and Cr/NAA obtained in the lesion were analyzed and compared with the values of contralateral normal parenchyma and peritumoral areas. The MR images and radiologic initial diagnosis were compared with histological findings and definitive diagnosis. From the analysis we found five metabolic patterns in the most frequent adult brain tumors including primary and secondary lesions. We describe these patterns finding in each different tumor kind trying to establish the global MRS contributions to brain tumor diagnosis and initial therapeutic approach.

Results
From the analysis of the metabolic patterns obtained we found an excellent correlation with definitive histological diagnosis in nearly 98% of the patients, suggesting tumor histology and grade. Those metabolic patterns were divided into five main groups: nontumoral lesions, low grade glioma, high grade glioma, primary central nervous system lymphoma and brain metastasis with characteristic peaks and metabolite ratios in comparison with normal brain parenchyma and lesions from other group. Nontumoral lesions show normal NAA and Ch peaks, with normal ratios or under tumoral values, without Lip/Lac in almost all cases. Low grade gliomas show two patterns: pseudonormal with normal NAA and Ch peaks, and tumoral pattern with mI in those from astrocytic origin, and normal or high mI/Cr ratios. High grade gliomas showed a typical pattern: high levels of Ch, low NAA with ratios very high and Lip/Lac in those lesions with necrosis and lower mI/Cr ratio. A very suggestive finding was the presence of a definite tumoral pattern in the peritumoral area. Primary central nervous system lymphoma was a diagnostic dilemma with a typical tumoral pattern, with high levels of lipids and lactate in a solid tumor. All last secondary brain tumors show a typical tumoral spectra with normal appearance metabolic pattern in the peritumoral area. All of these patterns show an excellent correlation with definitive diagnosis with high levels of sensitivity and specificity, 90-95% varying with each group. MR spectroscopy is a MRI technique which provides semiquantitative information of metabolic
composition as a different area of normal and abnormal brain tissue. In most cases measurement of pathological area allows to differentiate between tumoral and nontumoral lesions, evaluate tumor grade in different nature and different areas of the same lesion, metabolic composition of adjacent normal appearing brain and evaluate the evolution of lesions and normal brain.

Conclusions
The use of MRS in brain tumors has been clearly proved, showing a great metabolic heterogeneity among different tumors. It allows characterization of tumors with high sensitivity and good rates of specificity being consider an excellent noninvasive preoperative diagnostic tool in predicting tumor histology and grade.

KEYWORDS: Brain Neoplasms, Glioma, MR Spectroscopy

EdE-03

Molecular Neuroimaging of Brain Tumors Using Nanoparticles: A Pictorial and Educational Review of Basic Principles and Current Applications

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Purpose
Despite advancements in surgery, radiotherapy, and chemotherapy, the survival rate for patients with glioblastoma remains poor. Difficulty in identifying tumor margins and tumor dissemination remain major obstacles for successful treatment of these brain tumors. Contrast agents that could improve anatomical, functional, and molecular neuroimaging are critical for better pre-operative tumor delineation and postoperative therapy monitoring. In this exhibit, we present an overview of the basic principles of nanoparticles as source of image contrast and discuss various platforms that show promise in brain tumor imaging.

Materials and Methods
Nanoparticles with their characteristic size, shape and surface functionality offer a new paradigm for enhancing the selectivity and sensitivity of imaging modalities. Though there is no universal definition for nanoparticles, optimal brain tumor imaging favors particles <200 nm in size. Nanoparticles are classified as organic (liposomes, polymers, dendrimers, etc.) or inorganic (metallic nanoparticles, etc.) based on the chemical nature of their core structure. We will highlight features of currently available nanoparticles in this exhibit.

Results
The inherent optical, magnetic and electrical properties of inorganic nanoparticles make them attractive candidates for imaging brain tumors. Iron oxide nanoparticles are under clinical investigation as T2-weighted MR imaging (MRI) contrast agents for brain imaging. However, systemic delivery of imaging and therapeutic agents to the brain is markedly hindered by the blood-brain barrier (BBB), which prevents nonregulated brain entry of blood-borne chemicals and imaging agents. Surface modification of iron oxide particles with targeting peptides enables significant accumulation in tumor resulting in better contrast enhancement. Recently, gadolinium (Gd) and manganese-based nanoparticles have emerged as T1-contrast agents for brain tumor imaging. These contrast agents exhibit higher efficacy of contrast enhancement than clinically
used Gd-based agents. When surface functionalized with targeting molecules they show enhanced selectivity towards brain tumors. Conversely, use of diagnostic optical imaging generally suffers from significant barriers such as tissue auto-fluorescence, attenuation by skull, and tissue absorption. That said, metallic nanoparticles show promise as optical imaging agents for intraoperative tumor resection. Quantum dots and gold nanoshells emit in the near infrared region where there is less biological attenuation. Thus, peptide targeted quantum dots have been used for imaging tumor vasculature. Similarly, RGD targeted gold nanospheres accumulate significantly in glioma tumor models and show promise in imaging tumor margins. Polymeric nanoparticles encapsulating small-molecule optical imaging agents also have been used for imaging tumor margins. Iron oxide nanoparticles functionalized on the surface with fluorescent molecules have shown promise as dual (MRI-optical) imaging probes. Similarly, 64Cu-DOTA has been conjugated on the surface of iron oxide nanoparticles for combined MRI-PET imaging.

Conclusions
Many of these nanoparticle applications have been evaluated in vitro or in animal models, suggesting the need for further optimization prior to clinical translation. Despite some advancements in targeted delivery, crossing the BBB is still a significant obstacle for many of the above-mentioned platforms when injected systemically. With the advent of multivalent targeting and better strategies for theranostic administration (convection-enhanced delivery (CED), intra-arterial delivery, etc.) to the brain, nanoparticle-based platforms will continue to show enormous promise in the field of glioma imaging.

KEYWORDS: Blood-Brain Barrier, Glioblastoma, Molecular Imaging

EdE-09

Neuroimaging Findings of Encephalitis

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Purpose
Encephalitis affects approximately seven in 100,000 people per year. Occurrence often is fatal, resulting in over 100,000 deaths annually. There are several different types of encephalitis including herpes simplex encephalitis, Epstein-Barr encephalitis, West Nile encephalitis and Rasmussen encephalitis. Herpes simplex encephalitis can be treated if diagnosed early enough; untreated herpes simplex encephalitis has a 70% mortality rate. Therefore as a radiologist, it is important to recognize the imaging features of encephalitis in order to raise the possibility of the diagnosis at the earliest possible stage. The aim of this study is to present radiological findings and complications associated with the different types of encephalitis in order to provide an educational background for physician trainees.

Materials and Methods
After IRB approval was attained, a search of our institutional imaging database was conducted to generate a list of adult and pediatric patients who presented between 1/1/1995 and 10/10/13 for imaging to evaluate possible cases of encephalitis. Radiology imaging including CT and MRI was reviewed. Pertinent medical records including clinical notes, surgical and pathology reports were reviewed and correlated with imaging.
Results
Search of our institutional imaging database demonstrated numerous cases of encephalitis. Salient imaging features and other ancillary findings characteristic of distinct etiologies are reviewed. Several cases of herpes encephalitis at various clinical and imaging stages both before and following treatment are described. Illustrative cases of encephalitis resulting from various other etiologies are also detailed, including examples of Epstein-Barr encephalitis, Rasmussen encephalitis, rhomboencephalitis, rabies encephalitis and West Nile encephalitis. Finally, various complications related to encephalitis are reviewed such as hemorrhage, ischemia, necrosis and shunt malfunction.

Conclusions
Early recognition of encephalitis is critical, but can be quite complex due to diverse pathologies and overlapping features. Familiarity with the salient imaging features for some of the entities as well as ancillary findings presented in this exhibit provides a basic framework for correct and early diagnosis.

KEYWORDS: Encephalitis, Infections
EdE-35

Paradoxical worsening of symptoms following Type D carotid-cavernous fistula embolization: A case report

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Purpose
Syndrome of paradoxical worsening of ophthalmic symptoms following carotid-cavernous fistula embolization is an unusual phenomenon which usually results from thrombosis of superior ophthalmic vein (SOV)/cavernous sinus. Given its rare occurrence, it remains an under-recognized entity. We report serial imaging findings of a patient presenting with this syndrome.

Materials and Methods
Serial imaging studies on an 83-year-old male presenting with right ophthalmoplegia and tinnitus are reported, including pre- and postembolization CT/CTA, initially and following catheter arteriogram and fundoscopy findings.

Results
An 83-year-old male initially presented with gradual onset right ophthalmoplegia, proptosis and tinnitus. He was diagnosed with carotid-cavernous fistula on CTA and underwent a catheter arteriogram along with particulate embolization. This was followed by near complete resolution of symptoms. However, two months later he presented to the ER with severe right proptosis and ophthalmoplegia. Follow-up arteriogram demonstrated no residual AV shunting. However, CT orbits with contrast showed cavernous sinus thrombosis. The patient was managed conservatively with subsequent improvement without additional intervention. Such clinical deterioration has been attributed traditionally to increased blood flow through the malformations into the superior ophthalmic vein. However, in this case there was thrombosis of the cavernous sinus. The patient subsequently underwent spontaneous, complete resolution of symptoms. The alternation of clinical and angiographic findings in this case help to understand the etiology of paradoxical worsening of cavernous sinus DAVF and emphasize role of conservative management.

Conclusions
Syndrome of paradoxical worsening of ophthalmic symptoms following carotid-cavernous fistula embolization is an unusual phenomenon. Flow dynamics observed on follow-up imaging highlight the alternative explanation of clinical deterioration emphasizing conservative management of this rare condition.

KEYWORDS: Carotid Cavernous Fistula, Ophthalmoplegia, Thrombosis
EdE-15

Pictorial Review of Diffusion Tensor Imaging and Tractography

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Purpose
1. Describe the physical principle and mathematics of diffusion tensor imaging (DTI).
2. Describe the utilization of the DTI data.
3. Describe the principle of tractography.
4. Review of normal anatomy of the fiber tracts of the brain in correlation with tractography of the white matter.
5. Illustrate the clinical applications of DTI to characterize disease processes in the brain.
including stroke, neoplasm, neurodegenerative disorders, congenital anomalies, traumatic brain injury, and demyelinating disease.

**Materials and Methods**

Illustrations will be provided to ease the understanding of tensor theory as applicable to diffusion imaging. MR images of the brain based on diffusion data and fiber tracts will be displayed.

**Results**

Diffusion tensor imaging is an advanced form of diffusion imaging in magnetic resonance imaging (MRI), which has shown useful applications in clinical imaging. However, understanding DTI is no easy task, since it involves highly complex mathematics and physics of tensor analysis. Diffusion imaging is based on the inherently random motion of the molecules known as Brownian motion. Diffusion tensor imaging exploits this characteristic motion of water molecules in tissues allowing full characterization of molecular diffusion in the three dimensions of space. Diffusion anisotropy effects can be extracted fully, characterized, and utilized, thus providing even more exquisite details on tissue microstructure. The two most common scalar metrics are fractional anisotropy (FA) and mean diffusivity (MD), which are used to generate images of the diffusion data. Tractography also can be performed using data from diffusion tensor imaging to allow the mapping of the white matter tracts in the brain.

**Conclusions**

Diffusion tensor imaging is a useful tool in mapping tractography of the white matter. Clinical applications of DTI include characterizing disease processes in the brain such as stroke, neoplasm, neurodegenerative disorders, congenital anomalies, traumatic brain injury, and demyelinating disease.

**KEYWORDS:** Brain, DTI Tractography, White Matter Tracts

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**EdE-35a**

**Postictal Encephalopathy: Role of Functional Imaging**

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**Purpose**

1. To illustrate MR imaging findings associated with postictal encephalopathy, with emphasis on diffusion-weighted imaging (DWI). 2. To describe pertinent findings in cases of postictal encephalopathy on perfusion studies and PET imaging. 3. To review seizure-related pathology with discussion of the differential diagnoses and imaging pitfalls.

**Materials and Methods**

We evaluated patients presenting with diagnosis of status epilepticus to Radiology and Nuclear Medicine departments of our hospital over a period of five years (2008-2013). Findings on different MR sequences, perfusion studies and positron emission tomography (PET) imaging were evaluated thoroughly and utilized to frame an educational exhibit describing underlying pathophysiology, imaging pearls, potential pitfalls to be avoided and imaging differentials to be considered thus formulating a systematic approach to diagnosis of postictal encephalopathy.

**Results**

1. Characteristic findings of postictal encephalopathy are increased T2/FLAIR signal and
diffusion-weighted imaging (DWI) abnormalities in the hippocampi, pulvinar/medial aspect of the thalami and within the neocortex and underlying white matter. FLAIR and T2 sequences are relatively sensitive in detecting edema related to status epilepticus, but lack specificity with regard to vasogenic versus cytotoxic etiology. Diffusion-weighted imaging increases this specificity. 2. Prolonged seizure activity leads to profound glucose hypermetabolism with only mild increase in blood flow during status in areas of MR signal abnormality. These findings can be appreciated with combined MR perfusion studies and FDG PET. Postictal follow up reveals hypometabolism/hypoperfusion in these areas. 3. Important imaging differentials of postictal encephalopathy include mesial temporal sclerosis, herpetic and nonherpetic limbic encephalitis, Hashimoto encephalopathy, anti-NMDA encephalopathy, hypoxic ischemic encephalopathy, PRES, central nervous system (CNS) vasculitis, extrapontine myelinolysis, mitochondrial encephalopathy, gliomatosis, Langerhans cell histiocytosis, neurofibromatosis type 1 and Creutzfeldt-Jakob disease.

Conclusions
A knowledge of underlying pathophysiology and functional correlation on advanced imaging may help diagnose postictal encephalopathy with certainty and exclude imaging differentials such as infarction, neoplastic conditions, encephalitis or other encephalopathy. This may help in preventing unnecessary or invasive management such as conventional angiography, biopsy, or inappropriate therapies.

KEYWORDS: Diffusion-Weighted Imaging, PET, Postictal Encephalopathy

EdE-20
6:30AM - 9:00PM

Practical Approach to Analyzing Brain Stem Lesions in Daily Practice

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Purpose
The poster is to list the wide spectrum of diseases affecting the brainstem and to show the characteristic radiological findings including clinical tips and secondary effect referring the anatomy of major white matter pathways.

Materials and Methods
The brain stem is the posterior part of the brain, adjoining and structurally continuous with the spinal cord. Because 10 pairs of the 12 cranial nerves come from the brain stem and the nerve connections of the motor and sensory systems from the main part of the brain to the rest of the body pass through the brain stem, it is an extremely important part. Because the very important part of the brain stem must not be damaged, the biopsy usually is not performed. So, a noninvasive technique is very meaningful to diagnose the disease. In the radiological field, magnetic resonance imaging (MRI) is the most sensitive and specific technique, because computed tomography (CT) is not very useful due to the bone hardening artifact. Magnetic resonance spectroscopy (MRS) is also useful especially in judging whether the lesion is a tumor or not. The knowledge about clinical profile (patient age, past illness, characteristic symptom, clinical course, laboratory data, etc.) is also important. We retrospectively reviewed one thousand MRI examinations in daily practice per year from 2009 to 2013.
Results
First of all, the normal anatomy of the brainstem nuclei and fiber tracts will be reviewed through anatomical diagrams and corresponding MRI in order to understand the reason why such radiological finding or symptom is produced. Second, radiological findings of the lesions affecting the midbrain, pons, and medulla will be presented and also clinical tips. The subtle or unclear CT findings are not omitted for education. These diseases include dilated Virchow-Robin space, infarction (according to the affected artery), specific cause (systemic lupus erythematosus, dissection), vascular malformation (dural AVF, cavernous hemangioma), demyelinating disease [neuromyelitis optica (NMO)], multiple sclerosis, osmotic myelinolysis, Wernicke encephalopathy, Bechet disease, posterior reversible leukoencephalopathy syndrome, tumor [glioma (high grade, low grade)], chronic lymphocytic inflammation with pontine perivascular enhancement responsive to steroids, degenerative disease (multiple system atrophy, progressive supranuclear palsy). Clinical tips are the characteristic symptom (e.g., NMO is hiccup), patient age (e.g., the peak age of the glioma is child), and specific laboratory findings (e.g., Wernicke encephalopathy is vitamin B1 deficiency). Finally, based on the anatomical knowledge, secondary effect (Wallerian degeneration, hypertrophic olivary degeneration ) will be presented.

Conclusions
The lesions affecting brain stem are diverse. Being unable to obtain the pathological diagnosis easily, the radiological findings may be the key factor to diagnose it.

KEYWORDS: Brainstem
Central Pontine Myelinolysis

Neuromyelitis Optica

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EdE-26

Radiation-Associated Neoplasm: What Radiologists Should Know

A Sakata¹, T Okada¹, A Yamamoto¹, M Kanagaki¹, Y Fushimi¹, T Okada¹, T Dodo¹, K Togashi¹

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Purpose
Therapeutic advances in the treatment of malignant neoplasms including brain tumors have improved the prognosis but also have increased the risk of developing rare secondary tumors, which are often radiation-associated (i.e., secondary to radiation therapy). Our goal is to provide comprehensive review of clinical and imaging characteristics of various types of radiation-associated tumors.

Materials and Methods
Several cases of radiation-associated tumors, especially those affecting the brain, head and neck, at our tertiary care academic institution over the last several years will be selected for presentation. This educational exhibit will discuss the pathogenic background, the clinical presentation, and the imaging characteristics of radiation-associated tumors.

Results
Secondary radiation-associated neoplasms are usually associated with pediatric neoplasms including lymphoma, leukemia, retinoblastoma and pediatric brain tumor, but some of them occurred in adult patients with a history of postoperative irradiation for residual brain tumors such as pituitary adenoma or schwannoma. Secondary meningiomas, the most common second malignancy in the cranium, are characterized by a younger age, multiplicity and/or more aggressive clinical behavior than primary ones. High grade gliomas and other sarcomas occurred in the irradiation field may mimic tumor recurrence or other long-term toxicity such as radiation necrosis. Even in the situation with very limited clinical information, knowledge of imaging characteristics of not only secondary malignancy but treatment-related changes will give us a chance to diagnose correctly or suggest the possibility of secondary malignancy. Therefore, changes after radiation therapy also are summarized, and their relationships with secondary tumors will be discussed.

Conclusions
Radiation-associated neoplasm is a rare but dramatic late event that affects patients. Radiologist should be familiar with the long-term consequences of antineoplastic therapy to facilitate diagnosis and anticipate adverse outcome. Through this exhibition we hope to broaden our reader's knowledge regarding radiation-associated tumors.

KEYWORDS: Brain Neoplasms, Radiation Toxicity

EdE-17

Review of Bilateral Inferior Petrosal Sinus Sampling: Technique, Outcomes, and Utility in the Management of Hypercortisolemia

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Purpose
The aim of this exhibit is to review the technical aspects, procedural outcomes, and utility of bilateral inferior petrosal sinus sampling (BIPSS) in preoperative localization of hypercortisolemia in patients with Cushing's syndrome (CS). Cushing's syndrome carries a high morbidity and a five-year mortality approaching 50 percent in untreated cases. Therefore, it is of the utmost importance to localize the source of the hypercortisolemia for treatment planning.
purposes. However, the high dose dexamethasone suppression test, the standard noninvasive test utilized clinically to localize the culprit lesion, is only 60-80 percent specific for localization. Moreover, the presence of a demonstrable pituitary lesion on high resolution, dynamic contrast-enhanced magnetic resonance imaging (MRI) cannot solely be relied upon for localization, as up to 10 percent of the normal population has an incidental pituitary lesion by imaging. This exhibit demonstrates the power of BIPSS to definitively localize the source of hypercortisolemia.

Materials and Methods
We performed a retrospective case analysis with institutional review board approval of the 18 patients who underwent BIPSS for CS at our institution from 2000 to 2013. Simultaneous bilateral venous sampling with corticotrophin releasing hormone (CRH) augmentation was performed in all cases. Using a coaxial delivery system via a common femoral vein approach, microcatheters were advanced into each inferior petrosal sinus or as close to the sinus as was technically feasible. Peripheral venous access was established to allow sampling of peripheral venous blood as well. Venous samples were obtained from each source at baseline and then at specific time intervals following the intravenous administration of CRH. Central to peripheral ratios of the concentration of ACTH were calculated at each time interval. A central to peripheral ratio of greater than 2 at baseline and greater than 3 following the administration of CRH was considered positive for localization of hypercortisolemia to the pituitary.

Results
Bilateral inferior petrosal sinus sampling was successful in localizing the source of hypercortisolemia in all of the cases performed. Due to difficulty in accessing the inferior petrosal sinuses in two patients, it was necessary to place the microcatheters in the internal jugular veins approximating the inferior petrosal sinuses. A single patient experienced intense episodic muscle contractions immediately following administration of CRH, a rare, previously described reaction that subsided with time and supportive care and did not preclude successful completion of the procedure. There were no postprocedural complications.

Conclusions
Hypercortisolemia may present as a diagnostic quandary for clinicians in localizing the origin of abnormal cortisol secretion. This diagnostic uncertainty can be virtually eliminated with bilateral inferior petrosal sinus sampling (BIPSS), an invasive procedure that allows highly accurate localization of hypercortisolemia to the pituitary. Moreover, BIPSS has a high success rate and very low complication rate in the hands of an experienced operator. The exhibit demonstrates the significant diagnostic utility and viable clinical impact of BIPSS in the management of CS.

KEYWORDS: Clinical Outcome, Interventional, Pituitary Gland

EdE-27

Sellar Masses: The Snowman Myth

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Purpose
Snowman morphology of sellar masses has been classically described with pituitary
macroadenomas. This configuration is caused by suprasellar extension of a pituitary adenoma with indentation at the level of diaphragma sellae. The purpose of this investigation was to evaluate reliability of this sign for diagnosis of pituitary macroadenomas and whether other sellar lesions could manifest with this morphology.

Materials and Methods
A search of the picture archiving and communications system (PACS) at our institution and affiliated hospitals was used as the primary tool for identification of sellar masses with the desired snowman morphology. Pathology and/or historical data were obtained to establish final diagnosis.

Results
Numerous sellar masses with the desired Snowman morphology were identified. These included pituitary macroadenoma, craniopharyngioma, optic nerve glioma, aneurysm, meningioma, Langerhans cell histiocytosis, abscess, nasopharyngeal tumors and metastasis.

Conclusions
Although the Snowman configuration of a sellar mass has been described as a classic feature of the pituitary macroadenomas, our study demonstrated that a variety of entities, both benign and malignant, could create this specific shape. Therefore, final diagnosis of these masses should be performed with attention to their overall imaging characteristics, clinical information and if necessary, pathologic correlation.

KEYWORDS: Pituitary Adenoma, Sella

EdE-28
6:30AM - 9:00PM

Spectrum of Calvarial Lesions: An algorithmic approach for formulating a differential diagnosis.

S Garla	extsuperscript{1}, R Rojas	extsuperscript{2}, R Bhadelia	extsuperscript{2}
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Purpose
To illustrate the CT and MR imaging (MRI) findings of various calvarial lesions and how imaging can help with the differential diagnosis and guide further management.

Materials and Methods
CT and MRI studies of patients with calvarial lesions encountered at Beth Israel Deaconess Hospital will be presented in this exhibit. When possible pathologic correlation also will be provided.

Results
Skull/calvarial lesions frequently are encountered on both CT and MRI. The reported incidence of these lesions on radiography is approximately 7%, with benign etiologies more common than malignant ones. The appropriate differential diagnosis is important in determining further management such as biopsy, surgery or follow up. In this education exhibit the spectrum of calvarial lesions and their imaging findings on CT and MRI will be presented. Also, will describe an algorithm for formulating an appropriate differential based on patient demographics,
clinical history and imaging characteristics. When possible pathologic correlation will be provided.

Conclusions
Calvarial lesions are commonly encountered in everyday practice and imaging findings can help determine an appropriate differential that can further guide management.

KEYWORDS: Calvarial

EdE-33

Stroke Mimics, Pearls and Pitfalls: A Pictorial Essay

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Purpose
Various vascular and nonvascular diseases can present with symptoms similar to ischemic stroke. These stroke mimics are commonly encountered in the emergency room, and it is estimated that between 9-31% of patients suspected of having an acute ischemic stroke have one of these mimics. Appropriate imaging studies, most importantly diffusion weighted imaging, usually facilitate diagnosis. Nevertheless, several diseases can present with diffusion abnormality adding to confusion. Our purpose is to discuss different mechanisms causing diffusion abnormality in various diseases and the patterns of involvement, to help narrow the differential diagnosis.

Materials and Methods
1. Multiple cases of known stroke mimics with diffusion abnormality who presented to our tertiary care academic institution over the last several years were selected. 2. We performed a review of the literature to guide discussion of radiologic findings and pearls and pitfalls in differentiating stroke mimics from acute ischemic stroke. Pathophysiologic mechanisms resulting in decreased diffusion also are discussed. 3. Various disorders are categorized based on the patterns of diffusion abnormality to help narrow the differential diagnosis. Typical case examples of these stroke mimics are illustrated and discussed with respect to those patterns. An algorithm for differential diagnosis based on DWI pattern in combination with vascular imaging and MR perfusion findings is presented.

Results
Diffusion abnormality with decreased ADC can be seen with cytotoxic edema related to energy failure of the membrane-bound Na/K-ATPase pump due to ischemia and/or excitotoxic injury; tissue vacuolization or spongiform change; high protein concentration and increased viscosity; or dense cell packing. Diverse etiologies can mimic ischemic stroke including vascular, metabolic, medication-related, infectious, inflammatory, neoplastic and traumatic etiologies. The pattern of diffusion abnormality in combination with vascular imaging and MR perfusion findings can help narrow the differential diagnosis.

Conclusions
Knowledge of the most important stroke mimics and their imaging findings is essential for timely diagnosis of acute ischemic stroke and its differentiation from those mimics. Although a
few recent studies have demonstrated that thrombolysis may be a safe option in case of stroke mimics, it is important to correctly diagnose the etiology of the stroke mimic so that the patient is treated appropriately.

KEYWORDS: Differential Diagnosis, Ischemia, Stroke

EdE-31

6:30AM - 9:00PM


J Rozell¹, S Li²
¹Baystate Medical Center, Springfield, MA, ²Baystate Medical Center, Longmeadow, MA

Purpose
The aim of this exhibit is to review and explore the different pathologies and imaging characteristics affecting the ventricular system of the brain. The disease entities discussed include but are not limited to intraventricular masses, pseudotumor, infectious or inflammatory diseases, etc. We will discuss how the various steps leading to their proper diagnosis can dramatically affect clinical outcome.

Materials and Methods
Related cases will be provided with initial presenting clinical signs and symptoms. The presentation will include but is not limited to the following: infectious and noninfectious diseases, non-neoplastic lesions, ventricular associated neoplasms, and choroid plexus neoplasms. Associated secondary conditions will be identified. Different imaging modalities from initial workup to advanced techniques will be illustrated for each case. Additionally included will be pertinent examples of peri-operative findings, virtual histology, and post-treatment clinical course.

Results
1. Discuss causes of ventricular pathologies and clinical presentations. Pictorial examples will be provided. 2. Case-based demonstration of characteristic imaging findings for diagnosis. Emphasis will be on advantages and disadvantages of various imaging modalities/techniques, which may include CT, MRI, or US. 3. Discuss complications including intracerebral and intraventricular hemorrhage, obstructive hydrocephalus, and mass effect. 4. Discuss differential diagnoses and their clinical courses.

Conclusions
Pathologies affecting the ventricular system are rare and often difficult for radiologists to appropriately evaluate. Because proper diagnosis and treatment can dramatically improve outcome, an understanding of a large number of clinical correlating conditions and imaging diagnoses are equally critical. At the end of the presentation, the viewer will become familiar with causes, clinical presentations, diagnostic imaging features, and differential diagnoses.

KEYWORDS: Brain Abnormalities, Multimodality Imaging, Ventricles
EdE-30

Under Disguise: A Pictorial Review of Tumor Mimickers

L Nakamura¹, E McCrum¹, M Nicolas-Jilwan¹

¹University of Virginia, Charlottesville, VA
Purpose
Multiple inflammatory, infectious, and structural brain disorders frequently are misdiagnosed as brain tumors on imaging studies. The purpose of this exhibit is to highlight the characteristic imaging features of a wide variety of brain tumor mimickers in an effort to minimize unnecessary brain biopsies and craniotomies.

Materials and Methods
We present examples of a variety of infectious, inflammatory, and congenital brain disorders that are frequently misdiagnosed as brain tumors on imaging. Emphasis will be made on the key differentiating features.

Results
We will first present a case of tumefactive demyelination: a teenage girl referred to our institution for brain tumor resection. Next is an unusual case of chronic calcified stage neurocysticercosis which exhibited enhancement on preoperative imaging and went on for resection as a presumed brain tumor. Additional infectious disorders with characteristic differentiating features including tuberculoma and toxoplasmosis are presented. Finally, we discuss a few cases of cortical dysplasia and emphasize some differentiating features from low grade glioneuronal tumors.

Conclusions
Knowledge of the patient's age, sex, background, and clinical history is crucial to keep a high level of suspicion for a non-neoplastic process in face of a mass-like brain lesion. Identification of the key imaging features of these disorders helps to make the appropriate diagnosis and minimize unnecessary brain biopsies and craniotomies.

KEYWORDS: Cortical Dysplasia, Toxoplasmosis, Tumefactive Demyelinating Lesion

EdE-34

Underreported yet Important Mastoid Emissary Vein

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¹Johns Hopkins University School of Medicine, Baltimore, MD

Purpose
The mastoid emissary vein is one of the posterior fossa emissary veins that traverse through skull base cranial apertures resulting in extracranial venous drainage of the posterior fossa dural sinuses. They can cause clinical symptoms such as tinnitus, spread infections, causes perfuse bleed, or can serve as a pathway for intracranial vascular intervention. This exhibit illustrates their anatomy through case presentation and reviews embryology and anatomy based on high-resolution CT, CT angiography, and MR venography images.

Materials and Methods
This exhibit reviews protocol optimization and multidetector CT (MDCT) findings of mastoid emissary vein with high resolution skull base CT, CT angiography, and MR venography images with 2D and 3D rendering.

Results
This emissary vein is usually small and asymptomatic in healthy population, connecting between the sigmoid sinus and posterior auricular or occipital vein by crossing the mastoid foramen, with
further drainage into the suboccipital venous plexus or external jugular vein. They can protect the brain from increases in intracranial pressure in patients with lesions of the skull base or neck and obstructed internal jugular veins. It can enlarge in patient with high-flow vascular malformations, hypoplasia or aplasia of the jugular veins. It has been reported that mastoid emissary vein can be used to access an isolated or inaccessible transverse or sigmoid sinus system. This vein also is a potential source of life-threatening bleeding during surgical procedures or trauma. Furthermore, surgical materials or air, such as bone wax, may predispose one to complications through this pathway. It also can be a source of sinus thrombosis after middle ear surgery. Knowing this vein pre-operatively would allow one to modify the surgical procedure to reduce complications. This vein also may constitute a potential risk for spreading infectious processes from extracranial to intracranial compartments. Thrombosis of this vein causes edema and tenderness of the postauricular soft tissue overlying the mastoid process, Griesinger's sign.

Conclusions
Mastoid emissary vein should be recognized and reported by neuroradiologist. After reviewing this exhibit, the radiologist will gain an understanding of the myriad of pathology that could be related to the mastoid emissary vein. The importance of noncontrast-enhanced CT to recognize the mastoid foramen also is emphasized, and through case review, those MR and CT findings are illustrated.

KEYWORDS: Venous Drainage
Vascular Anomalies and their Initial Presentation to the Emergency Department

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Purpose
To review the initial emergency room presentations of various vascular anomalies and the pitfalls of diagnosing hemorrhage on nonenhanced computed tomography (CT). In cases where CT was the initial study, multiplanar reconstruction and subsequent magnetic resonance imaging (MRI) are crucial for clarifying the disease process and in some instances, altering diagnosis completely.

Materials and Methods
The clinical history and initial radiographic images obtained in the emergency room will be
presented, with identification of the abnormal imaging findings. Correlation will be made with multiplanar reconstructions and follow-up MR imaging, with discussion of the typical imaging and clinical features of different vascular anomalies.

Results
Clinical histories given by the emergency department for initial imaging scans include symptoms of stroke, headache, or a recent history of trauma. Initial nonenhanced CT is a quick way to evaluate for the presence of intracranial hemorrhage; however, a vascular anomaly without active hemorrhage may be mistaken for acute intracranial hemorrhage on initial CT. MR imaging can better evaluate vascular malformations. The cases we will present include a middle cerebral artery aneurysm found on nonenhanced CT; the initial diagnosis of questionable intracranial hemorrhage in a patient with reported trauma, later found on gadolinium-enhanced MR to be a capillary telangiectasia with a closely associated developmental venous anomaly; and a venous sinus thrombosis presenting to the emergency department with headache, among others.

Conclusions
While initial nonenhanced CT in an emergent setting provides valuable information, particularly in the setting of hemorrhage, or identification of an aneurysm, there are many times when additional imaging using MRI is needed. Particularly with vascular anomalies, MRI is useful for confirmation or further characterization. Otherwise, a vascular anomaly may be mistaken for hemorrhage, particularly when accompanied by clinical history of trauma.

KEYWORDS: Aneurysm, Capillary Malformation, Venous Sinus Thrombosis

EdE-18

Why is Balo Concentric Sclerosis Still a Surgical Disease?

J Anderson1, J Ulmer1, A Klein1, M Agarwal1, L Mark1, P Kochar1, C Lath1
1Medical College of Wisconsin, Wauwatosa, WI

Purpose
To elucidate the reasons and rationale for surgical biopsy of Balo concentric sclerosis, despite typical MR imaging (MRI) characteristics known preoperatively. To emphasize the pathognomonic imaging features of Balo concentric sclerosis and foster a correct diagnosis at presentation, thus minimizing the likelihood of a surgical biopsy.

Materials and Methods
Clinical and MR imaging features of three patients with histologically confirmed Balo concentric sclerosis are presented to illustrate the pathognomonic characteristics of the disease. Known classic imaging features and new physiologic imaging characteristics are presented and discussed. The perspectives of neurosurgeons and patients in proceeding with biopsy despite classic MR imaging features are analyzed through detailed electronic health record review.

Results
Balo concentric sclerosis is a rare demyelinating disorder characterized by alternating concentric layers of demyelination and relative myelin preservation, yielding a characteristic target appearance on T2-weighted images. The disease typically presents with acute onset of neurological symptoms and rapid clinical progression. On imaging, the lesion can enlarge over time, exhibit an MRS profile similar to that of tumor, and may not respond to typical doses of
glucocorticoids. Often, the lesion is initially misdiagnosed as neoplasm or neoplasm is considered in the differential diagnosis prior to entry into a tertiary center, though a misdiagnosis may be subsequently over-ridden by a trained neuroradiologist. This can result in contradictory interpretations in the setting of rapid clinical progression of neurological deficits. The anxiety associated with this scenario may engender an unnecessary surgical biopsy, which is more likely the longer the initial misinterpretation stands. Recognition of pathognomonic imaging features at presentation is essential to avoid a biopsy and its potential complications. An understanding of neurosurgical and patient perspectives as well as prompt contact between the neuroradiologist and neurosurgeon may influence surgical decision making.

Conclusions
Despite the best efforts of neuroradiology, Balo concentric sclerosis still may be misdiagnosed initially as neoplasm. Despite subsequent corrective interpretations, contradictory opinions in the medical record and psychological factors can prompt a biopsy. Identification of the pathognomonic imaging features at presentation and prompt communication with referring physicians should minimize the likelihood of a biopsy and its potential complications.

KEYWORDS: Arterial Spin Label Angiography, Demyelination, Diffusion-Weighted Imaging

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Education Exhibits (Print) - Anatomy
EdE-44

A Case-Based Review of Lesions Affecting the Lower Brainstem in the Adult and Pediatric Population

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Purpose
The purpose of this educational review is to discuss and illustrate the broad spectrum of pathology that affects the lower brainstem, defined as the pons and medulla. Common pathologies as well as rare findings will be reviewed and the differential diagnosis for both the adult and pediatric population will be discussed. Clinical manifestation and radiological features will be examined for each entity with focus on MR imaging (MRI) findings. This review will aid the radiologist in the interpretation and characterization of lower brainstem lesions.

Materials and Methods
An illustrative review of the broad differential of etiologies including vascular lesions, infections, neoplastic processes, postradiation therapy lesions, ischemic and hemorrhagic lesions, and demyelinating disease will be presented. Additionally, various congenital and mitochondrial disorders, with focus on the radiological manifestations in the lower brainstem, will be presented. Examples include Leighs syndrome, Mobius syndrome, and mitochondrial leukodystrophy.

Results
The lower brainstem is a common site for various neoplastic processes. In the pediatric
population, neoplasms including pilocytic astrocytomas and medulloblastomas are commonly encountered, while postradiation gliomas also may be seen occasionally. Vascular malformations, including capillary telangiectasias and cavernomas, may be identified and differentiated from other neoplastic lesions based on their MRI features, providing an important diagnostic measure in determining possible therapeutic intervention. Manifestations of demyelinating disorders and infectious processes demonstrate varying patterns and are recognizable on MRI, including multiple sclerosis, influenza and abscesses. A variety of congenital and metabolic disorders may manifest with lesions in the lower brainstem. Knowledge of imaging features and clinical history is crucial to recognize and narrow down the vast differential diagnosis of lesions found in the lower brainstem.

Conclusions
Review of the broad differential of pathology affecting the lower brainstem in the adult and pediatric populations, with illustrative discussion of cases encountered at our institution.

KEYWORDS: Brainstem

EdE-45

An Image-Based Review of Intracranial Calcifications

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Purpose
Intracranial calcifications are encountered daily in clinical practice and can represent a broad spectrum of physiologic and pathologic conditions. The purpose of this educational exhibit is to provide an image-based review of common, uncommon, and rare cases in which intracranial calcifications may suggest a specific diagnosis or narrow a differential allowing the interpreting radiologist to facilitate patient management and care.

Materials and Methods
We present a collection of cases archived by neuroradiologists at our institution as a pictorial review of intracranial calcification.

Results
Intracranial calcifications can be classified broadly as physiologic, congenital, metabolic, infectious, inflammatory, dystrophic, vascular, and neoplastic. It is often possible to suggest a specific diagnosis based on the calcification pattern and location of the lesion as well as the patient's age and presentation. For example, a cystic mass with a calcified mural nodule within the temporal lobe of a young patient presenting with medically refractory epilepsy is most likely a ganglioglioma. When a specific diagnosis is not possible, the differential often can be narrowed with a familiarity of pathologic conditions in which calcification occurs. For example, periventricular calcifications in an infant are likely secondary to in utero infection such as cytomegalovirus, toxoplasmosis, human immunodeficiency syndrome, and herpes simplex virus. In some situations, calcifications may be the only finding to suggest an underlying abnormality. For example, a seemingly innocuous frontal lobe calcification encountered on unenhanced CT may represent an underlying vascular malformation or neoplasm requiring further workup.
Conclusions
Intracranial calcifications can be seen in a variety of conditions and are encountered frequently in clinical practice. Knowledge of the potential etiologies as well as typical imaging characteristics can help facilitate clinical management. It is for this reason that we find this image-based review of intracranial calcifications useful for both the training and practicing radiologist.

KEYWORDS: Calcifications, Intracranial

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EdE-38

6:30AM - 9:00PM

Angiographic Anatomy of the Neck Vasculature and the Major Anastomotic Connections

R Brandt¹, C Eskey¹
¹Dartmouth Hitchcock Medical Center, Lebanon, NH

Purpose
To demonstrate the arterial vasculature of the neck from the subclavian artery to the level of the
mandible anteriorly and the occiput posteriorly using CT and digital subtraction angiograms. Emphasis will be placed on the arteries not commonly studied with routine cerebral angiography.

Materials and Methods
The arterial vasculature of the neck will be demonstrated with labeled angiographic images. Major branches, vascular territory and important anastomotic connections will be described. Cases will be used to further illustrate the arterial anatomy.

Results
The arterial vasculature of the neck supplies many vital structures including the larynx, trachea, thyroid gland, spinal cord and brachial plexus. The vessels of the neck also have several important anastomotic connections to arteries that may supply the brain and spinal cord. The major arteries supplying the neck arise from the subclavian and external carotid arteries; they include the vertebral arteries, costocervical trunk, thyrocervical trunk, dorsal scapular artery, and superior thyroid artery. Knowledge of these arteries is important in the targeted embolization of head and neck tumors and vascular malformations. There are important anatomical variants of the vascular structures of the neck, chief among them the origin of the radiocolommedullary artery, which can originate from either the vertebral artery, deep cervical artery and less commonly, the supreme intercostal artery. Knowing the anatomy of these variants and being able to recognize them on angiographic studies is important to avoid cerebral or spinal cord infarction during embolization procedures. Further, there are clinically relevant anastomoses between the deep cervical artery, ascending cervical and vertebral arteries. These anastomoses allow for reconstitution of flow to occluded vertebral or carotid arteries.

Conclusions
It is important for the neuroradiologist and the neurointerventional radiologist to be familiar with the vascular branches that supply the osseous and soft tissue structures of the neck. Knowledge of the clinically relevant anastomoses of neck vasculature as well as anatomical variants can be helpful for delineating disease and for planning interventional procedures.

KEYWORDS: Anatomy, Angiography, Head And Neck

EdE-53

As Hard As the Rock: Imaging of the Petrous Apex

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¹Montreal General Hospital, McGill University Health Centre, Montreal, Quebec, Canada

Purpose
To revisit the complex structural anatomy of the petrous apex, the adjoining cranial nerves and neurovascular bundles. To highlight the imaging features and salient differentiating characteristics of various petrous apex pathologies.

Materials and Methods
We archived 75 cases from the PACS with petrous apex lesions and then retrospectively analyzed each lesion based on location and characteristic imaging findings to reach a definitive conclusion.

Results
Based on the underlying cause, petrous apex lesions are classified into developmental,
inflammatory, infectious, neoplastic, vascular and osseous. We shall discuss some classical cases under each category having distinctive imaging features. The exhibit will include but is not limited to characteristic imaging features of the following petrous apex lesions on cross-sectional imaging: Petrous effusion, Pneumatization, Pseudo fractures, Mucocele, Cephalocele, Petrous Apicitis, Osteomyelitis, Cholesterol granuloma, Cholesteatoma, Meningioma, Schwannoma, Paraganglioma, Petrous Carotid Aneurysm, Endolymphatic sac tumor, Osteoblastoma, Giant cell tumors; Fibrous Dysplasia, Paget disease, Plasmacytoma, Chondroma, Chondroblastoma and Metastasis.

Conclusions
Lesions related to petrous apex cause diverse clinical sequelae ranging from mass effect to direct invasion of the neurovascular bundles. Due to its inert location, cross-sectional imaging plays an important role in recognizing, characterizing and also aids in treatment planning of the lesions. Understanding the anatomical units and their relations can lead to accurate and early diagnosis of petrous apex lesions.

KEYWORDS: Masses, Petrous, Petrous Apex
**CASE 1**

1: Axial CT section in Bone window showing a lytic lesion in the right petrous apex in a patient known with primary breast cancer

2: Axial MRI of the brain showing a Heterogeneously enhancing soft tissue lesion in the right petrous apex involving the carotid canal.

**Dx: Metastatic lesion**

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**EdE-55**

6:30AM - 9:00PM

Clearing the air: Incidental foci of air observed on cross-sectional imaging

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¹Beth Israel Medical Center, New York, NY, ²Mount Sinai Beth Israel, New York, NY
Purpose
On-call residents, as well as attendings, often are confronted with foci of air in abnormal places on CT scans of the head and sometimes even the spine. In some cases, this may be related to contrast injection or represent the sequela of routine vascular access obtained by a nurse or physician prior to scanning. This can be particularly troubling in the setting of trauma when small foci of venous air may raise alarm for skull base fracture. Similarly, in the setting of altered mental status, small collections of venous air may simulate infection. The purpose of this exhibit is to illustrate the typical regions in which air emboli may be found within the central nervous system (CNS) so as to help stratify suspicion for more ominous underlying injury.

Materials and Methods
We will use CT images focused on the head and spine to illustrate examples of air emboli and correlate these images with illustrations of corresponding venous anatomy.

Results
Blank

Conclusions
This exhibit will help on-call radiologists recognize the typical locations for venous air emboli within the CNS, in contradistinction to foci of air resulting from trauma or infection.

KEYWORDS: Iatrogenic, Venous Anatomy

EdE-51

Cortical Substrates of Cranial Nerve Functions

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¹Medical College of Wisconsin, Wauwatosa, WI

Purpose
To elucidate the cortical networks subserving cranial nerve functions, using diagrammatic and MR imaging illustrations.

Materials and Methods
Color-coded cortical networks subserving cranial nerve functions are presented diagrammatically. Corresponding functional color-coded cortical regions and networks are illustrated on multiplanar high resolution MR images and on 3D brain illustrations for intuitive reference. Cranial nerve deficits associated with cortical lesions and network disruptions are discussed and localized. The impact of the functional laterality and recoverability on clinical outcomes are discussed as well.

Results
The functional realm of the cranial nerves extends far beyond postganglionic innervation of the head and neck. In addition to critical sensory and motor functions, cranial nerves are involved in complex neuronal functions including memory, circadian rhythm and sexual stimulation. Most of these functions are directly or indirectly controlled by the cortex. Lesions of cortex affecting cranial nerve functions may manifest a confusing clinical picture. Clinical symptomatology and natural history depends on the extent of functional bilaterality, functional recoverability, and disease process. Thus, unilateral lesions may cause permanent or transient deficits, but the period of recovery may vary depending on the involved network. Bilateral lesions due to etiologies such
as stroke, trauma, and demyelinating disease may cause permanent and debilitating deficits, some of which may be lethal. Bilateral lesions may be separated temporally, thus appearing as unexplained and atypical unilateral syndromes. Cranial nerve dysfunction associated with neurodegenerative diseases may not be apparent on imaging, but an understanding of the same will facilitate an accurate diagnosis. An intuitive understanding of cranial nerve cortical functional networks empowers clinical neuroradiology.

Conclusions
Cranial nerve functions are varied and complex. Cortical representations often are not emphasized in clinical neuroradiology practice. A conscious appreciation of cranial nerve cortical functional networks will foster accurate imaging diagnoses of cranial nerve disorders.

KEYWORDS: Anatomy, Cranial Nerves

EdE-48

Diffusion-Weighted Imaging: Beyond Acute Stroke

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Purpose
Diffusion-weighted imaging (DWI) provides image contrast that is different from that provided by conventional magnetic resonance imaging (MRI) techniques. It is highly sensitive for detection of cytotoxic edema useful in the detection of acute infarcts. However, DWI is under-represented in the characterization of many other disease processes. The objective of this paper is to differentiate diseases that manifest with various neurological disorders, based on diffusion contrast and apparent diffusion coefficient (ADC) values and review hyper and hypo-intense lesions on DWI.

Materials and Methods
Content will be organized to first show how DWI is produced with a simple overview of spin echo and gradient pulse concepts, followed by a discussion of how patterns of diffusion reflect pathological processes. After reviewing the DWI/ADC characteristics in arterial and venous infarcts to consolidate the concepts of cytotoxic and vasogenic edema, we present cases of other neurological diseases for which there is good evidence for the utility of DWI. For each, DWI and ADC characteristics are explained pathophysiologically and compared with T1 or T2 MR findings. Lastly, a differential for diffusion-bright lesions is provided.

Results
We propose a differential diagnosis for diffusion-bright lesions, separated into the categories: Acute Ischemia, Infections, Tumors, Demyelination/Dysmyelination, Artifacts, Hemorrhage, Injury, and Metabolic Conditions. Since DWI is sensitive to early changes of cytotoxic edema, the sequence may show restriction in the descending white matter tracts that precedes Wallerian degeneration. In the acute stage of hypoxic ischemic injury, we usually see restricted diffusion in a pattern dependent upon the age of the patient and severity of the insult. In the chronic stage, there is free diffusion in the same distribution. Diffusion-weighted imaging is valuable in diffuse axonal injury because it identifies additional shearing injuries not visible on T2/FLAIR or T2
sequences. In brains that appear normal in the setting of CNS vasculitis, abnormalities may be demonstrated on DWI with lower ADC values in the anterior white matter, central white matter, thalami, and internal capsules. Abscesses appear hyperintense on DWI, with very low ADC values. Therefore, DWI is useful in the differential diagnosis of "ring-enhancing" cerebral masses. Diffusion-weighted imaging is more sensitive than conventional MR imaging in detecting early temporal lobe and limbic system cytotoxic edema of herpes encephalitis. In the setting of Japanese Encephalitis, DWI can reveal early involvement of the thalami. Apparent diffusion coefficient and index of diffusion anisotropy determinations have proven useful in the identification of arachnoid cyst, epidermoid cyst, meningioma, lymphoma and metastasis. Adrenoleukodystrophy changes on DWI are demonstrated often in the occipital lobes, with low ADC values. Lastly, the increased diffusivity of multiple sclerosis plaques, compared to that of normal white matter, appears to be more pronounced than corresponding T2 signal intensity changes.

Conclusions
Image contrast on DWI is dependent on the molecular motion of water, which is substantially altered by disease. A review of hyperintense and hypointense lesions on DWI with emphasis on the concept of cytotoxic and vasogenic edema may help in differentiating various neurological disorders.

KEYWORDS: Brain, Differential Diagnosis, Diffusion-Weighted Imaging

Table 1. Differential for diffusion-bright lesions.

<table>
<thead>
<tr>
<th>Acute Ischemia</th>
<th>Infections</th>
<th>Tumors</th>
<th>Demyelination/Dysmyelination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial infarct</td>
<td>Parenchymal abscess</td>
<td>Lymphoma</td>
<td>Multiple Sclerosis (few acute lesions, majority do not)</td>
</tr>
<tr>
<td>Venous infarct (areas of increased and decreased diffusion)</td>
<td>Empyema</td>
<td>High grade glioma (solid areas)</td>
<td>Devic's Disease</td>
</tr>
<tr>
<td>Global hypoxia</td>
<td>Cerebritis and encephalitis</td>
<td>Meningioma</td>
<td></td>
</tr>
<tr>
<td>Acute Wallerian degeneration</td>
<td>Granulomatous lesions</td>
<td>Metastasis (majority do not show restriction)</td>
<td>Leukodystrophies</td>
</tr>
<tr>
<td>Vasculitis</td>
<td>ADEM</td>
<td>Medulloblastoma</td>
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<table>
<thead>
<tr>
<th>Artefacts</th>
<th>Hemorrhage</th>
<th>Injury</th>
<th>Metabolic Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2 shine-through</td>
<td>Oxyhemoglobin</td>
<td>Diffuse axonal injury</td>
<td>Osmotic demyelination (reversible)</td>
</tr>
<tr>
<td>Susceptibility artefact</td>
<td>Deoxyhemoglobin (variable)</td>
<td></td>
<td>Methotrexate leukoencephalopathy (reversible)</td>
</tr>
<tr>
<td>Interface artefact</td>
<td>Intracellular methemoglobin (variable)</td>
<td>Non-hemorrhagic contusions</td>
<td>MELAS syndrome</td>
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<tr>
<td>Pseudolesions from unfolding</td>
<td></td>
<td></td>
<td>Leigh's Disease</td>
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Ecchordosis Physaliphora: A Report of Four Cases and a Review of the Literature

K Anton¹, S Dalal², J Smith³
¹Geisinger Medical Center, Danville, PA, ²Geisinger Medical Ctr, Danville, PA, ³Geisinger Health System, Danville, PA

Purpose
Ecchordosis physaliphora (EP) is a rare congenital hamartomatous remnant of the primitive notochord located in the midline along the craniospinal axis (1). Classically, they are asymptomatic and found incidentally on imaging or during an autopsy. Only few reported symptomatic cases are described in the literature. The purpose of this case series is to describe variations in imaging findings of this rare entity.

Materials and Methods
Four cases of retroclival ecchordosis physaliphora documented in imaging reports were identified by retrospective review of clinical charts. The reported cases were reviewed again by a neuroradiologist focusing on the imaging characteristics of EP. We present a case-based review of the imaging spectrum and a review of the EP literature.

Results
All four cases demonstrated classic findings reported in the literature including retroclival location, T2 hyperintensity, T1 hypointensity and nonenhancement, an important feature differentiating EP from chordoma (2). Irregularity and signal changes in the adjacent clivus were seen to varying degrees in all cases. Mild mass effect on the pons and basilar artery was identified in two. One of the cases was identified on workup for trigeminal neuralgia; however, no anatomical relationship of EP to the trigeminal nerve was noted on imaging. Although typically asymptomatic, cases of symptomatic patients have been reported when EP compresses adjacent structures (3). Few cases have been reported in the literature describing an association between EP and trigeminal neuralgia (4).

Conclusions
Ecchordosis physaliphora is a rare, benign lesion representing ectopic notochordal remnant, most commonly found incidentally on imaging. Precise knowledge of imaging characteristics, notably lack of enhancement, is vital in distinguishing EP from an enhancing chordoma (5). Patients with EP are managed nonoperatively, unlike those with chordomas who receive aggressive radiation therapy and surgery (6).

KEYWORDS: Chordoma, Ecchordosis Physaliphora
Focal Fluid Signal Change in the Cervical Spine: Anterior Median Fissure or Central Canal - Anatomical and Clinical Considerations

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Purpose
Evaluation of fluid signal changes affecting the cervical spinal cord may impact further clinical patient management. Specific linear T2 hyperintense signal, variable in not only craniocaudal extent but also in position in the antero-posterior direction frequently are encountered. Corresponding axial cross-section sequences show these signal changes relatively anterior, in the midline, with variable appearance of linear or rounded T2 hyperintensity, or a combination giving the appearance of a key hole. The differential diagnosis for this finding includes the anterior median fissure, a normal anatomical structure not requiring any medical interventions or follow up, or hydromyelia which is the sequela to variable pathological processes, with the possibility of progressing and requiring surgical and/or medical interventions. Anatomical sections or depictions place the base of the fissure and the central canal separated by 1 mm or less, with variable width and diameter of the 2 structures. This exhibit aims to emphasize distinguishing features of the anterior median fissure versus hydromyelia in patient with dilated CSF channels in the spinal cord (as might be seen with Chiari malformation, hydromyelia, syringomyelia, multiple sclerosis). In doing so, these features may help to not only distinguish fissure from canal, but also to elucidate pathogenesis, pathophysiology of syrinx formation.

Materials and Methods
Prospective review of 1.5 T and 3.0 T magnetic resonance imaging (MRI) cervical spine cases encountered in a clinical practice with a busy neurosurgical unit is underway. The exhibit includes a series of interesting cases from ongoing review that will illustrate the purpose and issues at hand. Imaging features hypothesized to be useful in distinguishing the differential diagnoses will be presented. Temporal changes of focal fluid signal changes, when available, also will be reviewed.

Results
Focal fluid signal change is not an infrequent finding. Anterior median fissures can have a variable appearance. It also can change in size with time. Syrinx and a prominent anterior fissure can co-exist in the same patient. There may be a relationship between a prominent anterior fissure and syrinx formation.

Conclusions
Focal fluid signal change may pose diagnostic conundrum in some patients. Correlation of findings on multiple planes is essential to distinguish fissure from canal. Increased awareness of potential differential diagnoses and imaging features to distinguish normal variant from pathology will help to eliminate the need for additional or follow-up spine imaging.

KEYWORDS: Spinal Cord, Spinal Imaging, Syringohydromyelia
**Purpose**

To illustrate the relationships between critical brain functions and CNS vascular supply, thus producing an intuitive "functional vascular anatomy" atlas.

**Materials and Methods**

The arterial vasculature supplying functional brain networks are presented on color-coded reconstructed CTA and MRA images. Corresponding color-coded functional cortical and subcortical brain regions are illustrated on high-resolution magnetic resonance imaging (MRI), to provide an intuitive understanding of anatomical-functional-vascular relationships. Functional deficits associated with specific vascular lesions are discussed.

**Results**

Advanced imaging technologies including fMRI and DTI can provide localization of functional brain networks prior to neurosurgical intervention, and have led to improved outcomes and reduced postoperative deficits. While such information has allowed neurosurgeons to avoid direct injury to elegant networks, vascular risks also must be considered to optimize surgical outcomes. Functional networks remote from a resected lesion may be compromised by vascular injury. Functional vascular supply is a central consideration in endovascular surgical plans as well. The relationship to, or involvement of, eloquent vasculature by brain lesions should be elucidated prior to surgical intervention. While larger arterial vessels may be readily identifiable preoperatively and intraoperatively, small perforators supplying vital neurological functions may not. Some functional vascular distributions are shared or variable. For example, motor cortex and white matter pathways are supplied by spatially distinct subdistributions in the MCA, ACA, and PCA territories. Likewise, speech and language functions may be compromised by lesions of MCA, ACA, and PCA subdivisions. Perforating arteries arising from anterior, communicating, and posterior circulations supply various elements of the visual pathways. These also may supply structures vital to memory functions, including the fornix, mammillary bodies, and portions of the thalamus and mamillothalamic tracts. The rostral third of the hippocampus is supplied by the anterior choroidal artery arising from the ICA, while the posterior two-thirds is supplied by middle and posterior hippocampal arteries arising from the PCA. The exhibit intuitively illustrates motor, visual, memory, and language functional vascular anatomy using standard clinical imaging techniques, required to estimate surgical or endovascular risks and to promote safe therapeutic plans.

**Conclusions**

Presurgical functional brain mapping has proved its value in surgical decision-making. Functional vascular anatomy has been less emphasized among neuroradiologists, but is equally as important. A thorough understanding of functional vascular anatomy is within the domain of Neuroradiology and can enhance presurgical consultations, surgical decision-making, and the assessments of vascular diseases.
Imaging of Intracranial Germ Cell Tumors: A Pictorial Essay

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Purpose
1) To revisit the WHO classification of types of intracranial germ cell tumors. 2) To review the location and general characteristic CT and MR imaging (MRI) findings of intracranial germ cell tumors with histopathologic correlation in some cases. 3) To discuss the differentiation diagnosis based on location.

Materials and Methods
A PACS search of CT and MRI examination was undertaken to identify and select cases representing germ cell tumors. An attempt was made to classify them based on location, CT and MRI findings. Note was made of clinical features and associated complications as mentioned in the history.

Results

Conclusions
Imaging findings of CNS germ cell tumors are nonspecific and correlation with clinical findings, oncproteins in CSF and serum with histopathological confirmation are required to arrive at the diagnosis.

Keywords: Germinoma, Teratoma
EdE-43

Imaging Review of Basal Ganglia and Thalamic Lesions

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Purpose
Assessment of disease of the basal ganglia and thalami can be complex, and often requires a combination of thorough clinical exam with history, serology workup, urinalysis, and imaging. The purpose of this educational exhibit is to categorically demonstrate a wide array of cross-sectional imaging findings of basal ganglia and thalamic lesions. Familiarity with these imaging findings will enable the radiologist to offer valuable information to the clinicians faced with diagnosing and treating these conditions.

Materials and Methods
This exhibit will provide a retrospective illustrative review of CT and MR imaging findings of various pathologic conditions which affect the basal ganglia and thalami. Categories of
underlying etiology will include metabolic, congenital, inflammatory, vascular, neoplastic, infectious, and neurodegenerative causes. The images are drawn from cases ranging back over 15 years. Some of the disease entities covered have characteristic findings on CT or MR, with a limited differential diagnosis. These findings will be emphasized, to aid the radiologist in improved detection and diagnosis. Other examples emphasize the importance of correlation with available clinical information and intracranial imaging findings outside the deep gray structures, or from imaging of other parts of the body.

Results
The basal ganglia and thalami are highly metabolically active, and various forms of metabolic derangement can result in a symmetric distribution of imaging findings. Metallic deposition, such as copper in Wilson's disease, or manganese in the setting of chronic hepatic encephalopathy, manifest as symmetric, bilateral imaging abnormalities. In addition, compromise of arteries or veins may present with symmetric findings, sometimes related to anatomical variation. However, as there is a vast differential of lesions involving the basal ganglia or thalami, many with nonspecific imaging findings, correlation with concurrent intracranial imaging findings outside the basal ganglia, supplemented with pertinent clinical information, can greatly aid in diagnosis. For example, in the setting of an asymmetric basal ganglia lesion, the history of immunocompromise could prompt the radiologist to recommend a thallium-201 brain SPECT examination to differentiate lymphoma from toxoplasmosis, or diffuse basal ganglia calcifications may suggest Fahr's disease in the presence of subcortical calcifications. Increased awareness of imaging patterns and corresponding histories will enable radiologists' to better recognize specific diseases of the basal ganglia and thalami.

Conclusions
Awareness of the common imaging patterns of various categories of disease is crucial for the radiologist's evaluation of lesions of the basal ganglia and thalami. Correlation with additional intracranial findings and with clinical history is also invaluable for deriving a limited and useful differential diagnosis for the referring physician.

KEYWORDS: Basal Ganglia Disease, Thalamic

EdE-36
6:30AM - 9:00PM

Limbic System in and beyond the Border Zone: Functional Concepts and Clinical Correlation

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Purpose
Limbic system is an ambiguous term used to describe a heterogeneous set of brain structures that drives from the diencephalon, mesencephalon and telencephalon. Despite of the diversity of these related structures they are connecting to form a neural circuitry that control visceral, olfactory, memory and learning functions. The expanding and crucial role of the limbic system has been the focus of the researchers. Detailed knowledge of the limbic pathway is essential for
the interpretation of the diffusion tensor imaging (DTI), functional MR imaging (fMRI) and routine clinical MR imaging (MRI).

**Materials and Methods**

The exhibit will describe the fiber pathways connecting the hippocampus to the basal ganglia, thalamus, amygdala, certain related cortical areas, and hypothalamus neural loops/circuitry. The morphology and location of these pathways will be related to readily visible anatomical landmarks and the functional significance of these connections will be illustrated.

**Results**

The key anatomical components of the intrinsic circuitry of the hippocampal formation are arranged transversely to the long axis of hippocampal formation. It is a trisynaptic circuit that projects from the entrohinal cortex. The entrohinal hippocampal intrinsic pathways are related to memory functions and learning. The afferent fibers that project to this intrinsic pathway are derived from cerebral cortex, the amygdala, the medial septal nucleus and the nucleus of the diagonal band mainly through the fornix, the anterior and midline nuclei of the thalamus via cingulate bundles and noradrenergic and serotoninergic fibers arising from the locus coeruleus and mesencephalic raphe nuclei projecting mainly through the fornix. The main efferent fibers of the hippocampal formation are mainly through the fornix. These projection fibers form the alveus and the fimbria.

**Conclusions**

The hippocampus contributes to several important functional pathways that affect memory function. Together with the amygdala participate in the elaboration of emotional behavior. Knowledge of these neural networks will not only improve the interpretation of routine MR imaging of the brain, DTI and fMRI but also will influence the application of those techniques.

**KEYWORDS:** Diffusion Tensor Image, FMRI, Limbic System

**EdE-46**

**Neuroimaging of Cribriform Plate Lesions: A Comprehensive Pictorial and Educational Review**

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**Purpose**

The cribriform plate (CP) is a part of the ethmoid bone, and is also known as the horizontal lamina or lamina cribrosa ossis ethmoidali. Cribriform is indeed derived from the Latin word "cribrum" owing to its sieve-like perforations that transmit the olfactory nerves. Anatomically it straddles two cavities, forming part of the floor of the anterior cranial fossa, where it articulates with the ethmoidal notch of the frontal bone, and it also forms the roof of the nasal cavity. It therefore divides the intracranial cavity and brain from the nasal cavity and supports the olfactory bulb. Accordingly, the CP is at an anatomical crossroads for a great variety of important structures and a consequent wide range of diseases that can affect this anatomical region. Scant attention has been paid to comprehensive classification of the neuroimaging
manifestations of CP abnormalities. In this educational exhibit we review the neuroimaging findings of lesions involving the CP and classify them according to their etiology.

Materials and Methods
We review and present the imaging manifestations of a wide spectrum of pathologies originating from or involving the CP, and we classify these entities according to their etiology.

Results
We describe the imaging anatomy of the CP and the ethmoid bone. We comprehensively display a pictorial review and discussion of the imaging findings of lesions originating from the CP itself or invading it from adjacent structures. First we review congenital lesions (e.g., nasal meningocele, meningoencephalocele, nasal glioma and nasal dermal sinus cysts); then we discuss acquired benign pathologies such as mucoceles and fractures consequent to trauma. We review neoplastic lesions, both benign and malignant. Benign lesions include olfactory groove menigioma, olfactory Schwannoma, inverted papilloma, juvenile angiofibroma and dermoid or epidermoid, either within or outside nasal dermal sinus cysts. Malignant lesions include esthesioneuroblastoma, squamous cell carcinoma, sinonasal undifferentiated carcinoma, melanoma, olfactory neuroblastoma, rhabdomyosarcoma, sinonasal teratocarcinosarcoma, chordoma of the skull base and lymphoma. Bone lesions also may be divided into benign (e.g., fibrous dysplasia, ossifying fibroma, osteoma), or malignant, such as osteoblastoma, osteosarcoma, chondrosarcoma and metastases. Several infective and inflammatory diseases also affect the CP, namely: sinusitis, tuberculosis, and sarcoidosis. Rare findings include vascular lesions (e.g., dural arteriovenous fistulas and anterior ethmoidal artery aneurysms, or iatrogenic lesions) resulting in CSF leakage after anterior craniofacial surgery, or very rare cases of CP perforation during medical procedures within the nasal cavity.

Conclusions
Management strategies for lesions involving the CP vary substantially, depending on the abnormalities revealed on neuroimaging. We comprehensively review the wide spectrum of pathologies encountered in this often neglected area in neuroimaging. This presentation will aid in differentiating the many imaging appearances of lesions in this region.

KEYWORDS: Classification, Congenital, Educational

EdE-42

Radiologic Anatomy of the Larynx

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Purpose
The purpose of this exhibit is to provide a radiologic overview of laryngeal anatomy with CT and MR imaging (MRI), along with correlative laryngoscopically-obtained pictures and histologic sections. Understanding the radiologic anatomy of the larynx is critical for understanding patterns of disease spread along natural anatomical planes. It is also important for staging disease and treatment planning. For these reasons, both radiologists and clinicians should have a good understanding of normal laryngeal structures and their appearances on various imaging modalities.
Materials and Methods
Using CT and MR images, clinical and endoscopic photos, and histologic sections, this exhibit will review important anatomical structures of the larynx.

Results
The larynx is defined superiorly by the glossoepiglottic and pharyngoepiglottic folds superiorly and inferiorly by the lower margin of the cricoid cartilage. The cartilaginous scaffolding consists of the thyroid, cricoid and arytenoid cartilages. The larynx is divided into the supraglottic, glottic, and subglottic regions. Within the supraglottic larynx are five anatomical subsites: the suprahypoid epiglottis, infrahyoid epiglottis, laryngeal surface of the aryepiglottic folds, arytenoids, and false vocal cords. The glottis contains the true vocal cords and the anterior and posterior commissures. The subglottis extends from the inferior surface of the vocal fold and is difficult to visualize clinically. The mucosal surface of the subglottis is applied closely to the cricoid cartilage and should have a smooth surface. Laryngoscopy is very sensitive for mucosal pathology and laryngeal function. However, direct visualization of the deep structures of the larynx is solely the realm of radiologic imaging. With current CT and MRI resolution, structures of the larynx can be evaluated in great detail. Thus, a wide array of diverse pathology in addition to normal anatomy can be visualized.

Conclusions
Having a working knowledge of the complex anatomy and relationships within the larynx is critical to understanding the pathology of this region.

KEYWORDS: Anatomy, Larynx

EdE-57

So You Think You Know Sensori-Motor Brain Anatomy

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Purpose
To foster a deeper understanding among neuroradiologists of sensori-motor functional anatomy and deficits associated with brain injury.

Materials and Methods
Cadaver brain images and overlaid illustrations foster a 3-dimensional (3-D) understanding of cortical functional anatomy and deficit localization. Correlative normal brain MR imaging (MRI) and functional brain mapping promote a 2-D understanding of sensori-motor brain anatomy. Sensori-motor cortico-cortical integration is discussed. Imaging of selected brain lesions illustrates applications in clinical practice. A stepwise approach focuses specifically on primary sensori-motor, pre-motor, and higher order sensory functional anatomy and deficits.

Results
The key to understanding functional anatomy of the sensori-motor system on cross-sectional imaging is an understanding of sulcal and gyral landmarks. Identifying these landmarks can localize functional anatomy of primary sensori-motor, pre-motor, supplementary motor, and secondary somato-sensory systems. In addition to obvious functional deficits such as contralateral weakness or basic sensory dysfunctions, neuroradiologists need to be able to
localize higher order deficits such as apraxia, mutism, acquired stuttering, alien hand syndrome, impaired discriminative sensations, and tactile agnosia, among others. An understanding of deficits and functional localization at standard cross-sectional imaging can impact diagnostic search patterns, imaging diagnoses, and imaging recommendations in patients with stroke, tumor, and other conditions. Sulcal and gyral landmarks are critical in interpreting brain mapping activation in normal as well as pathologic brains.

Conclusions
Sensori-motor functional anatomy and deficit locations can be identified readily by neuroradiologists using sulcal and gyral landmarks. An understanding of the sensori-motor system can improve diagnostic accuracy at cross-sectional imaging and functional brain mapping. A thorough understanding of sensori-motor anatomy and dysfunction is critical for the practicing neuroradiologists.

KEYWORDS: Anatomy, Functional Brain Mapping, Sulcation

EdE-37

Spinal CSF Leak: Current Status, Imaging Techniques and Treatment

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Purpose
1. To enumerate causes of spinal CSF leak. 2. To review the relationship between spinal CSF leak and spontaneous intracranial hypotension. 3. To analyze the various imaging modalities for detection of spinal CSF leak including their advantages and disadvantages. 4. To discuss possible treatment options.

Materials and Methods
1. Understand the pathophysiology of spinal CSF leaks, their clinical presentation and complications including spontaneous intracranial hypotension. 2. Discuss imaging findings of conventional brain and spinal MRI, CT/MRI myelography and radionuclear studies. 3. To showcase illustrative cases and discuss their findings. 4. Discuss treatment options including conventional conservative treatment, blood patch and surgical Intervention.

Results
1. MRI findings include: A) brain: i) Bilateral subdural collection with diffuse pachymeningeal enhancement. ii) Sagging of the brainstem with tonsillar herniation, crowding and effacement of the suprasellar cisterns and reduction in the mammillo-pontine distance. B) Spine (postintrathecal injection of gadolinium): i) Spinal extradural fluid collection. ii) Dilated perineural root sleeves, thought to be potential site of CSF leakage. 2. Radionuclide study: For delayed leaks. 3. CSF opening pressure following lumbar puncture: less than 12 cm of H2O at level of the right atrium.

Conclusions
This exhibit aims to reinforce the role of the neuroradiologist in diagnosis and treatment of spinal CSF leaks and associated complications, including spontaneous intracranial hypotension (SIH).

KEYWORDS: Idiopathic Intracranial Hypotension, Myelography, Spinal CSF Leak
Subcortical Substrates of Cranial Nerve Functions

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¹Medical College of Wisconsin, Wauwatosa, WI, ²Medical College of Wisconsin, Milwaukee, WI

Purpose
To elucidate the subcortical networks subserving cranial nerve functions, using diagrammatic and MR imaging illustrations.

Materials and Methods
Color-coded subcortical nuclei and neural tracts subserving cranial nerve functions are presented diagrammatically. Corresponding color-coded nuclei within the thalami, basal ganglia, and brainstem and associated white matter networks are illustrated on multiplanar high resolution MR images and on 3D brain illustrations for intuitive reference. Various cranial nerve functional deficits are localized and recoverability is discussed.
Results
The importance of functional and anatomical knowledge of subcortical cranial nerve networks cannot be overemphasized. Despite awareness of these networks in the anatomical literature, their locations on imaging studies are not directly discernible and therefore may not be emphasized in imaging diagnoses. The literature is replete with cases of unexplained neurological symptoms without corresponding imaging findings, attributed to isolated involvement of cranial nerve tracts or nuclei by lacunar infarcts, small demyelinating plaques, or injury. Knowledge of cranial nerve network functions and locations is of clear importance in such instances. For example, pure sensory symptoms that can be explained by subtle lesions in subcortical nuclei of the thalami may be ignored or even attributed to psychiatric illness. In some cases, cranial nerve functions may be disrupted by unilateral subcortical lesions, but may show considerable recoverability due to bilateral representations or alternate pathways. In other cases, bilateral lesions associated with conditions such as stroke, demyelinating disease, or trauma may be required to produce deficits. Debilitating sensory or motor modulatory symptoms may be manifest by disruption of bilateral subcortical substrates, but may be temporally separated. Cranial nerve dysfunction associated with neurodegenerative diseases may not be apparent on imaging, but an understanding of the same will facilitate an accurate diagnosis. Poor understanding of the functions and locations of subcortical cranial nerve networks engenders apathy toward correlative diagnoses in these areas. An intuitive understanding of cranial nerve subcortical functional networks empowers clinical neuroradiology.

Conclusions
Small subcortical lesions may produce debilitating deficits in cranial nerve functions. Tracts and subcortical nuclei of the thalami, basal ganglia, and brainstem form the basis of important cranial nerve circuitry. A conscious appreciation of subcortical cranial nerve network functions and anatomical locations will foster the proper diagnoses of cranial nerve disorders.

KEYWORDS: Anatomy, Cranial Nerves

EdE-56

Temporal Run: A Pictorial Essay of CNS Lesions with Predilection to the Temporal Lobes.

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Purpose
The aim of this exhibit is to review different pathologies and etiologies of lesions which have predilections for the temporal lobes, including but not limited to herpes simplex encephalitis, ganglioglioma, mesial temporal sclerosis, CADASIL (Cerebral Autosomal-Dominant Arteriopathy with Subcortical Infarcts and Leukoencephalopathy), and trauma, and to review each of their characteristic imaging findings. Their clinical presentations, course and treatment also are discussed.

Materials and Methods
Noteworthy cases are divided into different categories such as infection or inflammation, tumor, trauma, ... ... They include herpes encephalitis, ganglioglioma, mesial temporal sclerosis,
contusion/hemorrhage, CADISIL disease, etc. Initial discussion focuses on presenting clinical signs and symptoms and diagnostic planning. Different imaging modalities from initial studies to advanced techniques, including CT, MR, and CTA, PET, nuclear medicine study, then will be illustrated for each case. Post-treatment clinical course and available follow-up imaging also will be included.

Results
1. Discuss etiologies and mechanisms behind each of the provided examples of temporal lobe lesions. 2. Focused characteristic imaging findings for each of the provided diagnosis with emphasis on advantages and disadvantages of various imaging modalities/techniques. 3. Discuss differential diagnoses and the consequences of misinterpretation. 4. Discuss importance of treatment, plans of intervention, and characteristic imaging findings during post-treatment and resolution phase.

Conclusions
There are a number of interesting cerebral lesions which have a predilection for the temporal lobes. Due to the redundant nature of the function of the temporal lobes, clinical signs and symptoms often can be subjective, leading to either delayed or missed diagnoses. At the end of the presentation, the viewer will become familiar with causes, clinical findings, diagnostic imaging features, consequences of interpretations, and plans of treatment.

KEYWORDS: Brain Abnormalities, Multimodality Imaging
What Stems from the Brainstem?

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Purpose
Pathologies affecting the brainstem are diverse and occasionally can be challenging to differentiate on imaging because of their nonspecific appearance. The purpose of this exhibit is to categorize brainstem lesions and to describe their epidemiology, presentation, key imaging findings and differential diagnoses.

Materials and Methods
Brainstem lesions can be classified as focal or diffuse, with further subdivisions based on etiology. A search of our PACS will be undertaken to identify patients with brainstem lesions. The cases that best illustrate the typical imaging findings of lesions in each category will be retained and used as examples in this exhibit.

Results
Brainstem lesions can be classified as focal or diffuse. Focal lesions are generally well defined and confined to a single brainstem segment, whereas diffuse lesions are larger, with ill defined borders, occupying more than half of a brainstem segment, or extending across more than one segment. Focal and diffuse brainstem lesions can be further subdivided into tumor, ischemic, infectious, demyelinating, degenerative, metabolic, traumatic, and vascular. Some of these entities can present both as focal and as diffuse lesions. Examples of each category will be illustrated with cases from our institutions, and their characteristics and imaging findings will be highlighted.

Conclusions
Because brainstem pathologies can be so diverse, it is useful to divide them into categories to facilitate conceptualization. Placing brainstem lesions into categories, presenting different examples in each category, and reviewing their characteristics will enable better differentiation and identification of such lesions on imaging.

KEYWORDS: Brainstem, Classification, Masses
“Stop and Smell the Roses”: Olfactory Dysfunction from Lesions along the Olfactory Pathway

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Purpose
Review the olfactory pathway and imaging features of lesions that can cause decreased olfaction.

Materials and Methods
The anatomy of the olfactory system and the radiologic findings of different pathologic processes along the olfactory pathway will be discussed. These include sinonasal infections, neoplasms such as esthesioneuroblastoma and olfactory groove meningioma, traumatic
intracranial injury, neurodegenerative diseases such as Alzheimer disease, and congenital disorders such as CHARGE syndrome (ocular Coloboma, heart defects, choanal atresia, retarded growth/development, genital anomalies, and characteristic ear anomalies) and Kallmann syndrome.

Results
Anosmia/hyposmia is the loss of smell or diminished sense of smell, and can be caused by lesions that affect the olfactory pathway. Knowledge of the olfactory anatomy therefore aids in the imaging evaluation of disorders affecting the sense of smell. Olfaction is induced by the stimulation of olfactory receptors, located in the roof of the nasal vault. This information is transmitted by the olfactory nerves to the olfactory bulbs through the cribriform plate. The olfactory bulbs then give rise to the olfactory tracts, which project to areas of the brain including the olfactory nucleus, piriform cortex (uncus and anterior parahippocampal gyrus), amygdala, and entorhinal cortex. There also are connections with the dorsomedial thalamus, insula, hippocampus, and orbitofrontal cortex. Sinonasal infections, both acute and chronic, are a common cause of olfactory disturbance. This is felt to be secondary to olfactory mucosal edema and nasal airflow obstruction to the olfactory receptors. Neoplasms, such as esthesioneuroblastoma and olfactory groove meningioma, also can affect olfaction. Esthesioneuroblastoma arises from the olfactory epithelium in the nasal vault and directly involves the olfactory receptors. An anterior skull base mass such as a meningioma can cause secondary compression of the olfactory bulbs and tracts, thereby affecting olfaction. Traumatic injury can injure or shear the olfactory fibers at the cribriform plate via a coup or contra-coup mechanism. Trauma affecting the orbitofrontal regions or temporal lobes also can affect olfaction. Decreased olfaction has been documented in neurodegenerative disorders such as Alzheimer disease. This is felt to be due to disproportionate volume loss of central olfactory structures such as the temporal lobes and hippocampus. Congenital disorders such as CHARGE and Kallmann syndromes are associated with anomalies of the olfactory sulci, bulbs, and tracts, which can be hypoplastic or aplastic.

Conclusions
Decreased olfaction traditionally has been overlooked compared to other cranial nerve dysfunction. Although there is a broad differential for olfactory deficits, knowledge of the anatomy of the olfactory system facilitates the imaging evaluation of patients presenting with anosmia or hyposmia.

KEYWORDS: Cranial Nerve Pathology, Olfaction

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Education Exhibits (Print) - Head and Neck
EdE-69

Clinical and Radiological Assessment for Staging of Laryngeal Cancer

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Purpose
Radiological imaging and clinical and endoscopic information have critical complementary roles in the staging and treatment planning for laryngeal cancer; over 90% of which is squamous cell carcinoma. While endoscopy is superior in assessing disease of the mucosal surface, imaging with CT and MRI best assesses deep extension. Accurate pretreatment staging will ensure appropriate treatment and lend toward a more favorable prognosis. It is therefore essential that the radiologist be familiar with anatomy of the laryngeal spaces and regional architecture in order to fully characterize spread of disease, and thereby, tumor stage.

Materials and Methods
Using CT and MR images, clinical and endoscopic photos and pathologic specimens, this exhibit will review important imaging features and regional subsites of laryngeal cancer spread.

Results
Tumors arising in the larynx can be divided into three types by region: supraglottic, glottic, or subglottic tumors. For the purposes of staging, the supraglottis is divided into five subsites: suprathyoid epiglottis, infrahyoid epiglottis, laryngeal surface of the aryepiglottic folds, arytenoid cartilages, and false vocal cords. For the glottis, the important components to evaluate are the vocal folds and anterior and posterior commissures as well as evidence for invasion of the thyroid cartilage. Although involvement of the anterior or posterior commissures does not alter tumor stage, it often can alter surgical approach and this observation is important to report. The subglottis extends from the inferior aspect of the vocal cords to the inferior margin of the cricoid and is bounded laterally by the conus elasticus. Imaging of the subglottic region is particularly important as endoscopic evaluation is limited to the mucosa. Involvement of cricoid cartilage mandates total laryngectomy. For each laryngeal region, tumor bulk beyond the subsite of origin will alter staging with multiple subsite involvement or transglottic spread of tumor classified as T2. Additionally, vocal cord fixation, paralaryngeal or pre-epiglottic tumor extension or partial cartilaginous invasion will further upstage a laryngeal tumor to T3. Extralaryngeal or transcartilaginous invasion will upstage to T4a while invasion into the prevertebral space, mediastinum, or carotid artery adventitia to T4b indicating unresectability. Initial assessment of possible cartilaginous invasion is done by imaging alone, and although specificity and sensitivity of CT and MR are variable and particularly low for early invasion, the presence of invasion alters treatment; favoring extensive surgical resection over nonsurgical organ preservation therapies such as radiation or chemoradiation therapy. Evaluation of nodal status and distant metastatic disease conclude the T-N-M staging.

Conclusions
Knowledge of laryngeal regional subsite involvement and accurately reporting tumor extension will aid in accurate assessment of pretreatment staging and treatment options; thereby optimizing patient prognosis.

KEYWORDS: Larynx, Squamous Cell Carcinoma, Staging

EdE-64

Deep Soft Tissue Venous Malformations of the Neck: Imaging Pitfalls to Avoid in the Adult

B Chandrasekaran¹, G Berberian¹, D Kowal¹
Purpose
Venous malformations are slow-flow vascular malformations, the most common vascular malformation and occurring in approximately 1% of the population. However, venous malformations are uncommonly seen in the neck of the adult, where if present may be mistaken for more aggressive neoplastic lesions, leading to unnecessary and invasive testing. Our purpose is to comprehensively review the characteristic CT, MRI, ultrasound and scintigraphic imaging findings of these lesions through case presentation, highlighting techniques to avoid pitfalls and misdiagnosis.

Materials and Methods
We review the imaging findings in three patients with soft-tissue venous malformations, describing the specific imaging features using a multimodality approach. Patients with venous malformations in the posterior cervical triangle, submandibular space, and masticator space will be presented. Comparison to common neck malignancies such as adenoid cystic carcinoma will be performed for contrasting purposes.

Results
Vascular anomalies of the head and neck can be divided into vascular neoplasms (such as infantile hemangioma) and vascular malformations. Hemangiomas and other benign vascular neoplasms are characterized by proliferation of endothelial cells, are typically present at birth, and often spontaneously involute. Vascular malformations result from abnormal morphogenesis of blood and lymphatic blood vessels and can present at any age including adulthood. Vascular malformations are divided into low-flow and high-flow lesions, with low-flow lesions further divided into venous, lymphatic, and venolymphatic malformations. Depending on their location, venous malformations can be confused with malignant neoplasms if their characteristic imaging appearance is not realized. On noncontrast CT, venous malformations typically are well circumscribed lobulated masses containing characteristic calcified phleboliths. A variable but predominantly avid enhancement pattern on contrast-enhanced studies typically is seen. The excellent contrast resolution of MRI allows for detailed evaluation of the extent of the lesion and its relationship to adjacent structures, including the preservation of surrounding fat planes. On T2-weighted imaging, venous malformations classically appear as multiple high-signal-intensity lobules. Areas of fibrosis, calcification, phleboliths and thrombus appear as low signal intensity with blooming present on gradient echo sequences. Avid postcontrast enhancement usually is present. Red blood cell scintigraphy can be a powerful problem-solving tool showing specific intense, slow filling and persistent late-phase uptake.

Conclusions
In summary, we present three cases of neck soft tissue venous malformations in adult patients illustrating the specific multimodality imaging features of these benign lesions. Awareness of these features can prevent unnecessary invasive testing, and guide the patient toward more appropriate testing such as red blood cell scintigraphy.

KEYWORDS: Venous Malformations
Dental Disease: A Frequently Misdiagnosed Source of Head and Neck Pathology

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Purpose
Dental disease often is overlooked as a potential source of head and neck pathology, frequently resulting in misdiagnosis. A familiarity with the various imaging manifestations of dental disease will help prevent this. This exhibit will illustrate examples of dental pathology that has potential to be confused with other head and neck disease processes.

Materials and Methods
A retrospective review of our teaching files has yielded a number of clinical cases demonstrating dental disease that was misdiagnosed initially or had the potential to be confused with other head and neck pathologies.

Results
A few examples of the cases that will be presented in this exhibit that were misdiagnosed initially or had the potential for misdiagnosis are as follows: 1. Endodontal infection initially
misdiagnosed as infected submandibular gland with cutaneous fistula. 2. Endodontal infection initially misdiagnosed as calculus with associated inflammation in parotid gland duct near 2nd maxillary molar. 3. Oroantral fistula following tooth extraction initially misdiagnosed as maxillary sinusitis, unresponsive to treatment. 4. Osteitis condensens (sclerosis of bone surrounding chronic dental infection) initially misdiagnosed as an osteoblastic malignancy. 5. Endodontal infection initially misdiagnosed for a soft tissue tumor.

Conclusions
Dental disease is a common source of head and neck pathology that often is overlooked. A working knowledge of dental disease and its imaging manifestations will aid in preventing potential misdiagnoses. Endodontal disease, periodontal disease, and dental anatomy is reviewed in a separate submission entitled "Endodontal and Periodontal Disease Made Ridiculously Simple: A Radiologist's Guide."

KEYWORDS: Oral Cavity

EdE-75

Ears Looking at You: A Pictorial Essay of Middle Ear Pathology Correlating Temporal Bone CT with Archived Otoscopic Photographs

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Purpose
To demonstrate the utility of correlating temporal bone CT with archived otoscopic images to refine the differential diagnosis of common middle ear pathologies.

Materials and Methods
The medical image archive at our institution recently has been expanded to include otoscopic photographs taken by the ENT specialist during the physical examination. The availability of these images at the time of CT interpretation significantly impacts the neuroradiologist's ability to narrow the differential diagnosis of middle ear disease.

Results
The temporal bone CT and correlative otoscopic appearance of common inflammatory, vascular, neoplastic, traumatic and congenital conditions of the middle ear are presented. The impact of the otoscopic appearance on CT interpretation is discussed.

Conclusions
The radiographic differential diagnosis of middle ear disease can be refined using otoscopic images uploaded to a common institutional image archive leading to a more concise interpretation of temporal bone CT findings.

KEYWORDS: Anatomy, Temporal Bone

EdE-78

Endodontal and Periodontal Disease Made Ridiculously Simple: A Radiologist’s Guide.
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Purpose
Endodontal and periodontal disease are frequent causes of Head and Neck pathology, including facial swelling, sinus tracts, fistulas, masses, abscesses, sinus disease, etc. Unfortunately, radiologists traditionally have had little understanding of dental disease, thus causing endodontal and periodontal lesions to be confused with other pathologies. This exhibit reviews the pertinent dental anatomy and elucidates the radiographic manifestations of endodontic and periodontal disease and its treatment.

Materials and Methods
Retrospective review of our teaching files has yielded clinical cases that will be used to demonstrate the imaging appearances of endodontic and periodontal disease.

Results
Endodontal disease: The vital structure of the tooth, the neurovascular bundle, enters from the apical foramen at the root apex and travels up the radiolucent root canal to access the radiolucent pulp chamber within the crown. Dental caries (cavity) refers to bacteria that cause demineralization of the tooth. Caries may erode through enamel and dentin to access the pulp chamber, resulting in pulpitis. The infection then may travel down the root canal forming an abscess or granuloma at the root apex. This infection causes resorption of bone around the root apex creating periapical radiolucency. Treatment: Endodontal disease is treated with a root canal procedure in which the dentist gains access to the pulp chamber by drilling through the crown. He next uses special endodontic files to remove the infection and shape the root canals. The root canals then are sealed with gutta percha, a radioopaque latex material. A crown, which sometimes requires posts for more support, will therefore be used to restore the tooth.

Periodontal disease: The teeth are held in the bony socket by the periodontal ligament, which attaches to the cementum of the root and the lamina dura of the socket. Bacteria-laden plaque on the teeth may lead to inflammation of the gums (gingivitis). The hyperemia from this inflammation often results in bleeding gums. The infection then can extend into the periodontal ligament (periodontitis) along the lateral surface of the root, eroding bone and creating a space, or periodontal pocket. Radiographically, these lesions appear as lucencies associated with bone loss at the lateral surface of the tooth. Treatment: The periodontal pocket is curettaged to remove the infection and necrotic tissue. The remaining defect then is packed with bone graft material and allowed to heal. Tissue stimulating proteins also may be used to enhance bone growth.

Conclusions
A working knowledge in combination with a systematic approach to endodontal and periodontal disease will aid radiologists in understanding the role these lesions play in Head & Neck pathology. These dental related pathologies will be addressed in a separate submission entitled "Dental Disease: A Frequently Misdiagnosed Source of Head & Neck Pathology."

KEYWORDS: Oral Cavity
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Purpose
Horner's syndrome is a classic neurologic syndrome characterized by the triad of ptosis, miosis and anhydrosis. It results from an interruption of the oculosympathetic pathway. It is classified into three types (central, preganglionic and postganglionic) depending on the location of the lesion. We present a brief review of the anatomy of the oculosympathetic pathway, describe the clinical features of the three types of Horner's syndrome and neuroimaging strategies.

Materials and Methods
Reviewing the literatures on PubMed about imaging in Horner's syndrome in the last 30 years. We also reviewed the anatomy of the oculosympathetic pathway and database of Horner's syndrome in our institute.

Results
Horner's syndrome results from an interruption of the oculosympathetic nerve supply to the eye and is characterized by the classic triad of ptosis, miosis and anhydrosis. It is classified into central, preganglionic and postganglionic types according to the location of the lesion in the first, second and third-order neurons; respectively. The neural pathway affected in Horner's syndrome is complex, it extends from the hypothalamus, brainstem, spinal cord, upper thorax, neck, skull base to the eye. The associated clinical presentation varies in every location. The differential diagnosis is broad and the pathology ranges from a benign to a life-threatening condition. It needs clear combined clinical, pharmacological and imaging guide to establish the diagnosis and the underlying cause.

Conclusions
The various clinical presentations of Horner's syndrome have to be known in order to tailor the appropriate imaging at the correct anatomical site in order to provide the diagnosis. This presentation provides an imaging teaching tool to review the anatomy and clinical correlations of the complex pathway that may be affected in Horner's syndrome and offers examples of several pathologies that lead to this clinical presentation.

KEYWORDS: Horner'S Syndrome

EdE-62
6:30AM - 9:00PM

How to Use Lymphotropic Superparamagnetic Iron Oxide Nanoparticles to Improve Accuracy of Malignancy Detection in Cervical Lymph Nodes on Magnetic Resonance Imaging

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Purpose
Detection of malignant cells in lymph nodes is critically important for staging and treatment planning. Undetected malignant cells can serve as a cancer reservoir, predisposing the patient to recurrence, and making it difficult or impossible to cure the disease. The crucial pretreatment
knowledge of whether each cervical lymph node harbors malignancy currently primarily depends on anatomical characteristics such as size and morphology. The accuracy of these indicators is suboptimal because metastatic disease can be present in small nodes, whereas infections and other benign causes can enlarge nodes beyond the size criteria. While other technologies such as positron emission tomography can be useful, they too suffer accuracy limitations particularly in small nodes. There is a need for a better method to evaluate lymph nodes for malignant disease, and the relatively new technology of superparamagnetic iron oxide nanoparticles (SPIONs) as contrast agents for magnetic resonance (MR) imaging has been shown to be useful for this purpose.

Materials and Methods

The SPION-containing agent currently commercially available in the United States is ferumoxytol, although its use for MR contrast is an off-label indication. Ferumoxytol is an intravenous iron replacement product which was approved by the Food and Drug Administration (FDA) in 2009 for the treatment of iron deficiency anemia in adults with chronic kidney disease (1). The drug contains superparamagnetic iron oxide magnetite (Fe3O4) particles coated with polyglucosan sorbitol carboxymethyl ether, with a colloidal particle size of 17-31 nm diameter. The carbohydrate shell shields the iron oxide from plasma, until the particles are taken up by macrophages of the reticuloendothelial system. Ferumoxtran 10, an alternative SPION-containing agent, has been used for many of the early studies of this technique, but is not currently approved by the FDA. MR scanning is first performed prior to administration of the agent utilizing standard sequences. The SPION agent is administered, and then the patient returns approximately 48 hours afterwards for post-SPION imaging. The timeframe is chosen to optimize relocation of the particles to the reticuloendothelial system, in particular within lymph nodes. SPIONs are useful as contrast agents for MR imaging due to physiologic localization to normal lymph nodes, and magnetic susceptibility properties enabling visualization on MR images. Superparamagnetism of these particles causes T2* dephasing, resulting in hypointense signal on gradient-recalled echo (GRE) T2*-weighted sequences.

Results

On the MR images post-SPION administration, lymph nodes are evaluated primarily on T2*-weighted sequences. In benign lymphatic tissue, the SPIONs within macrophages cause local magnetic susceptibility and thus decreased T2* signal. In foci of tumor infiltration, the macrophages and particles are not present and therefore the signal remains unchanged from precontrast images. The fatty hilum is also unchanged, but can be differentiated based on signal characteristics on other sequences included in the exam. One of the largest studies performed evaluating this technique was a phase III study of SPIONs for evaluation of neck and body lymph node metastases (2). The study found sensitivity, specificity, and accuracy of 54%, 82%, and 68%, respectively based on size; 83%, 77%, and 80% after administration of a SPION agent; and 96%, 87%, 93% in the subgroup of head and neck cancers. These results reveal that SPION-enhanced imaging is superior to traditional size-based criteria, and works specifically for head and neck cancers. This technique can be used on existing MR scanners with an FDA-approved medication (although off-label). Ferumoxytol is relatively safe and well tolerated. In clinical trials, anaphylaxis was reported in 0.2% of subjects, and other hypersensitivity type reactions in 3.7% (1). An additional benefit of ferumoxytol is that it is safe in patients with renal insufficiency, as its primary indication is in adults with chronic kidney disease, in contradistinction to gadolinium-based contrast agents which are typically avoided in these patients.
Conclusions
SPIONs are useful as contrast agents in MR imaging through localization to macrophages in normal lymph nodes and inducing magnetic susceptibility. Benign nodes become hypointense on T2*-weighted sequences after SPION administration, whereas foci of malignant cells do not change signal. SPION agents have been shown to improve sensitivity, specificity, and accuracy in head and neck lymph node evaluation for malignancy. A SPION-containing agent is commercially available, and the technique can be used on existing MR scanners. While further advances will continue to improve this technology and increase the body of evidence demonstrating its accuracy, SPION technology has arrived in the clinical realm and can benefit patients.

KEYWORDS: Contrast Agents, Lymph Node Metastasis, MR Imaging

EdE-68
Imaging Hemifacial Spasm

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Purpose
Hemifacial spasm (HFS) is a severe and disabling condition characterized by unilateral facial nerve hyperactive dysfunction. Vascular compression of the facial nerve is the most common etiology of HFS; however, not all segments of the facial nerve are equally susceptible to compression. The purpose of this exhibit is to discuss the anatomy and vulnerable portions of the facial nerve and to demonstrate the imaging appearances of those patients who were successfully treated with microvascular decompression.

Materials and Methods
Following a review of the pertinent facial nerve anatomy, the imaging appearances of vascular compression in patients with HFS who were treated successfully with microvascular decompression will be reviewed. The pertinent imaging protocols also will be presented.

Results
Pulsatile vascular compression is the most common cause of HFS. The facial nerve emerges from the brainstem within the pontomedullary sulcus and then adheres to the undersurface of the pons for 8-10 mm, referred to as the adherent segment. It then separates from the pons at the root detachment point. The transition zone extends laterally from the root detachment point for approximately 4 mm and is the area where the central glial myelin transitions into the peripheral myelin created by Schwann cells. Lateral to the transition zone is the cisternal segment of the facial nerve. The vulnerable segment of the facial nerve begins at the pontomedullary sulcus and extends to the lateral aspect of the transition zone. Many neuroradiologists are unaware of the fact that the facial nerve is adherent to and vulnerable to arterial compression along the undersurface of the pons. Furthermore the majority of cases of vascular compression causing hemifacial spasm occur along this adherent segment. Dedicated thin section multiplanar steady-state free precession MR images and anatomical knowledge of the vulnerable regions of the facial nerve allow for identification of the offending vessels and delineation of compression points that would be amenable to microvascular decompression.
Conclusions
Hemifacial spasm is a rare but debilitating disorder, most commonly caused by vascular compression of the facial nerve proximal to its cisternal segment. Knowledge of the anatomy and vulnerable portions of the facial nerve and utilization of specific MR imaging protocols is critical to correctly identify patients who are candidates for microvascular decompression, to locate the culprit arterial vessel, and to guide surgical management. Failure to identify vascular compression of the proximal facial nerve can delay or prevent neurosurgical referral and potential cure.

KEYWORDS: Cranial Nerve Pathology

EdE-80

Imaging of the External Auditory Canal

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Purpose
Lesions of the external auditory canal (EAC) can present a diagnostic dilemma to both clinicians and radiologists. The purpose of this exhibit is to present a simplified approach to evaluating acquired EAC lesions in adults. The imaging appearance of common lesions which occur in the EAC will be reviewed.

Materials and Methods
From an imaging standpoint, lesions of the EAC may be categorized into erosive and nonerosive etiologies, which will be the focus of this education exhibit.

Results
The walls of the EAC comprise a medial osseous and a lateral cartilaginous component. Erosion of the osseous segment of the canal suggests an infectious, inflammatory or malignant etiology. Abnormal osseous erosion may be a result of a cholesteatoma, infections such as malignant otitis externa, or malignancy. The most common malignancy to involve the EAC is squamous cell carcinoma. Less common malignancies include adenoid cystic carcinoma, melanoma, sarcoma, metastasis and lymphoma with variable associated erosive changes. Intracranial extension or perineural spread are important findings to convey to the referring surgeon. Nonerosive EAC lesions are more likely benign. Considerations include osteoma, exostosis, keratosis obturans, and benign neoplasms such as a pleomorphic adenoma. Several of these lesions have a characteristic imaging appearance that may allow for a specific radiologic diagnosis.

Conclusions
External auditory canal lesions can be categorized into erosive and nonerosive lesions. Within these categories many lesions have a characteristic imaging appearance that suggest specific diagnoses.

KEYWORDS: Cholesteatoma, ENT, Squamous Cell Carcinoma
EdE-65

Imaging of the Glaucoma Drainage Implants

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Purpose
1. Pictorial review of the most commonly used glaucoma drainage implants. 2. Discuss the CT and MR appearance of glaucoma drainage implants. 3. Identify the normal postsurgical changes, and differentiate it from possible pathologies. 4. Delineate the role of imaging in diagnosis of postsurgical complications associated with glaucoma drainage implants in a case-based review. 5. Explore the possible pitfalls in imaging interpretation of these implants.

Materials and Methods
The structure and functional mechanism of each type of glaucoma drainage implant will be discussed briefly using several photographs and graphics. Intra-operative images will be used to illustrate the surgical technique and anatomical concept of these implants. CT and MR images of a series of glaucoma drainage devices will be reviewed, with pearls to help identify the normal in vivo appearance of these devices, expected postsurgical changes, and associated pathologies. The Ahmed glaucoma valve, the most commonly used glaucoma drainage device, will be emphasized. Imaging findings associated with different surgical techniques, including scleral flap versus scleral or pericardial graft, will be discussed using a case-based review.

Results
A glaucoma valve consists of a small plate with a valve that regulates the intra-ocular pressure (IOP), and a tube that drains aqueous humor. A scleral flap or graft covers the implant. Glaucoma drainage devices are designed to divert aqueous humor from the anterior chamber to an external reservoir, where a fibrous capsule forms about 4-6 weeks after surgery and regulates flow. The plate of the glaucoma valve is made of radiopaque material, in curvilinear configuration conforming the curvature of the globe. On CT images, the plate is seen as convex density along the superotemporal aspect of the globe. Fluid and low density fibrotic tissue is seen around the reservoir within the scleral pocket in the majority of the late postsurgical imaging. This finding is a pitfall for misinterpretation as an abscess or abnormal fluid collection. Edematous periocular tissue adjacent to the glaucoma valve is another important postsurgical change caused by drainage of the aqueous humor to the reservoir, commonly appreciated on CT images. On MR images, low signal plate and nonenhancing bleb in the superotemporal quadrant of the globe delineate the presence and position of the glaucoma valve. Infection of the implant and endophthalmitis are rare complications of glaucoma valve implantation. The infection-related imaging findings include periorbital soft tissue and uveoscleral thickening, edema, and abnormal enhancement on CT and MR images. Giant reservoir formation is another rare postsurgical complication manifested on cross-sectional imaging. Detailed image review is essential to differentiate the abnormal findings from expected postsurgical changes.

Conclusions
This pictorial exhibit will provide practical information for the radiologist to accurately and comprehensively diagnose and interpret the imaging findings in the presence of glaucoma drainage implants.
Non vascular Neck Imaging with MRI and CT: When to Use and Which to Pick

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Purpose
The neck is an anatomically complex region affected by a variety of complex disease processes well visualized by advanced neuroimaging modalities like CT and MR imaging (MRI). The purpose of this educational exhibit is to review the clinical indications for nonvascular head and neck imaging using CT and MRI, to identify their relative strengths and weaknesses and to compare their performance across a variety of indications for head and neck imaging.

Materials and Methods
Literature review of guidelines for head and neck imaging with MRI and CT including ACR appropriateness criteria, National Guidelines Clearinghouse, National Comprehensive Cancer Network (NCCN) and European/International sources, Literature review using Pubmed for studies comparing the performance of CT/MRI in the neck.

Results
Review common indications for nonvascular CT neck with contrast, without contrast. Review common indications for nonvascular MRI neck. Review benefits and drawbacks of CT and MRI. Review benefits /drawbacks of CT and MRI for the following regions orbits: temporal bones, suprahypoid neck, Infrahypoid neck including thyroid.

Conclusions
Both MR and CT are powerful imaging modalities for visualization of nonvascular neck pathology in appropriately selected patients. While MR or CT may be clearly superior for specific clinical indications (for example evaluation of perineural spread or marrow abnormalities with MRI), in many cases the decision to use one modality over the other may be determined more by the patient than by the indication.

KEYWORDS: Neck Infections, Neck Lesions, Neck Masses

Occlusion of the Internal Auditory Canal Alters Cochlear Fluid Homeostasis: A New Mechanism Explaining Hearing Loss Due to Vestibular Schwannomas

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Purpose
To present the imaging findings that support the new hypothesis that occlusion of the internal auditory canal (IAC) alters cochlear fluid homeostasis eventually resulting in SNHL.
Materials and Methods
Representative MR imaging (MRI) findings from neurofibromatosis 2 (NF2) patients enrolled in a natural history study, using high-resolution FLAIR imaging to suppress signal from normal endolymph and perilymph to reveal subtle alterations in the protein content of these intralabyrinthine fluids were reviewed.

Results
Cases with SNHL demonstrated abnormal signal from the labyrinth. Cases with normal intralabyrinthine fluid signal demonstrated normal hearing. Cases with an occluded IAC (no CSF communication from the CPA to the modiolus) typically had an abnormal labyrinth signal. Cases with no occlusion invariably had normal signal. Particularly instructive were (1) cases of very small tumors with profound SNHL and (2) cases of large tumors with normal hearing. Examples of (1) show that these small tumors were situated at the fundus of the IAC, occluding the cribriform area that normally permits communication between the CSF and the cochlea. In congruence with the hypothesis, elevated protein in the cochlea was demonstrated in these cases. Examples of (2) revealed that the IAC has remodeled around these large tumors such that a pathway of CSF from the cerebellopontine angle cistern can be demonstrated. In these cases with normal hearing, FLAIR signal in the inner ear was normal.

Conclusions
Because vestibular schwannomas of the internal auditory canal impinge upon the cochlear nerve, the mechanisms postulated for the associated SNHL typically focus more on the nerve than on the sensory end organ. However, two common observations cannot be explained by a nerve centered mechanism. First, is the dissociation of SNHL and tumor size. Many patients with small tumors suffer from a profound SNHL, and, conversely, many patients with large tumors have preserved hearing. Second, significant facial nerve dysfunction is almost never found even for large tumors, even though there is no a priori reason why the facial nerve and the cochlear nerve should respond differently to pressure exerted from a vestibular schwannoma. The detection of abnormal signal in the labyrinth in those patients with SNHL indicates that pathology in the sensory end organ is a necessary condition for SNHL. But, if the tumor is not in the labyrinth, what accounts for this biochemical degradation? Because there is a normal communication of CSF with the perilymph, these observations can be explained by the following cascade of events: (1) tumor growth leads to (2) occlusion of the IAC which results in (3) alteration of normal cochlear homeostasis (accumulation of protein in the cochlea) (4) which eventually leads to hearing loss. Occlusion of the IAC is proposed as the inciting event that leads to audiovestibular dysfunction in NF2 patients with vestibular schwannoma. Hyperintense signal in the labyrinth on FLAIR MRI demonstrates the accumulation of protein within inner ear fluids representing the alteration of cochlear homeostasis which is an intermediate stage in this process.

KEYWORDS: Acoustic Schwannoma, Hearing, Internal Auditory Canal

EdE-63
6:30AM - 9:00PM

Ophthalmic Artery: Angiographic Anatomy, Anatomical Variants and Collaterals

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Purpose
The purpose of this exhibit is to briefly summarize the usual origin, development, and branches of the ophthalmic artery as well as its anatomical variants in origin and collateral flow by using angiographic imaging.

Materials and Methods
A literature search of review of the anatomy, anatomical and angiographic variants, and collateral routes of the ophthalmic artery was performed and relevant case reports will be obtained from Northwestern Memorial Hospital. A review of normal origin, development, and branches of the ophthalmic anatomy as well its anatomical variants in origin and collateral flow will ensue with examples from angiographic imaging.

Results
We will review: 1. The segments and branches of the ophthalmic artery. 2. The embryology of the ophthalmic artery with special emphases on description by Padget and Lasjaunias, et al. 3. The variants in origins of the ophthalmic artery, the most common of which is the middle meningeal artery. Other variants in origin (i.e., persistent dorsal ophthalmic artery) involving the ophthalmic artery also will be discussed with special emphasis on the clinical significance of the relevant variations. 4. The several potential orbital collateral routes from the external carotid artery to the ophthalmic artery will be discussed as well. The most common of these involves the middle meningeal and anterior deep temporal arteries.

Conclusions
Several variants can involve the origin of the ophthalmic artery, the most common of which involves the middle meningeal artery, which also serves as a collateral route with connection between the external carotid and ophthalmic artery. MR and traditional angiography can play an important role in differentiating and identifying these variants in origin. By reviewing the common variants in origin and collateral routes of the ophthalmic artery, the radiologist will be able to provide surgeons and/or interventionalists with relevant information that can prevent blindness during surgical or embolization procedures.

KEYWORDS: Ophthalmic Artery

EdE-74

6:30AM - 9:00PM

Pediatric Parotid Lesions: Review of Pathologic Entities and Role of MR Sialography

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Purpose
Parotid lesions in the pediatric and adult population may arise from a variety of pathologies, many with nonspecific imaging appearances. Many of these entities are mistaken for only occurring in the adult population. We present a review of the various pathologic entities affecting the pediatric parotid gland with imaging examples, emphasizing characteristic imaging appearances of certain pathologic entities.
Materials and Methods
Pediatric parotid lesions are presented by pathologic category: inflammatory/infectious, congenital/developmental, autoimmune, adenopathy, mesenchymal neoplasia, benign parenchymal neoplasia, and malignant parenchymal neoplasia. Otolaryngologic epidemiological data is reviewed to show relative incidences of lesions in pediatric and adult populations. Role of specialized imaging, including ultrasound, conventional and MR sialography is highlighted.

Results
Pediatric parotid lesions can be classified as inflammatory/infectious, congenital/developmental, autoimmune, adenopathy, mesenchymal neoplasia, benign parenchymal neoplasia, and malignant parenchymal neoplasia. • Inflammatory/infectious etiologies are far more common than neoplastic changes in children compared to adults. Diffuse bilateral gland enlargement can be seen in acute bacterial and viral inflammation, however lymphoma may rarely have a similar appearance. Juvenile recurrent parotitis, presenting in mid-childhood and frequently resolving by puberty, has characteristic ultrasound and MR imaging appearances of multifocal punctate sialectasis, partially overlapping with HIV sialopathy, which can be distinguished with serologic testing. • Congenital/developmental lesions are most commonly hemangiomas and venolymphatic malformations. Hemangioma, the most common neonatal lesion, is characterized by a trans-spatial enhancing mass with phleboliths and frequently spontaneously resolves. First branchial cleft cysts are congenital lesions that present during childhood, most commonly with parotitis, and may demonstrate a fistulous tract to the external auditory canal on imaging. • Autoimmune disease is most commonly Sjogren's syndrome, with children demonstrating early tooth decay from xerostomia. • Adenopathy is the most common lesion as the parotid gland is not encapsulated and contains intraparotid lymph nodes. • Mesenchymal neoplasia includes neurofibroma and rhabdomyosarcoma. • Benign and malignant parenchymal neoplasia pathologic entities occur in similar relative frequencies as adults, with pleomorphic adenoma being the most common benign neoplasia and mucoepidermoid carcinoma being the most common malignant neoplasia.

Conclusions
The presentation will review the normal anatomy of parotid space, imaging assessment of parotid lesions in children and the different pathologies involving the pediatric parotid gland. Specific imaging pearls would be provided. Malignancy and Sjogren's syndrome should be included in differential diagnosis of pediatric parotid lesions. Although many pathologic entities have overlapping imaging appearances, hemangioma may be characterized specifically by presence of phleboliths, venolymphatic malformations by fluid-fluid levels, and first branchial cleft by external auditory canal fistulous tracts. MR sialography, with thin, heavily-weighted T2-weighted images, may demonstrate multifocal punctate sialectasis characteristic of juvenile recurrent parotitis.

KEYWORDS: Parotid Gland, Pediatric Head And Neck, Pediatric Neoplasms
Peripheral incidentalomas—Soft tissue lesions in review areas on neuroradiological images: what are they and what you should do? A pictorial review.

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Purpose
In clinical practice incidental subcutaneous and soft tissue lesions commonly are encountered on MR imaging (MRI) and CT of the brain, head, and neck. It is important for neuroradiologists to detect such lesions and to be familiar with their appearance, so as to appreciate which lesions can be ignored and which require further evaluation. Cutaneous and subcutaneous lesions of the head and neck regions can comprise a broad and potentially confusing array of benign and malignant processes. Characterization of these lesions often can be problematic despite advances in imaging. Clinical history, lesion location, calcification, and signal intensity on MRI can help determine the diagnosis and narrow the differential diagnosis for lesions that demonstrate indeterminate characteristics. We present a pictorial review of the spectrum of subcutaneous and soft issue masses constituting the most common and some rarer subcutaneous entities. We provide a systematic approach to assessment of these incidental soft-tissue lesions.

Materials and Methods
We review the imaging findings in a wide spectrum of common and uncommon, benign and malignant subcutaneous lesions which can be found on brain, head, and neck MRI and CT imaging.

Results
The lesions presented include neoplastic processes such as skin squamous cell carcinomas, melanomas, a variety of sarcomas, and metastatic disease. We also demonstrate some examples of benign lesions such as lipomas, hypertrophic scar, keloid scars, pilomatrixoma, epidermal inclusion cysts and desmoid tumors. We discuss subcutaneous manifestations of systemic diseases such as phakomatoses, iatrogenic and cosmetic augmentation changes such as silicon or Alloderm foreign bodies. We also discuss infectious processes and vascular abnormalities such as hemangiomas.

Conclusions
Neuroradiologists should be able to thoroughly assess incidentally encountered subcutaneous lesions, taking into consideration the spectrum of possible causes and direct the need for further examination or investigations. This presentation will aid in differentiating the often overlooked imaging appearances of subcutaneous lesions on images of the head and neck.

KEYWORDS: Incidental Findings

EdE-70

Postsurgical Temporal Bone: A Pictorial Essay of Commonly Encountered Neurootologic Surgical Approaches and Postoperative Imaging Appearance

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Purpose
Interpreting the imaging findings of the temporal bone after middle ear, mastoid, and internal auditory canal surgery can be challenging for neuroradiologists in training as well as those in practice. We aim to review the more commonly encountered neurootologic surgical approaches and their indications as well as the expected postoperative findings on cross-sectional imaging of
the temporal bone. A greater understanding of the radiologic postoperative appearance facilitates the recognition of complications and recurrent disease.

Materials and Methods
We aim to present a pictorial essay coupling schematic illustrations of various neurootologic surgical procedures with corresponding cross-sectional imaging. Intraoperative photographs also will be presented when applicable. Special attention will be given to indications and distinguishing features associated with each surgical procedure.

Results
The intrinsically complicated anatomy of the temporal bone can be especially intimidating after being altered by surgery. However, familiarization with the types of highly specialized surgeries practiced by otolaryngologists and their indications as well as their appearance on cross-sectional imaging is essential to demystifying the postoperative temporal bone. This enables the radiologist to expertly detect recurrent disease and potential complications which then can be communicated accurately to clinicians. We will review the various types of mastoidectomy, including canal-wall-up (CWU) mastoidectomy and the more extensive canal-wall-down (CWD) mastoidectomy. We also will review the surgical approaches to the internal auditory canal, namely the translabyrinthine, retrosigmoid, and middle cranial fossa approaches. Ossicular reconstruction will be described, highlighting stapedectomy with prosthesis placement and the fundamental concepts underlying partial and total ossicular replacement prostheses. Finally, we will describe cochlear implant surgery with attention to facial recess approach, round window niche, and desired electrode placement within the cochlea.

Conclusions
Although potentially complicated, imaging of the postsurgical temporal bone is vital to evaluating for recurrent disease and complications. Familiarity with the various surgical procedures commonly encountered in the temporal bone and expected postoperative findings enables the radiologist to provide expert interpretation to the surgeon.

KEYWORDS: Postoperative Findings, Temporal Bone
Spectrum of Atypical Sites of Distant Metastases in HPV-Positive Oropharyngeal Carcinoma: A Case Series

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Purpose
To describe unusual sites of distant metastases occurring in patients with HPV-positive squamous cell carcinoma of the oropharynx (SCCOP).

Materials and Methods
We describe a retrospective case series of patients with HPV-positive SCCOP and distant metastases at presentation or distant metastatic recurrence without local-regional recurrence. HPV-positivity was defined by positive p-16 immunohistochemical staining and situ hybridization. Chart and imaging review were performed and sites of distant metastases are described.

Results
Eighteen patients with distant metastases were identified. Twelve of these presented with
isolated distant metastases after successful local regional control with chemoradiotherapy. The remaining six patients had metastatic disease on initial presentation prior to treatment. Among the 12 patients presenting with local-regional control but distant metastatic recurrences, the interval between successful completion of chemoradiotherapy and identification of distant metastases ranged from 3 to 14 months with mean of 7.5 months. Clinical characteristics of patients with HPV-positive SCCOP presenting with isolated distant metastases are presented in Table 1. Half of these distant metastatic recurrences were at nonpulmonary sites including soft tissues/skeletal muscle (3), bone (3), brain (2), and thyroid (1). With the exception of brain metastases, all sites were biopsied with histology revealing squamous cell carcinoma in the absence of known synchronous or metachronous squamous cell tumors. Metastatic lesions to the orbit and ethmoid were HPV-positive by in situ hybridization. In particular, brain, skin and skeletal muscle metastases presented within our series are atypical sites for isolated distant metastases of oropharyngeal squamous cell carcinoma. Of the patients presenting with distant metastases, sites of metastatic disease included the pterygopalatine fossa (1), parotid (3), thyroid (3), submandibular gland (1), femur (1) and liver (1). All metastases demonstrated squamous cell histology. Two of three thyroid metastases, one parotid metastasis and the pterygopalatine fossa metastasis were p-16 positive. Of note, one patient presented with pathologic femur fracture and unknown T1 base of tongue tumor, prompting the search for the primary tumor. Limitations to our retrospective review included small sample size and lack of testing of all distant metastases for p-16 and HPV-positivity.

Conclusions
Patients with HPV-positive SCCOP may develop distant metastatic recurrence despite local regional control. Given these sites of distant recurrence being at atypical (nonpulmonary) sites, clinicians and radiologists should consider distant recurrence when evaluating unusual symptoms or imaging findings. Additionally, when evaluating patients presenting with metastatic squamous cell carcinoma with unknown primary tumor, familiarity with unusual sites of distant metastatic disease related to HPV-positive SCCOP may prompt consideration of an oropharyngeal primary lesion in the absence of other known primary squamous cell tumor.

KEYWORDS: Cancer, Oropharynx

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<th>Clinical Characteristics of HPV-positive SCCOP Presenting with Isolated Distant Metastases</th>
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<tr>
<td>Age [median(range)]</td>
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<td>Sex</td>
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<tr>
<td>Primary Tumor Subsite</td>
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<td>N Category</td>
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<td>Stage</td>
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### Clinical Characteristics of HPV-positive SCCOP Presenting with Isolated Distant Metastases

<table>
<thead>
<tr>
<th>Age [median(range)]</th>
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**EdE-72**

**To Leak or not to Leak: Imaging Manifestation of Spontaneous Cerebrospinal Fluid Leak**

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**Purpose**

Spontaneous cerebrospinal fluid (CSF) leak refers to the drainage of CSF outside of the normal dural venous sinus system. The pathogenesis of this disease is dynamic and involves multiple factors, namely the presence of elevated CSF pressure and associated prominent arachnoid granulations that exert detrimental effect on the surrounding bones over time resulting in thinning, erosion, formation of meningoceles/meningoencephaloceles, and eventually CSF leakage. Skull sites prone to this process include the temporal bone, sphenoid sinus, and ethmoid roof. Abnormal congenital thinning of bone at these sites has been proposed as a predisposing factor to CSF leak. In this retrospective study, we investigate CT and MR images for findings that suggest CSF leak versus intracranial hypertension in patients with clinical and imaging presentation suspicious for spontaneous CSF leak.

**Materials and Methods**

A total of 14 subjects were selected retrospectively between 2007 and 2013 based on the presence of meningoceles/meningoencephaloceles, prominent arachnoid granulations, and clinical suspicion of cerebrospinal fluid leakage. Their images are analyzed closely for the presence of empty sella, tegmen tympani dehiscence, arachnoid granulations, encephaloceles, middle fossa/sphenoid sinus pits, and degree of sinus pneumatization. Imaging signs of intracranial hypertension (prominent perioptic nerve sheath CSF, optic nerve blunting, and sclera flattening) also were sought for. Correlations are made with medical records for clinical presentation of CSF leak and intracranial hypertension.

**Results**

Twelve of 14 subjects have imaging and clinical presentation of spontaneous cerebrospinal fluid leak. These subjects have an average age of 67 and the majority of them (8 of 12) are female. All 12 subjects have imaging finding of arachnoid granulations and encephaloceles. None of the patients have thick skull base. The majority have middle fossa pits (10 of 12). The incidence of empty sella and sphenoid sinus pits are less pronounced (6 of 12) and (4 of 12), respectively. There is no discernible trend regarding signs of intracranial hypertension in these 12 patients.
Among the two patients without diagnosis confirmation of CSF leak, one patient has imaging finding of thick skull base and clinical evidence of intracranial hypertension. The second patient has imaging findings of right cribiform plate dehiscence but no tegmen tympani dehiscence or clinical presentation of CSF leak.

Conclusions
Spontaneous cerebrospinal fluid leak is a complex and dynamic disease that requires time to fully manifest itself. Patients with this disease tend to not seek medical work up until signs and symptoms of actual fluid leakage occur, which is often late in their lives. This is reflected by a rather advanced average age seen in our spontaneous CSF leak group, and overwhelming evidence on CT and MR imaging of spontaneous CSF leak at initial presentation. Alternatively patients may present with headache and imaging findings of intracranial hypertension at younger age, as seen in one of our subjects. We suspect that these younger patients with intracranial hypertension will proceed to have CSF leak later on in life as the skull base eventually gives way to the elevated pressure, or they may continue with signs/symptoms of intracranial hypertension if they have a congenitally thick skull base.

KEYWORDS: Arachnoid Granulation, Cerebrospinal Fluid, Intracranial Hypertension

EdE-71

Uncommon Solid and Cystic Orbital Masses

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Purpose
Many orbital masses overlap in clinical and radiological presentation. While typical orbital masses such as hemangioma, lymphoma, and pseudotumor are commonly seen, there is a wide spectrum of entities for which the orbit is an uncommon location. The purpose of this Education Exhibit is to illustrate examples of uncommon orbital masses that can help expand the radiologist's differential diagnosis.

Materials and Methods
First, we will present a brief review of basic orbital anatomy. Then we will illustrate uncommon solid and cystic orbital masses that we have seen at our institution. We will show pathologically proved cases of cholesterol granuloma, dermoid cyst, chondrosarcoma, undifferentiated carcinoma, melanoma, malignant fibrous histiocytoma, and metastatic paraganglioma occurring in the orbit.

Results
Many etiologies often are not thought of when confronted with an unknown orbital mass. Having an awareness of some uncommon orbital masses, based on their composition and location, is important for generating an appropriate differential, making the correct diagnosis, and guiding clinical management.

Conclusions
A wide spectrum of masses can occur in the orbit, which can look very similar and present with overlapping clinical symptoms. Knowing the imaging features of some uncommon solid and cystic orbital masses is helpful for expanding the differential diagnosis.
“Plug in Your Jug!”: An Imaging Review of Jugular Vein Thrombosis

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Purpose
While identifying jugular vein thrombosis (JVT) on imaging is relatively straightforward, the difficulty comes in determining its etiology and identifying associated pathology and complications. The purpose of this educational poster is to provide a comprehensive review of the critical anatomy, pathophysiology, etiologies, imaging findings, and diagnostic pitfalls of JVT.

Materials and Methods
We reviewed our institution’s imaging database for illustrative cases of JVT and present a selection of multimodality (CT, MRI, US, angiographic, and nuclear medicine) imaging. Additionally, a review of the current medical literature was performed.

Results
Jugular vein thrombosis is a serious finding occasionally encountered by radiologists. While identifying thrombus within the internal jugular vein (IJV) usually is not a diagnostic dilemma, the sundry etiologies, potentially devastating complications (including pulmonary embolism, septic emboli, and dural sinus thrombosis), and high association with neoplasm warrant careful consideration by the interpreting radiologist. The pathophysiology of JVT is rooted in the well-known Virchow triad, which posits that three broad categories of factors are at play in the development of vascular thrombosis: static blood flow, endothelial injury, and hypercoagulability. A disruption of one or more of these variables increases the risk of developing a thrombus. In its native state, the IJV is unlikely to spontaneously develop
thrombus, due to its paucity of valves and gravitational venous return. Altering the dynamics of the Virchow triad can shift patients into a prothrombotic state. While JVT is most commonly encountered in patients with thrombogenic central venous catheters or postoperatively following neck dissections, various etiologies of JVT exist beyond the obvious iatrogenic sources. These include neoplastic, infectious, traumatic, hematologic, rheumatologic, gynecologic, congenital, endocrine, and idiopathic causes, which we address in this educational exhibit.

Conclusions
Given the many etiologies of JVT, it is important for radiologists to consider the clinical context of this important imaging finding. In doing so, one can suggest an appropriate, patient-specific, clinically relevant differential diagnosis and add clinical value to a radiologic report. In addition to imaging clues, correlation with the medical record and consultation is often needed to answer the question of "Why?". The diagnosis of JVT should be seen as an investigational starting point and not simply a dead end observation.

KEYWORDS: Jugular Veins, Thrombosis, Thrombus Imaging
Amplatzer Vascular Plug for rapid vessel occlusion in Interventional Neuroradiology

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¹QE II Health Science Center, Dalhousie University, Halifax, Nova Scotia

Purpose
Amplatzer vascular plug (AVP) has been used for transcatheter embolization in peripheral vasculature; occlusion of abnormal vessel communications and other neurovascular conditions (4, 5). With the nonavailability of detachable balloons in the market, there is a need for a device with potential for rapid vessel occlusion. We believe AVP can be used in some of these scenarios. The purpose of this paper is to report different uses of endovascular AVP treatment for rapid vessel occlusion in the field of Interventional Neuroradiology.

Materials and Methods
We retrospectively reviewed our interventional neuroradiology database from November 2010 to October 2013 and found five patients who were treated with endovascular AVP treatment. Amplatzer vascular plug was used for rapid vessel occlusion in all of these patients. Two patients presented with carotid blowout with massive hematemesis from oral cancer, two patients had preoperative balloon test occlusion and sacrifice and the fifth patient had massive hematemesis from erosion of the right internal jugular vein from oral cancer.

Results
The right internal carotid artery (ICA) was sacrificed without balloon occlusion test (BOT) in two patients with carotid blowout. The left ICA was occluded after BOT in one patient and the left vertebral artery was occluded after BOT in one patient. The right internal jugular vein was occluded without BOT in one patient. Amplatzer vascular plug was deployed in all patients using 5 french guiding catheter. In two out of the five patients 2-3 coils were used in addition to the AVPs. In all cases, more than one AVP was used and the occlusion was almost immediate with no thrombo-embolic complications. Compared to expected number of coils needed to occlude these vessels, we believe use of AVP was significantly cheaper.

Conclusions
Use of AVP is a feasible, safe, fast and cost-effective method for rapid occlusion of larger size vessels for different indication. In the past in many of these situations, detachable balloons were being used for rapid vessel occlusion. Amplatzer vascular plug appears to be useful and cheaper alternative to detachable balloons for rapid vessel occlusion in many clinical scenario.

KEYWORDS: Arterial Occlusion
Congenital Pial Arteriovenous Fistulas in the Infant and Neonatal Population: Clinical Series and Review of the Literature

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¹Indiana University, Indianapolis, IN, ²Goodman Campbell Brain and Spine, Indianapolis, IN

Purpose
Pial arteriovenous fistulas (AVFs) are a rare entity with a paucity on the subject in the neurointerventional literature. Pial AVFs are characterized by having direct communication between a pial artery and a cerebral vein, absence of intervening nidus, an often dilated venous varix, and location in the subpial space. This characteristic architecture distinguishes this lesion from dural arteriovenous fistulas, vein of galen malformations, and cerebral arteriovenous malformations. The purpose of this exhibit is to describe the clinical presentation, imaging findings, and management of pial arteriovenous fistulas through four illustrative cases.

Materials and Methods
An IRB-approved, retrospective review of the Indiana University Health neurointerventional database from January 2005 to December 2013 was conducted for children presenting under the age of two years with pial AVFs confirmed by angiography. Only true single-hole and multiple-hole pial fistulas were included. Clinical histories and diagnostic imaging were obtained.

Results
Four children with congenital pial AVFs were reviewed. Profound high-flow congestive heart failure was the initial presentation in the two patients presenting within the first week of life. Seizure was the initial presentation in the two patients presenting within the first week of life. Initial diagnostic imaging varied and included transcranial doppler ultrasound, CT, and MRI. In each case, digital subtraction angiography demonstrated a dilated venous varix along with single or multiple hypertrophied arterial feeders. Three patients underwent a combination of endovascular coiling, N-butyl-cyanoacrylate (NBCA), and/or ethylene vinyl alcohol copolymer (EVOH, Onyx) embolization. Partial coil embolization with subsequent surgical resection was utilized in one case.

Conclusions
Pial arteriovenous fistulas are a rare form of congenital arteriovenous anomaly with an angi-architecture that differentiates it from other forms. The presentation is variable with some patients presenting very early in development with high output cardiopulmonary failure and others presenting with neurologic sequelae such as seizure. In this group, therapeutic management included endovascular embolization, and in one case, surgical disconnection and resection.

KEYWORDS: Arteriovenous Fistulas, Embolization, Endovascular Management

<table>
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<th>Case</th>
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<td>0</td>
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<td>L Temporoparietal</td>
<td>Coil and NBCA embolization</td>
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<tr>
<td>2</td>
<td>M</td>
<td>10</td>
<td>Seizure</td>
<td>L Temporoparietal</td>
<td>Coil embolization</td>
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<tr>
<td>3</td>
<td>M</td>
<td>0</td>
<td>CHF</td>
<td>L Parieto-occipital Complex Multi-hole</td>
<td>Staged Coils, NBCA, EVOH embolization</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>23</td>
<td>Seizure</td>
<td>L Frontal</td>
<td>Partial coil embolization, Surgical resection.</td>
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</tbody>
</table>
Extracranial Arteriovenous Malformation of the Head and Neck: Our Approach for Endovascular Treatment

M Akdol\textsuperscript{1}, A Amole\textsuperscript{1}, E Erdem\textsuperscript{1}
\textsuperscript{1}University of Arkansas for Medical Sciences, Little Rock, AR

Purpose
Arteriovenous malformations (AVM) of the head and neck are rare and complex vascular diseases. AVMs can potentially create long-term functional, cosmetic sequelae, and intractable bleeding; prompt and early intervention is required to address these problems. The interventions include a wide spectrum of treatments from surgical excision and reconstruction to endovascular embolization. Respective combination therapy also may be used depending on the location of the lesion and treatment goals. The aim of this presentation is to clarify our approach to endovascular treatment of head and neck AVMs, the various agents used including the advantages/disadvantages based on certain localizations and clinical situations.

Materials and Methods
The major determining factor for the treatment is the location and extent of the disease. Prompt surgical treatment is recommended for all accessible lesions at an early stage. This can be performed with or without presurgery embolization depending on the lesion size and presence of feeders originating from surgically difficult to reach areas. In our experience, patients with large AVMs and extensive soft tissue involvement tend to have better outcomes with staged embolization. Aggressive clinical follow up is required to minimize the progression of the disease process. Surgical intervention is warranted whenever resection and reconstructive
surgical procedures become viable option to control potential complications, cosmetic and functional disfigurement. Therefore, close collaboration with the surgical team and continuous assessment of the treatment progress is mandatory. In daily practice we favor liquid embolic agents over solid ones, like coils due to lack of intranidal flow control. The three major liquid embolic agents used are: dehydrated ethyl-alcohol (ETOH), n-butyl cyanoacrylate (NBCA) glue and ethylene vinyl alcohol copolymer in dimethyl-sulfoxide (Onyx). Each of them has unique capabilities and drawbacks. Specific characteristics are interrogated in this exhibit in detail.

Results
Head and neck AVMs are poorly understood and the progress of the disease process presents many dilemmas. Long-term follow up of the patients reveal high recurrence rate and progressive cosmetic, functional deformity of the structures involved. Pain and intractable bleeding also may present challenges to the patient. Aggressive follow up and surgical intervention are the mainstay approach. But, due to progressive nature of the process, it is unlikely to obtain a cure in most cases. With the introduction of new embolic agents and materials, endovascular embolization also became a viable option to control the course of the disease. As mentioned previously, several agents can be used. The localization, vascular architecture of the AVM nidus, extent of the tissue involvement, origins of the feeding branches are the major factors to determine the suitable embolic agent.

Conclusions
The head and neck AVM presents unique challenges to the patient and physician. High recurrence rate of the disease despite aggressive treatment, and progressive functional loss are the main difficulties. Especially in the setting of a large head and neck AVM, proactive, aggressive approach with combination of surgical and endovascular interventions may limit the disease progress and improve the patient's symptoms.

KEYWORDS: Arteriovenous Malformation, Endovascular Embolization, Head And Neck

EdE-83

6:30AM - 9:00PM

Spinal Arteriovenous Lesions: A Review of Imaging Manifestations, Diagnosis and Treatment

A Hurlbut1, F Rivas Rodriguez1, V Vadlamudi2, A Pandey2, N Chaudhary1, B Thompson2, J Gemmete1

1University of Michigan Medical Center, Ann Arbor, MI, 2University of Michigan Health System, Ann Arbor, MI

Purpose
To review in an interactive format the imaging manifestations of spinal arteriovenous malformations and arteriovenous fistulas to ensure appropriate diagnosis and treatment.

Materials and Methods
Use a series of case examples to illustrate the imaging appearance of the different subtypes of spinal arteriovenous malformations and arteriovenous fistulas. The cases will be presented utilizing a variety of imaging modalities including CTA, MR, MRA, and conventional angiography. In addition, we will review spinal cord, spinal vascular, and paraspinal anatomy as it pertains to diagnosis and treatment of spinal arteriovenous lesions. Intraprocedural and
postprocedural case examples also will be provided using both cross-sectional imaging and conventional angiography to discuss the full spectrum of the management process.

Results
Spinal arteriovenous lesions are uncommon; however, failure to accurately diagnosis and treat these complicated lesions can lead to poor patient outcomes. Therefore, a review of this complex subject is important to ensure the interpreting physician renders the appropriate diagnosis and guides the patient towards the next proper step in management. Understanding the pertinent spinal vascular anatomy, imaging manifestations, pathophysiology, and treatment options are important components to improving care in patients with spinal arteriovenous lesions.

Conclusions
The different subtypes of spinal arteriovenous lesions will be reviewed with emphasis on imaging findings, diagnosis, and treatment. We will use the series of case examples to improve the healthcare provider's knowledge of spinal arteriovenous lesions with the ultimate goal of improving patient management.

KEYWORDS: Spinal Angiography, Spinal Arteriovenous Malformation, Spinal Vascular Disorders
Congratulations, You Made the Diagnosis of Neurofibromatosis! Now What?

M O'Dell¹, D Fursevich¹, J Macke¹, B Harshman²
¹Florida Hospital, Orlando, FL, ²Florida Hospital - Radiology Specialists of Florida, Orlando, FL

Purpose
The phakomatoses are a group of heterogenous disorders characterized by congenital malformations of ectodermal origin. The most common, neurofibromatosis (NF), has several distinct subsets each with its own set of characteristics. We often focus on the characteristics necessary to make the diagnosis, possibly at the expense of identifying complications the disease can cause for the patient. This exhibit reviews some of the common tumors and subsequent pathology apparent when evaluating imaging of an NF patient.

Materials and Methods
A Montage search was performed with radiologic-pathologic correlation for all cases of neurofibromatosis within our hospital system over the last seven years. Our search for "neurofibromatosis" produced over 1080 studies, 26 of which had surgical pathology correlates. A sample of images was obtained from children and young adults under the age of 23. We then chose a representative group of cases where the disease process led to symptoms or where resection of a concerning lesion was necessary.

Results
Many of the surgical cases required resection of a benign lesion causing symptoms or a lesion suspicious for malignancy. It is important to be aware, that of the many tumors seen with neurofibromatosis, several have potential to be malignant. We briefly discuss the pathophysiology of NF and cover some lessons learned from a tertiary center with an NF clinic.

Conclusions
Although there are many "Aunt Minnie" features of neurofibromatosis, it is important to be aware of the complications and malignancies that may occur with this disease, and to develop a pattern of search to spot them.

KEYWORDS: Neurofibromatosis, Phakomatoses
Purpose
This pictorial essay will review T2* imaging techniques that are currently available. A brief discussion of the various susceptibility techniques used such as gradient recalled echo (GRE), susceptibility-weighted imaging (SWI), quantitative susceptibility mapping (QSM), and blood oxygen level dependent (BOLD) imaging will be included. We are presenting select case histories to demonstrate their clinical usefulness in pediatric neuroimaging.

Materials and Methods
Select cases demonstrating the utility of T2* imaging in the evaluation of pediatric pathology were identified retrospectively for this educational exhibit.

Results
T2*-based imaging is a technique that accentuates the paramagnetic properties of blood products such as deoxyhemoglobin, intracellular methemoglobin, and hemosiderin. It is particularly useful for detecting intravascular venous deoxygenated blood as well as extravascular blood products. It also is sensitive in detecting and quantifying the presence of iron. We have used this technique in the past several years to study a wide variety of pediatric neurological disorders. T2* relaxation imaging has the ability to reveal pathologic and physiologic conditions of the brain that alter regional susceptibility and reveal abnormalities that are unapparent on conventional MR sequences.

Conclusions
T2*-based imaging is a sequence with broad applicability and should be included in standard imaging evaluation of pediatric pathology.

KEYWORDS: BOLD FMRI, GRE, Susceptibility-Weighted Imaging

EdE-96

Diagnostic Value and Pitfalls of Double Inversion Recovery MRI: a Case Based Pictorial Essay

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Purpose
Double inversion recovery (DIR) is a novel MR sequence that nullifies signals from both the cerebrospinal fluid and normal white matter. Selectively imaging gray matter structures is essential in the evaluation of various neurologic disorders, including inflammatory/demyelinating diseases, malformations of cortical development, mesial temporal sclerosis, and neoplastic processes in the adult and pediatric population. The aim of this educational exhibit is to illustrate the advantages and disadvantages of DIR brain imaging in patients with a variety of disease entities.

Materials and Methods
Using data aggregation and search technology software from our institution's PACS/RIS system,
several illustrative cases of the diagnostic value and pitfalls of DIR were identified for presentation as a pictorial essay.

Results

Superior delineation between gray and white matter can be achieved with DIR MR imaging (MRI) consisting of two inversion pulses applied to simultaneously suppress the signal from two tissues with different longitudinal relaxation times. By selectively suppressing CSF and white matter signals, gray matter only images can be obtained. Double inversion recovery has evolved over the years with recent research focusing on its feasibility at higher magnetic fields and three-dimensional MR imaging. Double inversion recovery is considered advantageous for increased sensitivity and improved lesion detection for a variety of disease entities. We illustrate the increased lesion conspicuity of multiple sclerosis plaques with DIR MRI, especially as it pertains to intracortical lesions. Double inversion recovery MRI has a proven role in lesion detection and lateralization in patients with epilepsy. We demonstrate the role of DIR MRI in epilepsy with cases of malformations of cortical development and mesial temporal sclerosis (MTS). We address the concept that DIR MRI may be over sensitive for the evaluation of MTS. Illustrative cases of the role of DIR to differentiate infiltrating/nonenhancing tumor and vasogenic edema are presented. Identification of cortical tubers in tuberous sclerosis with DIR MRI also has been described in the literature. Because suppression of the MR signal from normal white matter relies on its narrow range of T1 values, the diagnostic value of DIR MRI is limited in the incompletely myelinated child. This educational exhibit raises awareness of the advantages and potential interpretative pitfalls of DIR MRI.

Conclusions

Double inversion recovery MRI is a recent innovation that provides important insights into the study of many neurologic diseases. This case-based pictorial essay serves to broaden the radiologist's understanding of the diagnostic value and potential pitfalls of DIR MRI in a variety of disease entities.

KEYWORDS: Advanced MR Imaging, Epilepsy, Multiple Sclerosis

EdE-97

6:30AM - 9:00PM

Diffusion Tensor Tractography of the Pediatric Cervical Spinal Cord Using 3.0 Tesla MRI

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\(^1\)Mayo Clinic Jacksonville, Jacksonville, FL, \(^2\)Wolfson Children’s Hospital, Jacksonville, FL

Purpose

Diffusion tensor imaging and fiber tractography of the spinal cord allows for imaging of the white matter tracts of the spine in vivo. Specifically, alterations of the spinal white matter tracts due to spinal lesions can be detected. This has great clinical utility for biopsy and neurosurgical treatment planning as well as follow up. Our aim is to review the application of diffusion tensor imaging of the spine in the pediatric population and provide example cases illustrating the impact of diffusion tensor imaging and fiber tractography on surgical planning.

Materials and Methods

We perform literature review about latest techniques used for diffusion tensor imaging and fiber tractography of pediatric spinal cord using 3.0 T MR imaging (MRI). We compare various
methodologies like reduced field of view, coronal acquisitions and axial acquisitions. Usefulness of spinal cord tractography to assess resectibility of intramedullary tumors will be discussed. We also address limitations of spinal cord tractography with current technique. We illustrate the utility of spinal cord tractography with example cases (graphic).

Results
Spinal cord tractography demonstrates displacement versus destruction of white matter fiber tracts. The location of fiber tracts with respect to the spinal cord lesion may help the neurosurgeon decide the approach for biopsy as well as surgical resection. Resectability of the spinal cord intramedullary masses can be assessed pre-operatively using this information.

Conclusions
Advanced MRI techniques like diffusion tensor imaging and fiber tractography of the pediatric spinal cord using 3.0 T MRI provides excellent information for surgical planning.

KEYWORDS: Diffusion Tensor Image, Pediatric Spine, Spinal Cord
EdE-85
6:30AM - 9:00PM

Imaging Manifestations of Natural Course and Complications of Spinal Dysraphism following Repair

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Purpose
Spinal dysraphisms refer to congenital spinal disorders in which there are anomalous differentiations of dorsal midline structures, with or without incomplete closure. They frequently are misclassified, with reports inaccurately swapping between "myelocele" and "myelomeningocele" from findings to impression. We review the correct terminology and classification of spinal dysraphisms, showing XR, US, CT, and MR imaging examples.

Materials and Methods
Spinal dysraphisms are classified as open or closed, depending on whether or not the abnormality is covered by skin. This exhibit begins with a review of normal spinal cord development and anatomy and then information is presented in pictorial format with open and closed spinal dysraphisms subtypes discussed individually, and then comparisons are made between lesions to reinforce similarities and differences to help the clinician narrow their differential diagnosis. Several examples of dysraphisms following repairs also will be presented with common complications including CSF leak, arachnoiditis, acquired arachnoid cysts, and postoperative meningocele/pseudomeningoceles. The natural course of each disease despite surgery also will be highlighted including hydronephrosis and scarring from neurogenic bladder, developmental hip dysplasia, progressive scoliosis from associated segmental spinal dysgenesis, decrease in size but persistence of the distal syrinx, persistent tethered cord and low-lying conus, and residual lipomyelocele resembling primary intradural lipoma.

Results
Open spinal dysraphisms involve neural tube closure defects with open communication of the spinal cord to the environment. They can be classified based on location of the neural placode with respect to the skin. In myelomeningocele and hemimyelomeningocele, the neural placode protrudes above the skin surface, whereas in myelocele and hemimyelocele, the neural placode is flush with the skin surface. Hemimyelomeningocele and hemimyelocele have associated diastematomyelia. Closed spinal dysraphisms (CSD) are skin-covered and are subdivided based on their association with a subcutaneous mass. CSDs with hypertrophic subcutaneous fat components include lipomyelomingocele (placode outside canal, widening of the subarachnoid space) and lipomyelocele (placode inside canal, no widening of the subarachnoid space). CSDs with herniation of CSF can be subdivided into whether the herniation includes neural tissue: in terminal myelocystocele a syringocele herniates into a meningocele whereas no neural tissue is seen in herniation with meningocele and nonterminal myelocystocele. CSDs without subcutaneous masses are categorized into simple or complex. Simple CSDs include intradural lipoma (fat inside dural sheath, usually tethered cord), filum terminale lipoma, tight filum terminale (short, thickened, nonfatty filum with tethering), persistent terminal ventricle, and dermal sinus (epithelium-lined tract extends from the skin surface with possible communication
with the subarachnoid space). Complex CSDs are separated by disorders of midline notochordal integration versus notochordal formation. Those with notochordal integration defects include dorsal enteric fistula (tubular structure extends from skin to bowel), neurenteric cyst (congenital cysts lined by intestinal epithelium), and diastematomyelia (type I vs II). Disorders of notochordal formation include caudal agenesis (types I and II) and segmental spinal dysgenesis.

Conclusions
Spinal dysraphisms represent a challenging group of lesions for the diagnostic radiologist. Understanding the key differences and imaging characteristics is invaluable for differentiating lesions. Increasing the specificity of the differential diagnosis and providing the referring provider appropriate management recommendations is of utmost importance. Through an understanding of the anatomical anomalies found in each defect using XR, CT, US, and MR imaging, a correct diagnosis can be made and necessary surgery performed before onset or progression of symptoms. Knowledge of the natural course and postoperative complications will aid in patient management.

KEYWORDS: Spinal Dysraphism

EdE-94

More Than Just a Headache: What You Need To Know about Pediatric Pineal Region Masses

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Purpose
The pineal region can be a blind spot for many radiologists given limited CT detail and anatomical complexity on otherwise innocuous exams. Pediatric patients often present with headache or hydrocephalus when a pineal tumor is still very small, necessitating early recognition. The differential is fairly predictable and when neoplasm is present, it is often benign or responsive to treatment. The purpose of our exhibit is to review normal pineal development and discuss the differential for pediatric pineal region tumors.

Materials and Methods
A Montage search was performed with radiologic-pathologic correlation for all pineal lesions within our hospital system over the last seven years. The search yielded 1509 radiological studies where a pineal lesion was described, 20 cases of which had surgical pathology correlation. A representative sample of images was obtained from children and young adults under the age of 23, including classic and uncommon cases.

Results
The pineal gland has a variable appearance in the pediatric population, typically growing until two years of age then stabilizing in size. The pineal gland may calcify in as many as 30% of patients by late adolescence. Calcifications under age six are uncommon and can be worrisome. The most common lesion overall is a pineal cyst. When tumor occurs, it is generally either germ cell or pineal cell origin with germinoma being the most common in the pediatric population. Treatment is often a combination of surgery and chemoradiation.
Conclusions
Although only a small percentage of central nervous system (CNS) tumors originate in the pineal region, they are several times more likely in children than adults and the consequences can be quite significant. Knowledge of anatomy and early tumor recognition is imperative. Our exhibit provides clinicians with a review of the pediatric pineal region with respect to development and neoplasms.

KEYWORDS: Pineal Calcification, Pineal Cell Tumor, Pineal Cyst

EdE-87


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Purpose
1). To review and demonstrate Brain MR imaging (MRI) features of neonatal encephalopathy (NE) which suggest etiologies other than hypoxia-ischemic injury (HII). 2).To provide an easy to use road map for important alternative (other than HII) diagnostic considerations to the radiologist performing neonatal MRI.

Materials and Methods
A retrospective analysis of 750 consecutive neonatal MRI brain studies obtained between November 2010 and October 2013 at presentation of encephalopathy was performed to assess the imaging findings that suggest etiologies other than HIE. Inclusion criteria were term neonates (≥ 36 weeks gestational age) with seizures, hypotonia, altered sensorium, feeding difficulty or difficulty in maintaining respiration. Preterm babies and those studies performed for reasons other than the aforementioned were excluded from our study. Where feasible and necessary, additional information was obtained from patient's electronic charts. Entities with rare incidence such as some of the metabolic causes of NE, have been included selectively in this study from former hospital database for the sake of complete depiction of the spectrum.

Results
The causes of NE are heterogeneous. The outcomes of NE range from potentially reversible to severe long term morbidity such as cerebral palsy, intellectual disability, learning/behavioral problems and/or mortality. MR imaging evaluation has been extremely valuable to assess neonatal brain in NE for the purpose of diagnosis and prognostication. HII is the most common cause of NE for which characteristic MR appearances have been described. Neonatal brain imaging is becoming more commonplace and neonatal brain injury often leads to medico-legal cases involving physicians, hospitals and parents. Given the facts that there is a considerable overlap of clinical and MRI appearances of different etiologies and that more than one etiology may co-exist, it is exceedingly important to recognize the patterns of brain injury that constitute the complex imaging spectrum of NE. Diffusion-weighted imaging (DWI) and MR spectroscopic imaging are particularly useful and often problem-solving tools in the setting of metabolic encephalopathy. MR angiography, MR venography and susceptibility-weighted imaging compliment neonatal vascular imaging and neonatal head trauma at time of injury. MR
evaluation may, thus, point to an alternate and/or co-existent etiology, aiding in accurate
diagnosis and timely institution of specific therapy. Table 1 is a list of various etiologies (other
than HII) which will be reviewed and demonstrated as an easy to review road map for important
alternative diagnostic considerations.
Conclusions
Neonatal encephalopathy is etiologically diverse with a wide range of outcomes and broad MR
imaging spectrum. MR imaging appearances can help to identify additional and/or alternative
diagnosis in apparent HIE and point to a specific etiology. This is invaluable for appropriate
management decisions, prognosis and medicolegally.

KEYWORDS: Encephalopathy, Metabolic, MR Imaging Brain

Etiologies of Neonatal Encephalopathy:

I. Metabolic encephalopathy

1. Hyperbilirubinemia
2. Hypoglycaemia
3. Hypernatremia
4. Inborn errors of Metabolism:
   a. Congenital lactic acidosis :
      i. Mitochondrial electron transport defect
      ii. Disorders of gluconeogenesis
          1. Pyruvate dehydrogenase deficiency
          2. Pyruvate carboxylase deficiency
   b. Fatty acid oxidation disorder
   c. Amino and organic aciduria
      i. MSUD
      ii. Propionic aciduria
   d. Urea cycle defect
   e. Co-factor, vitamin and metal deficiency
      i. Molybdenum co-factor deficiency
      ii. Menke’s syndrome
   f. Defect in glycine cleavage
      i. Nonketotic hyperglycinemia
   g. Peroxisomal disorder
      i. Zellweger disease

II. Malformations

1. Agenesis of the corpus callosum with / without colpocephaly
2. Polymicrogyria-agyria
3. Heterotopia
4. Hemimegalencephaly
5. Hydranencephaly
6. Brainstem malformation
7. Cerebellar dysplasia
8. Sturge Weber Syndrome

III. Perinatal stroke

1. Arterial ischemic stroke
2. Sino-venous thrombosis
3. Hemorrhage due to coagulopathies

IV. Congenital and neonatal CNS infections

1. Neonatal meningitis
2. Encephalitis
3. Congenital infection (TORCH)

V. Tumour

1. Teratoma
2. Choroid plexus papilloma
3. Astrocytoma
4. Glioblastoma

VI. Trauma

1. Severe birth trauma
   a. Iatrogenic
   b. Non-iatrogenic

Pediatric Brain Imaging in Congenital Heart Disease. A Pictorial Essay

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Purpose
The purpose of this pictorial essay is to illustrate and explain the spectrum of abnormalities visualized on brain MR in pediatric patients with congenital heart disease, including presurgical, surgical and postsurgical complications, cardiac arrest and infections.
Materials and Methods
We have retrospectively reviewed 500 brain MRI images from our pediatric institution in which the word "cardiac" was included in the report from March 2006 until November 2013. These studies have been reviewed by a pediatric neuroradiologist and a pediatric radiology fellow. A consultant pediatric neurologist reviewed the clinical chart of the cases shown in this review. Neurological symptoms, vascular studies and the pattern of ischemic changes were recorded.

Results
The studies were performed before surgery, within two weeks of surgery, and several months after surgery. Neurological complications after cardiac surgery included stroke, encephalopathy, persistent cognitive impairments and signs of infection. Acute imaging findings included infections/abscesses and stroke. Territorial stroke was seen associated with either septic or nonseptic cardiac emboli. The mechanisms underlying these neurological events may include microemboli and hypoperfusion during surgery, and postoperative atrial fibrillation.

Periventricular leukomalacia was found in multiple studies as previously shown by Galli et al (3). It was found in >50% of neonates after cardiac surgery but rarely in older infants. Hypoxemia and hypotension in the early postoperative period, particularly diastolic hypotension, may be important risk factors for periventricular leukomalacia (4). Brain imaging within 24-48 hours of postcardiac arrest was negative in four patients with diffuse positive finding in imaging performed later. On late imaging, it is frequent to see multiple foci of susceptibility on gradient-echo sequences in the deep and subcortical white matter as a unique finding in some patients with previous surgery. They could be the result of microhemorrhages from previous anticoagulation treatment or emboli.

Conclusions
Mild ischemic lesions, primarily in the form of PVL, occur in a number of neonates with CHD before surgery and >50% of patients postoperatively. Resolution of these lesions is common four to six months after surgery (1). Diffusion-weighted imaging (DWI) and gradient-echo sequences have shown to be the most sensitive sequences to detect ischemic changes; however, in cardiac arrest, the imaging findings may present after 48 hours. Thus, in our population, focal cortical lesions were common after open heart surgery, and, in addition, diffuse brain abnormality on MRI plus neurological sequelae were common after prolonged hypothermic circulatory arrest (5). More precise neuroimaging of patients with these complications may lead to a better understanding of the etiology and treatment of these disorders.

KEYWORDS: Abscess, Congenital Anomalies, Stroke

EdE-86

Pediatric Strokes: What You Need to Know

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Purpose
Pediatric stroke (PS) is a relatively uncommon but underdiagnosed condition with heavy consequences, both individual and social. Most survivors subsequently suffer some form of cognitive or neurologic impairment, adversely impacting functional status and quality of life.
This in turn increases burden on health care resources (1, 2). This pictorial essay focuses on increasing awareness of PS. Emphasis is on etiologies, general risk factors and predisposing conditions unique to different age groups, classification, imaging approaches to diagnosis, treatment options, and outcomes.

Materials and Methods
Clinical challenges resulting in misdiagnosis or delayed diagnosis that negatively impact overall outcome are presented. Cases depicting factors that may increase clinical suspicion, and thus aid in promoting awareness are included (1). Stroke mimics are discussed.

Results
Etiologies and risk factors for PS are substantially different from adults. Clinical presentation may vary depending on age (1, 3). Pediatric stroke is believed to be under-diagnosed or misdiagnosed in infancy and childhood (1, 3, 4). Yet the consequences are serious, with increased morbidity, variable long-term outcome and high costs (2). About half of survivors of PS may have neurologic or cognitive impairment. Just over a quarter of survivors will develop some form of epilepsy. Neonates are particularly vulnerable, making up to 25% of acute ischemic stroke patients in the pediatric population. Additionally, as many as 14% of newborns with seizures are diagnosed with cerebral infarction (4). Increasing knowledge about stroke in the pediatric population is crucial in order to reduce morbidity and mortality. Awareness of etiologies and risk factors unique to a specific age group may facilitate prompt referral.

Appropriate workup (including neuroimaging, metabolic, and hematologic investigation) is key to correct diagnosis and timely, optimal treatment. Although management strategies are mainly extrapolated from adults, pediatric-specific considerations (such as short-term anticoagulation and guarded recommendations on thrombolytics) remain useful.

Conclusions
Increased awareness may help overcome the clinical challenges that often result in misdiagnosis or delayed diagnosis of stroke in infancy and childhood. Timely diagnosis and referral coupled with optimal treatment may lead to a more favorable outcome.

KEYWORDS: Pediatric Stroke

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<th>Pediatric Stroke: Fast Facts</th>
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Trauma (nonaccidental or otherwise)

Mimics
- Migraine
- Todd’s Paralysis (seizure)
- Hypoglycemia
- Congenital metabolic

(Picture: TCT_EdE-86_StrokeforRobert.jpg)

### EdE-90

6:30AM - 9:00PM

### Pictorial Review of Childhood Primary Central Nervous System Vasculitis

L Verhey¹, M Moharir², M Shroff³

¹The Hospital for Sick Children Research Institute, Toronto, Ontario, Canada, ²The Hospital for Sick Children, Toronto, Ontario, Canada, ³The Hospital for Sick Children/University of Toronto, Toronto, Ontario, Canada

**Purpose**

Primary angiitis of the central nervous system (PACNS) is being recognized increasingly in children and represents an acute inflammatory disorder in which immune cells target the arterial endothelial cells of the CNS causing severe neurological deficits in previously healthy children. Three subtypes currently are recognized: nonprogressive large-medium vessel childhood PACNS (cPACNS), progressive large-medium vessel cPACNS, and small vessel cPACNS. We provide a pictorial review of the neuroimaging features of cPACNS.

**Materials and Methods**

The pictorial review represents the collaborative expertise essential to caring for children with cPACNS, and includes input from a multidisciplinary team of pediatric neuroradiologists, pediatric neurologists with expertise in inflammatory disease, and pediatric rheumatologists at The Hospital for Sick Children (Toronto, Canada). A review of the neuroimaging features of
Children with PACNS, who were identified from the neuroradiology and neurology databases at The Hospital for Sick Children, will be presented. Hallmark features on conventional MR imaging (MRI) and time-of-flight MR angiography, conventional catheter cerebral angiography, and advanced MRI techniques such as contrast-enhanced vessel wall imaging will be reviewed. 

**Results**

Large-medium vessel cPACNS shows irregularity and narrowing, and in some instances occlusion, of the vessels on MR angiography and conventional catheter angiography; T2-weighted and diffusion-weighted imaging show features of acute ischemic stroke. T2-weighted, gradient-echo, and susceptibility imaging have a role in detecting hemorrhage which can inform on acute therapeutic decisions. MR angiography and conventional catheter angiography is normal in children with small vessel PACNS, necessitating brain biopsy for definitive diagnosis. T2-weighted and FLAIR imaging features may resemble those of inflammatory demyelination; however, leptomeningeal enhancement may be a specific feature of small vessel cPACNS. Contrast-enhanced wall imaging provides new insight into the radiographic visualization of the pathologic processes of vessel wall inflammation operative in PACNS.

**Conclusions**

Neuroimaging plays a key role in the diagnosis of childhood PACNS. Recognition of patterns on multimodal neuroimaging is essential to identifying disease subtypes and screening patients for invasive diagnostic techniques such as conventional catheter angiography and brain biopsy. Serial neuroimaging is essential in the clinical care of children. Understanding MRI indices of neurological outcome is pivotal and relies on ongoing follow up of children followed in our program.

KEYWORDS: Inflammatory, Pediatric Brain

**EdE-92**

**Pictorial Review of Mimics of Acquired Inflammatory Central Nervous System Demyelination in Children**

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**Purpose**

An acquired demyelinating syndrome (ADS) is characterized by acute neurological deficits and focal or multifocal areas of T2-hyperintensity in the brain, optic nerves, or spinal cord on magnetic resonance imaging (MRI). Common presentations include optic neuritis, brainstem syndromes, polyfocal neurological deficits, transverse myelitis, and acute disseminated encephalomyelitis. Acquired demyelinating syndrome may occur as a monophasic illness in some children, while it may represent the incident clinical manifestation of multiple sclerosis (MS) in others. The clinical features of acute demyelination are not specific. Clinicians must be aware of MRI features (i.e., "red flags") that should prompt consideration of diagnoses other than ADS and MS. We provide a pictorial review of MR imaging (MRI) features of diseases that mimic ADS and MS that radiologists should consider in the differential diagnosis.
Materials and Methods
Children less than 18 years of age who were initially considered to have acquired demyelination and for whom evolving clinical features, laboratory evaluations and MRI findings helped confirm an alternative diagnosis were included. Participants were identified from a national prospective study of children with CNS demyelinating disease (1) and from the neuroradiology database at The Hospital for Sick Children (Toronto, Canada). MR imaging features considered to be "red flags" that may assist radiologists in distinguishing inflammatory demyelination from other CNS disorders will be presented.

Results
Mimics of acquired demyelination in our cohort include malignancy (e.g., infiltrative astrocytoma), fibrocartilaginous embolic infarct of the spinal cord, small-vessel primary angiitis of the CNS (SV-pACNS), CNS lupus, Lyme disease, neurosarcoidosis, viral encephalitis, cerebellitis, and mitochondrial disease. "Red flags" seen on MRI include: leptomeningeal enhancement (seen in SV-pACNS and malignant and infectious processes), lesion expansion on serial MRI (although recognized in MS, this finding should prompt consideration of a diagnosis of neurosarcoidosis or tumor), and hemorrhage (acute necrotizing encephalitis, cerebellitis and CNS vasculitis).

Conclusions
Prompt diagnosis and early initiation of corticosteroid therapy are important in the clinical management of ADS and MS. However, their diagnoses remain challenging; early identification of atypical MRI features will facilitate proper investigations to aid in making an alternative diagnoses.

KEYWORDS: Demyelination, Differential Diagnosis, Pediatric Brain

EdE-93

Stuffy Noses: A Review of Pediatric Paranasal Sinus Masses

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¹Florida Hospital, Orlando, FL, ²Florida Hospital - Radiology Specialists of Florida, Orlando, FL

Purpose
The purpose of this exhibit is to review the CT and MR imaging features and pathology of common and more rare pediatric nasopharyngeal and paranasal sinus lesions. Such lesions often are not detected until later stages; therefore, it is imperative for the radiologist to be cognizant when reviewing head CTs for vague pediatric complaints such as headache. In addition, we will review common pitfalls and propose a few points for a more thorough pattern of search.

Materials and Methods
A Montage search was performed with radiologic-pathologic correlation for all nasopharyngeal and paranasal sinus lesions detected by CT or MR imaging of the skull at our institution over the last seven years. An exclusion age criteria of 25 years was used, since many pediatric paranasal tumors can be slow growing. Images were obtained in cases with designated classic, subtle or ambiguous findings.
Results
There is a broad differential for tumors in the paranasal sinuses of pediatric patients. Whereas in adults, squamous cell cancer is the most common tumor by far, the pediatric differential diagnosis is a little more complex. The epidemiology of benign and malignant paranasal sinus tumors is demonstrated with the selected cases. Additional mimics of benign and malignant lesions are presented.

Conclusions
Pediatric paranasal sinus lesions have a broad differential and when lesions are discovered, it is commonly late in the disease course. Given the often vague presenting complaints, it is important for the interpreting radiologist to have a strong search pattern and understanding of the pathology that can arise from the paranasal sinuses. This exhibit reviews imaging features and pathology of common and more rare pediatric nasopharyngeal and paranasal sinus tumors.

KEYWORDS: Nasal Mass, Pediatric Head And Neck

EdE-89
Thalamic Lesions in the Pediatric Population

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Purpose
A large number of lesions involve the thalamus in the pediatric population. The purpose of this educational exhibit is to review computed tomography (CT) and magnetic resonance (MR) imaging findings of thalamic lesions in the pediatric population.

Materials and Methods
We retrospectively reviewed MR and CT images of multiple children with thalamic lesions diagnosed at our tertiary care children's hospital. We illustrate disease entities using advanced MRI techniques like tractography (figure), perfusion MRI and MR spectroscopy acquired using 3.0 T and 1.5 T MRI equipments. Differential diagnosis for the imaging findings and salient imaging features of each entity are discussed. We perform literature review to generate discussion of disease entities with focus on advanced MR imaging.

Results
The thalami are paired symmetric structures, which serve to relay signals between the cerebral cortex and midbrain. They are susceptible to various pathologies, some of which are predominantly seen in the pediatric population. Neoplastic, inflammatory, congenital, vascular, and traumatic processes affect the thalamus. We review the unique imaging features of each of these categories of lesions with specific example cases. These lesions include pilocytic astrocytoma, grade II astrocytoma, arteriovenous malformation, tumefactive multiple sclerosis, hypoxic ischemic injury, and neurofibromatosis type 1 lesions.

Conclusions
Awareness of the disease processes and diagnostic imaging features of thalamic lesions in the pediatric population are important to recognize in order to provide timely and appropriate management.
Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Education Exhibits (Print) - Socioeconomics
EdE-101

Bibliometric Research for the Neuroradiologist: A Review of Strengths, Limitations, and Case Examples

L Wing¹, T Massoud²
¹John Radcliffe Hospital, Oxford, UK, ²Stanford University School of Medicine, Stanford, CA
Purpose
We summarize the current and potential roles of bibliometric (quantitative analysis of research publications and citation rates) research in neuroradiology. We also demonstrate uses of bibliometric indicators in the neuroradiologist's academic and clinical practice, and introduce potential future research performance metrics and their uses.

Materials and Methods
The use of bibliometrics is becoming increasingly widespread in the academic community, with applications ranging from individual use in journal selection to institutional use in resource allocation and academic recruitment. Since the invention of Garfield's Scientific Citation Index in 1961 and the Journal Impact Factor shortly thereafter, a vast array of bibliometric indicators have been developed, many of which are in active use today. The way in which research findings are communicated to the academic community has evolved, heavily affecting the relevance of such bibliometric indicators. The abundance of citation-based metrics can pose many questions to today's neuroradiologist: What does each metric represent? Which metric should be used? How should they be interpreted?

Results
We present a clear and up-to-date explanation of the most commonly used citation-based metrics in the academic community (including Journal Impact Factor and H-index) in the context of today's increasingly online academic community. We explore the advantages and pitfalls of using such metrics through several case examples: (a) using a range of indicators to compare two hypothetical neuroradiologists' research output; (b) examining the academic output of neuroradiologists compared to other radiological subspecialties; (c) using temporal trends in publication output and citation rates to identify potential growth in research fields and therefore aid decisions in funding. Importantly, we also introduce newer concepts such as "altmetrics" and "webometrics", demonstrating their utility in neuroradiology research and education through case examples.

Conclusions
Bibliometric indicators have a wide range of applications in neuroradiology; from enabling us to compare the work of individuals to extracting trends from decades of research publication in an entire research field. As bibliometric information and data become increasingly prolific, we aim to demystify these seemingly complex metrics and provide a clear insight into their strengths and limitations to encourage neuroradiologists to use these powerful tools.

KEYWORDS: Anatomy

EdE-98

Meaningful Use and Electronic Health Records in Neuroradiology

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Purpose
To explore the meaningful use electronic health record incentive program and its impact on neuroradiologists.
Materials and Methods
Due to the government electronic health record incentive program, known as meaningful use, many hospitals and physician groups have begun implementing electronic health records. We evaluate the meaningful use regulations as they apply to neuroradiologists. Furthermore, we will evaluate the potential benefits of having access to detailed patient history.

Results
Meaningful use is a government-run program to accelerate the adoption of electronic health records in the U.S. Through a carrot and stick approach, physicians, including radiologists, can receive incentive payments for compliance and may be penalized for noncompliance. Following the 2012 rule-making, radiologists have received a five-year "significant hardship exemption", meaning that they can receive incentive payments for compliance but will not be penalized for noncompliance. Meaningful use is divided into stages, and everyone starts with stage 1. We look closely at stage 1 and stage 2 regulations and determine potential challenges in achieving meaningful use for neuroradiologists. For example, neuroradiologists (who do not do procedures) have very limited face-to-face contact with patients. While this initially may seem like a hurdle to meaningful use compliance, a lot of exclusions to the meaningful use regulations may be applicable. It could be possible to implement meaningful use with little or no interruption to current workflow. Accurate interpretation of functional MRI, diffusion tensor imaging, and advanced MRI protocols require detailed patient history. It is not enough to know if a patient has had surgery or radiation therapy, but what the time course of treatment has been. What medications has the patient received and when? It is not possible for a referring physician to impart all of the required information either in a requisition or even separate paperwork. When such paperwork is received, it often is disorganized and easily misplaced. Even when a hospital system has an electronic health record populated with patient information, it often is difficult to access. We look at the potential risks and benefits of having neuroradiologists improved access to a hospital's electronic health records. We also look at how an electronic health record can be filtered to suit the neuroradiologists workflow.

Conclusions
There are definite financial benefits in achieving meaningful use through incentive payments. However, the true benefit in meaningful use and electronic health records is complete access to the patient history. Neuroradiologists often are reading complex studies to answer complex questions, and having access to progress notes, medications, and lab results can significantly improve the quality of our reports and patient care. It is imperative that neuroradiologists become more vocal both within the radiology department and within the hospital administration about improving access to patient history. It is not enough to have access to the hospital's electronic health records but that access has to be optimized in order to display neuroradiology-pertinent information in a concise and timely manner. Modern day electronic health record software allows this flexibility. Cooperation between the neuroradiology department, electronic health record vendor, and hospital IT can lead to the creation of a neuroradiologist centered electronic health record that is more robust and better integrated into the daily workflow.

KEYWORDS: Economics
Purpose
The introduction of the Milestone Project by the ACGME for use in evaluation of residents and fellowship physicians poses new challenges to resident and fellowship curriculums. The purpose of this exhibit is to introduce the 12 milestones and show the need to adapt to this form of evaluating and at the same time strengthen our radiology and fellowship program's proposed new tools to adapt to the milestone project.

Materials and Methods
The ACGME milestones are a behavior, attitude or outcome related to general competencies that describe a significant accomplishment expected of a resident by a particular point in time, progressing from beginning of residency through graduation and are defined as the "knowledge, skills and attitudes, and other attributes for each of the ACGME competencies organized in a developmental framework from less to advanced". Milestones are to be used biannually as a review of resident or fellow performance. The Milestones evaluate the competencies and are arranged into levels from 1 through 5 that go from the resident demonstrates milestones expected for one who has had some education in radiology (level 1) to a level where the resident has advanced beyond performance (level 5). The milestones are part of the new accreditation system. In January 2013 the milestones of core programs were published, in July 2013 the subspecialty milestone development begins. Milestones: Patient care and technical skills. Consultant: Competence in procedures. Medical Knowledge: Protocol selection and optimization of images. Interpretation of examination system-based practice. Quality improvement. Health care economics. Practice-based learning and improvement. Patient safety: Contrast agents; radiation safety; sedation; Self-directed learning; Scholarly activities. Professionalism: Professional values and ethics. Interpersonal and communication skills. Effective communication with patients, families, and caregivers. Effective communication with members of the health care team.

Creating or adapting exiting tools as metrics to integrate into the milestone system is crucial.

Results
Fellowship program directors must be aware of the changes facing the programs in the near future.

Conclusions
Fellowship programs are facing new challenges, understanding and preparing to adapt to the Milestone Project.

KEYWORDS: Educational, Neuroradiology Training

EdE-99
6:30AM - 9:00PM

Seeing the Unseen: Expanding Your Search Patterns to Make the Peripheral Findings

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1University of Arizona Medical Center, Tucson, AZ, 2University of Arizona, Tucson, AZ, 3Dartmouth Hitchcock Medical Center, Lebanon, NH
Purpose
In an age of image overload and pressure to read more quickly, it is easy to focus individually on the brain, neck, or spine and overlook the peripheral findings that may be just as important or more important than the central ones. Masses, fractures, aneurysms, hemorrhage and other diagnoses can go unnoticed if not sought after. This exhibit is a multimodality review that focuses on peripheral imaging findings and how to make them consistently.

Materials and Methods
The exhibit includes a discussion of expanded search patterns, how to maximize images to obtain the highest diagnostic yield including windowing and leveling, and focuses on both difficult and more obvious peripheral diagnoses that can be overlooked. The exhibit is divided into brain, spine, and head and neck in both the traumatic and nontraumatic settings.

Results
Studies of the head include findings in the orbits, in the pterygopalatine fossa, and upper face and neck. Images of the neck cover findings in the brain, spine, mediastinum, lungs, and pleura. Those of the spine include findings in the skull base, neck, chest, abdomen, and pelvis. Individual diagnoses will include primary tumors, metastases, hemorrhages, fractures, vascular abnormalities, infection, and many more. Frequently missed lesions will be illustrated.

Conclusions
In reviewing this exhibit, radiologists will: 1. Be more familiar with search patterns that will lead to routine recognition of peripheral imaging findings. 2. Be exposed to a wide array of pathology outside of the central focus of dedicated neurological imaging studies.

KEYWORDS: Quality Assurance, Quality Control, Quality Improvement
Purpose
Review the complex formula that CMS (Centers for Medicare and Medicaid Services, or Medicare) uses to reimburse direct practice expense (PE). Discuss the multiple ways in which practice expense reimbursement to neuroradiologists has been cut by CMS in recent years.

Materials and Methods
1) Describe the Medicare Resource-Based Relative Value Scale (RBRVS) payment system with respect to the Technical Component of reimbursement under the Medicare Physician Fee Schedule. 2) Review of multiple (10) legislative and regulatory changes to that formula that are resulting in diminished Practice Expense reimbursement. 3) Discussion of recent unilateral regulatory changes in Medicare policies regarding equipment and labor costs that are having a further impact on neuroradiology CT and MR exams. 4) Describe current policy initiatives under development that may have further TC revenue impact -- direction and extent uncertain.

Results
The Medicare formula to determine PE reimbursement is complex, and includes allowance for the imaging equipment cost, equipment time, and the labor cost, adjusted by technologist type and time needed for a particular exam. Through regulatory and legislative action, there have been multiple cuts to the technical (TC) component of Medicare payment over the past few years, involving adjustments to various parts of the PE formula. Practice expense cuts prior to and including 2014 (these items will be described in the poster): Multiple Procedure Payment Reduction (MPPR) – TC (2006), Deficit Reduction Act (DRA) (2007), Physician Practice Information Survey (PPIS) (2010 and ongoing), Utilization Rate (2010 and ongoing), MPPR – TC (2010), Code bundling (2010 and ongoing), MPPR – TC (2011) – TC, Interest Rate (2013), New PE cuts for 2014: Utilization Rate: CMS Room Time and Labor Cost Assumptions – CMS unilaterally changed its method to calculate room time allocated per exam for advanced imaging tests beginning in 2012; less time means less PE reimbursement for the equipment and the labor costs per exam. This has been phased in on a per-code basis for those procedures that have been re-valued at the RUC. This will be discussed further, with examples. Neuroradiology codes affected beginning 1/1/14 include fluoro guidance for epidural injections; head CT codes; and brain/spine MR codes. In Process: PACS valuation transition – Film processing and viewing equipment costs are only now transitioning from analog to digital inputs for purposes of accounting TC. This transition may begin this calendar year, and may result in further diminution in TC reimbursement by CMS. Future: Separate MR/CT Cost Centers – Proposed by CMS, but ultimately postponed in the 2014 Final Rule, awaiting further data. Site-neutral assumptions – Same TC payments for outpatients, whether imaged in a hospital or in a separate outpatient facility. Proposed by CMS, postponed in Final Rule.
Conclusions
Medicare's technical reimbursement for radiology services has been cut by numerous methods over the past 5 years. As of January 1, 2014, new cuts to the technical component are directly affecting neuroradiology services. These cuts may create financial strain for imaging centers and hospitals that own advanced imaging equipment and employ technologists, and that bill either the TC component alone, or the global fee.

KEYWORDS: CT, Medicare, MR Imaging

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Education Exhibits (Print) - Spine
EdE-105

6:30AM - 9:00PM

Abnormal Cord Signal Revisited: Anatomical and Pathophysiologic Approach

A Betts¹, H Morales¹
¹University Hospital/University of Cincinnati College of Medicine, Cincinnati, OH

Purpose
T2 hyperintense signal abnormalities within the spinal cord on magnetic resonance imaging (MRI) can evoke a broad differential diagnosis, and can present a diagnostic dilemma. We describe an approach to help radiologists provide a succinct and relevant differential diagnosis based upon imaging patterns and anatomical/pathophysiologic correlation. In a series of cases, we provide clues and imaging pearls, focusing on inflammatory, infectious, demyelinating, vascular, and metabolic involvement of the spinal cord.

Materials and Methods
Patterns of distribution of signal abnormality in the axial and sagittal plane are discussed. Injury or disease processes may have a predilection for anterior, central, or posterior cord. Therein, pathophysiology of the disease often correlates with the anatomical involvement, which can provide diagnostic clues. Furthermore, involvement of specific white matter tracts also may provide important diagnostic information. In general, syrinx and tumors have a distinct appearance. A syrinx presents with a well defined cavity, while tumors usually distort the architecture of the cord. Both entities will be described briefly as important considerations during the initial approach of signal abnormalities, but are not the focus of this exhibit.

Results
Short segment involvement typically is seen with multiple sclerosis (MS) and its mimics (e.g., sarcoid, vasculitis), as well as compressive myelopathy and metabolic abnormalities. Long segment processes involving more than two vertebral segments, is seen less commonly with inflammatory or demyelinating diseases such as transverse myelitis or neuromyelitis optica (NMO), as well as vascular diseases such as venous hypertension or arterial infarct. In both short and long segment processes, the distribution of abnormal signal in the axial plane may further narrow the differential diagnosis. Thus, correlating the location of the abnormality to the white matter columns and/or central gray matter is critical. Patchy signal that predominates in the
posterior or lateral white matter columns in an asymmetric distribution suggests MS. Well defined symmetric signal of the posterior central gray matter or ventrolateral posterior columns ("snake-eye" sign) commonly is seen with compressive myelopathy. Subacute combined degeneration (vitamin B12 deficiency) involves the posterior columns. Predominant gray matter abnormality of the anterior horns is seen with arterial infarction, often in a symmetric pattern. Centromedullary gray and white matter involvement is typical for transverse myelitis and NMO. Venous hypertension secondary to vascular malformations of the spine can lead to diffusely increased signal of the cord with a thin remnant of peripheral hypointensity on axial images. Infectious myelitis is particularly challenging. However, some patterns of involvement have been described. HIV-associated vacuolar myelopathy typically involves the thoracic spine and present symmetric involvement of the white matter columns (lateral and posterior). Polio or West Nile virus has a predilection for the anterior columns. These patterns of signal abnormality can overlap. However, we believe that careful evaluation of the anatomical distribution is helpful in most cases. Conclusions Intramedullary signal abnormalities of the spinal cord have a broad differential diagnosis. Evaluation of the pattern of cord signal abnormality in both sagittal and axial distributions can provide diagnostic clues. Correlation with the pathophysiology of the disease can assist radiologists in providing succinct and clinically relevant differential diagnoses.

KEYWORDS: MR Imaging Spine, Spinal Cord
Demystifying the MR Evaluation of Spondylolisthesis: Tricks of Our Trade.

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\textsuperscript{1}University of Alabama Birmingham, Birmingham, AL

Purpose

The goal of this presentation is to review the MR imaging features of lumbar spondylolisthesis with special emphasis on identifying the spondylolytic form. The presentation will provide useful teaching points that help the radiologist confidently identify spondylolysis when faced with an MR exam and no corresponding lumbar spine radiographs or CT.
Materials and Methods
The presentation will discuss the anatomical and pathological differences between "true" spondylolisthesis secondary to a pars interarticularis defect and "pseudo" or degenerative spondylolisthesis. MR features that distinguish the two entities will be presented with an emphasis on properly diagnosing spondylolysis in the lumbar spine.

Results
Concern for degenerative disease in the lumbar spine is the most common indication for a clinician to order a lumbar spine MR imaging (MRI). Often we are faced interpreting these studies without an accompanying conventional radiograph or CT. MR imaging alone is adequate to evaluate spondylolisthesis but proves difficult to completely assess the nature of the patient's pathology. In any type of spondylolisthesis there will be anterior displacement of the vertebral body (along with the entire superior spine) in relation to the inferior vertebral body. The neural foramen will become obliquely oriented (instead of the normal vertical orientation) and assume a figure 8 configuration. Relying on the hypointense line solely to identify a pars defect can be tricky as a sclerotic pars can mimic a fracture. This presentation will describe and provide MR examples of three helpful findings to confirm pure spondylolysis: 1. "Step off sign" of the spinous process above the level of the pars defect, whereas the step off is below the level in degenerative spondylolisthesis. 2. Widening of the lower lumbar canal when compared to the L1 diameter, whereas the canal is narrower in degenerative retrolisthesis. 3. Epidural fat interposition between the dura and spinous process.

Conclusions
Spondylolysis of the lower lumbar spine can be a challenging diagnosis to make by MR alone. This presentation will provide the radiologist with three practical tools to use in the reading room to help correctly and confidently differentiate spondylolytic from other forms of spondylolisthesis.

KEYWORDS: Degenerative, Spinal Canal, Spondylolysis

EdE-108
6:30AM - 9:00PM

Exophytic Midline Spinal Cord Hamartoma: MRI Features of a Distinct Clinical Entity

G Gong¹, M Auster¹
¹Johns Hopkins University School of Medicine, Baltimore, MD

Purpose
Congenital midline spinal cord hamartomas are relatively rare with only 16 cases reported. Correct diagnosis can be made by characteristic MR imaging (MRI) findings. This exhibit reviews those imaging findings, differential diagnosis from other intraspinal masses, the key anatomical and clinical features, and current clinical management recommendations.

Materials and Methods
The authors report a case of congenital cervical spinal cord hamartoma in a young woman who presented with progressive bilateral upper extremity weakness and paresthesia. MR imaging findings and protocol suggestions, histological and anatomical features, clinical presentations and management recommendations of this entity are discussed with literature reviews of reported cases.
Results
The more commonly seen congenital spinal cord masses include lipomas, epidermoids, dermoids, and teratomas, etc. Congenital midline spinal hamartomas are relatively rare. It is believed that they represent embryologic neural tube error. They are composed of mature and well differentiated histological components which are in an abnormal location/configuration. Spinal hamartomas can be seen in any segment of the spinal cord. Most patients harboring this anomaly are neurologically intact but may present with a skin dimple, cutaneous angioma, subcutaneous mass, or normal overlying skin. These lesions are not related to brain malformation or neurofibromatosis. On MR imaging, these lesions demonstrate isointensity with the adjacent spinal cord parenchyma on all MRI sequences. They are mostly peg-like appearing tissue broadly based on the dorsal midline spinal cord parenchyma with a pointed narrow end inferiorly, possibly due to tethering of the cord. They may show a dermal sinus tract with vascularity that tethers the cord at the level of the lesions. Adequate MRI sequences should include precontrast routine axial and sagittal T1- and T2-weight images with thin sections through the lesion. Postcontrast fat saturation sequence images also may be obtained for differential diagnosis. The differential diagnosis is straightforward from other spinal masses on the basis of MRI findings. Teratomas are characterized by heterogeneous signal and by contrast enhancement. Most dermoids have a signal intensity similar to fluid on both T1- and T2-weighted images. Most dermoids are T1 bright and appear similar to intraspinal lipoma. Surgical consultation is recommended for clinical management with possible intervention to prevent neurological damage resulting from tethering of the cord in young patients, to prevent infection of the dermal sinuses, or to correct focal cosmetic defect.

Conclusions
Midline spinal cord hamartoma is an uncommon but distinct congenital spinal lesion representing embryologic neural tube error caused by both incomplete and possibly premature disjunctions. They are likely being increasingly encountered due to wide availability of MR imaging. Most of the patients are asymptomatic or only have minimal neurological deficits. MR imaging features allow one to distinguish them from other intraspinal masses. This case review adds help for recognizing this entity based on MRI features – isointensity signals with the spinal cord on all sequences.

KEYWORDS: Spinal Cord
Pictorial Demonstration of Imaging, Diagnosis, and Treatment of Traumatic Spinal Injury in Patients with Ankylosing Spondylitis

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¹Westchester Medical Center, Greenwich, CT, ²Westchester Medical Center PMB 578, Valhalla, NY, ³Westchester Medical Center, Valhalla, NY

Purpose
-To review the unique features of pathogenesis, natural history, imaging features and treatment of acute spinal injury in patients with seronegative spondylopathy such as Ankylosing Spondylitis (AS).
-To present multiple examples of different types of spine injuries in AS patients so as to improve diagnosis through recognition of areas to specifically look for injury.
-To review the unique biomechanics of spine fracture in AS patients.
-To demonstrate salient radiographic, CT, and MR imaging features of traumatic spine injury in AS patients.
-To demonstrate the necessary surgical treatment options and challenges for AS patients with traumatic spine injuries.

Materials and Methods
Pathophysiology and epidemiology of spine fractures in seronegative spondylopathy patients.
-Brief discussion of the current literature on this specific disease. Review of imaging findings:
-Radiographic imaging findings.
-CT imaging findings with discussion regarding important anatomical regions to direct focus to help avoid missed diagnosis.
-MR imaging findings with optimization of diagnosis and secondary findings. Discussion of treatment options, including pre- and postoperative imaging, and a review of outcome with significant clinical and educational ramifications.

Results
Recognition of the history, epidemiology, biomechanics, imaging features, and treatment for trauma patients with Ankylosing Spondylitis is important for both patient treatment and outcome. We review the optimal imaging methods and search patterns to evaluate these patients.

Conclusions
1. Discussion of the common radiographic findings for spine trauma in patients with seronegative spondylopathy.
2. Presentation of multiple cases of spine injuries in patients with seronegative spondylopathy such as Ankylosing Spondylitis through use of CT and MR, including pre- and postoperative imaging.

KEYWORDS: Ankylosing Spondylitis
Sacroiliitis. Diagnosis by MRI

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¹Fundación Santa Fe de Bogota, Bogota, Colombia, ²Fundación Santa Fe de Bogota, Bogota, Cundinamarca, Colombia

Purpose
To review and discuss the anatomy of the sacroiliac joints, the MR imaging (MRI) techniques, and radiological features of the sacroiliitis.

Materials and Methods
Based on a cases series of patients with inflammatory lumbar pain and suspected diagnosis of sacroiliitis taken from the radiology department of the Fundación Santa Fe de Bogota University Hospital, we did a complete review of the literature and discussed the radiological features of the different diseases affecting the sacroiliac joint, especially the sacroiliitis.
Results
In whom an MRI of the sacroiliac joints was performed, semiquantitative assessment of the degree, extension and activity of the inflamed sacroiliitis base on imaging findings was done.

Conclusions
The MRI findings allow an early diagnosis, staging and extension of the inflammation and patient follow up.

KEYWORDS: Sacroiliac

<table>
<thead>
<tr>
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<tr>
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<td>33% of the quadrant</td>
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<tr>
<td>3</td>
<td>66% of the quadrant</td>
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<tr>
<td>4</td>
<td>more than 66% of the quadrant</td>
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Spinal Meningeal Cysts: What Are They and Why Should I Care? An Interactive, Case-Based Tutorial

N Turman¹, W Smoker¹, L Gentry²
¹University of Iowa Hospitals and Clinics, Iowa City, IA, ²University of Wisconsin, Madison, WI

Purpose
1. Become acquainted with the anatomical classification of spinal meningeal cysts.
2. Identify the various types of spinal meningeal cysts.
3. Recognize various meningeal cyst mimics.
Materials and Methods
CT, MRI and CT myelography images of meningeal cysts of the cervical, thoracic, and lumbar spine are shown to highlight pathology and key features in distinguishing the correct diagnosis.

Results
Spinal meningeal cysts are rare lesions. They can be classified, based on their location and presence or absence of nerve root fibers within the cysts, into three categories: Type I are extradural meningeal cysts without spinal nerve root fibers (IA = extradural arachnoid cysts; IB = occult sacral meningoceles); Type II are extradural meningeal cysts with spinal nerve root fibers (Tarlov perineural cysts); and Type III are intradural meningeal (arachnoid) cysts. There are a number of pathologies that occasionally mimic these various cysts that need to be considered in the differential diagnosis of these lesions (transdural cord herniation may mimic a Type III meningeal cyst; post-traumatic pseudomeningoceles may mimic Type II meningeal cysts, dural ectasia may mimic a Type IB meningeal cyst, etc.). We present and discuss the various meningeal cysts and their mimics in an interactive, case-based tutorial that leads the reviewer to the correct diagnosis. Imaging includes plain radiographs, CT, MRI and CT myelography for various cases.

Conclusions
Spinal meningeal cysts are classified into three categories based on location and presence or absence of nerve root fibers within the cyst. There are a number of important differential diagnostic lesions that need to be considered. In this interactive tutorial the reader is presented with a variety of intraspinal cystic lesions and led to the correct diagnosis through a step-by-step analysis.

KEYWORDS: Classification, Cyst, Meningeal
Type III Meningeal Cyst

Flattening of the spinal cord (green arrow) is key in differentiating this from transdural cord herniation

(Filename: TCT_EdE-103_Slide5.JPG)

EdE-106

6:30AM - 9:00PM

Spinal Subdural Space: Review of Normal Anatomy and Pathologic Imaging Findings

K Yadwadkar\textsuperscript{1}, A Sayah\textsuperscript{2}

\textsuperscript{1}Georgetown University, Washington, DC, \textsuperscript{2}Medstar Georgetown University Hospital, Washington, DC
Purpose
The subdural space of the spine is a common location for spinal pathology, but often is identified poorly and misunderstood. The purpose of this exhibit is to present a concise overview of the normal anatomy of the spinal subdural space and to review the imaging findings of the various pathologies that occur in this compartment.

Materials and Methods
The normal anatomy of the spinal subdural space is discussed, with accompanying images and diagrams. In addition, the imaging findings of spinal subdural space lesions are discussed and presented, and differentiated from the other spinal compartments including the epidural and subarachnoid space. Common pathologies of the spinal subdural space are reviewed via sample cases and relevant imaging findings.

Results
The spinal subdural space is a potential space between the outer surface of the arachnoid and the dura. Accurate localization of lesions within this space aids in differential diagnosis. Common conditions found in this space include spontaneous, traumatic, or iatrogenic spinal subdural hematomas, spinal hygromas, and empyemas. Subdural injection of contrast agent during myelography also can occur and is important to recognize. Spinal subdural space pathologies can spread easily along multiple levels of the spinal canal so accurate and timely diagnosis is important in appropriate patient management and favorable clinical outcome.

Conclusions
This exhibit will present the normal anatomy of the subdural space and the imaging findings of common associated pathologies. An understanding of the anatomy and imaging findings of the spinal subdural space can aid in accurate recognition and diagnosis.

KEYWORDS: Spinal Canal, Subdural, Subdural Hemorrhage

EdE-107

6:30AM - 9:00PM

Ventral Spinal Cord Herniation: A Report of Four Cases and Review of the Literature

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\textsuperscript{1}Geisinger Medical Center, Danville, PA

Purpose
Idiopathic spinal cord herniation is a widely under-recognized and under-reported cause of progressive Brown-Sequard syndrome. This rare entity results from anterior herniation of the spinal cord through a defect in the ventral dura, usually in the thoracic spine. The purpose of this case series is to display variant imaging findings and raise awareness of existence of this potentially reversible cause of myelopathy.

Materials and Methods
Four cases of reported idiopathic spinal cord herniation were identified retrospectively and their clinical charts reviewed. All patients had magnetic resonance imaging (MRI) of the spine. We present a case-based review of the variations in imaging findings of spontaneous ventral spinal cord herniation.

Results
Idiopathic spinal cord herniation has a fairly characteristic appearance on imaging and a
confident diagnosis frequently can be made on MR findings alone. Despite pathognomonic imaging features (1, 2), definitive diagnosis is commonly delayed until worsening clinical symptoms lead to surgical intervention and intra-operative confirmation of herniation. In our case series, classic findings were demonstrated on thoracic MRI, including focal ventral displacement and angulation. Each patient experienced the sequelae of focal anterior cord compression, including varying degrees of progressive lower extremity paresthesia and myopathy leading to gait instability (3, 4). There was evidence of cord signal abnormality suggestive of focal myelomalacia, a rare entity, in two patients.

Conclusions
Ventral spinal cord herniation is uncommon and patients frequently experience progressive symptoms for prolonged periods of time prior to diagnosis. Cognizance of the imaging findings of ventral spinal cord herniation can result in earlier diagnosis and prompt surgical intervention. In appropriate surgical candidates there is potential for reversal of neurological deficits (5).

KEYWORDS: Arachnoid Cyst, Myelopathy, Spinal Cord
Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Education Exhibits (eEdE) - Adult Brain
"Imaging Highlights in Parkinsonian Syndromes" What The Radiologist Needs to Know.

L Amaral¹, P Hanagandi², F Goncalves³, V Marussi⁴
¹Medimagem - Hospital Beneficencia de Portuguesa de São Paulo and Hospital São Jose, São Paulo, Brazil, ²The Ottawa Hospital, University of Ottawa, Ottawa, Ontario, Canada, ³Brasilia Children's Hospital, Brasilia, Brasilia, Distrito Federal, Brazil, ⁴Medimagem - Hospital São Jose and Beneficencia Portuguesa de São Paulo, São Paulo, Brazil

Purpose
The purpose of this study is to describe and illustrate the imaging highlights of atypical Parkinsonian syndromes encountered in routine clinical and radiological practice that can mimic Parkinson's disease. The role of follow-up imaging in these cases will be highlighted to differentiate and recognize these uncommon diseases and differentiate from Parkinson's disease.

Materials and Methods
A wide spectrum of neurodegenerative diseases presenting with Parkinsonism syndromes will be described in this electronic educational exhibit with emphasis on the role of MR imaging and salient features described in neuroradiology literature and their differential diagnosis.

Results
A diverse spectrum of neurodegenerative diseases are encountered in routine neurology-neuroradiology practice presenting with common clinical symptoms of tremor, rigidity, ataxia and bradykinesia. Most of these diseases are clinically diagnosed as Parkinson's disease. During the initial presentation, routine MR imaging studies are unremarkable or subtle findings are often missed. To name a few diseases, we intend to highlight and summarize the imaging findings of Multisystem atrophy (MSA-P and MSA-C), CBD (cortico basal degeneration), PSP (progressive supranuclear palsy), NBIA (group of iron deposition disorders) postinfectious Parkinsonism, Shydragger syndrome, ALS (amyotrophic lateral sclerosis), Variants of Fronto temporal dementia, metabolic-toxic related conditions, tumors and vascular causes of Parkinsonism.

Conclusions
It is crucial to identify and interpret subtle and classical imaging findings in parkinsonian syndromes as most of the diseases are gradually progressive with poor outcome. Early diagnosis can aid in therapy, assessing posttreatment response, prognosis and future patient care.

KEYWORDS: MR Imaging, Neurodegenerative, Parkinson Disease
A Schwantastic Journey through the Cranial Nerves: Imaging Guide to Cranial Nerve Schwannomas

A Skolnik\textsuperscript{1}, K Learned\textsuperscript{1}, L Loevner\textsuperscript{1}, L Bagley\textsuperscript{1}

\textsuperscript{1}University of Pennsylvania Health System, Philadelphia, PA
Purpose
Schwannomas are typically benign slow-growing neoplasms, though can reach substantial proportions presenting with cranial nerve (CN) dysfunction or local mass effect, particularly upon the brainstem. Surgical biopsy of intracranial schwannomas rarely is indicated due to the high risk of CN injury. Therefore, imaging evaluation plays a crucial role. This exhibit will review the MR imaging (MRI) features for diagnosis and treatment of schwannomas arising from the intracranial and skull base courses of the 12 CNs.

Materials and Methods
Retrospective review of radiologic, pathologic and clinical evaluations of patients with intracranial schwannomas will be performed. Relevant normal anatomy and intracranial and skull base courses of the CNs are reviewed. Literature reviews of the general imaging features of CN schwannomas and their relative frequencies are summarized and illustrated by representative examples. The treatment options for intracranial CN schwannomas are discussed as well as the relevant post-treatment imaging features.

Results
The 12 paired CNs have complex courses through the cisterns and calvarial foramina and are increasingly visible with modern imaging techniques including steady-state free precession MRI. Improved depiction of these structures (Table) allows greater detection and characterization of associated pathology. Schwannomas occur anywhere along the anatomical course of the CNs from intracranial cisterns to skull base as small oval avidly and homogeneously enhancing masses expanding the nerves and skull base foramina and fissures. Occasionally, heterogeneous enhancement, cystic degeneration, or hemorrhage may be seen. Schwannomas arising along the courses of CN I and CN II are exceedingly rare. Vestibular schwannoma are most common, followed by trigeminal and facial nerve schwannomas. The unique course of CN VII gives rise to variable morphology of associated schwannomas, appearing tubular in the geniculate fossa, round in the middle cranial fossa, lobulated in the middle ear, and indistinct in the mastoid air cells. Neurofibromatosis type 2 is associated with bilateral vestibular schwannomas, and with schwannomas of other CNs, most commonly CN III and CN V. Other CN schwannomas are uncommon. Management options include observation, stereotactic radiosurgery, and surgical resection. Surveillance MRI evaluates for stability or slow growth. Stereotactic radiosurgery may cause initial expansion of the tumor for 12-18 months, commonly with central necrosis and subsequent shrinkage. Evaluation following surgical resection requires an understanding of the expected appearance specific to the surgical approach, for example, cerebellar atrophy following a suboccipital approach.

Conclusions
Understanding the unique anatomical courses of the CNs is essential for accurate diagnosis and treatment planning of CN schwannomas. Knowledge of the treatment options and expected post-treatment sequelae is crucial for the evaluation of stability and for assessment of new or recurrent neurologic deficits.

KEYWORDS: Cranial Nerves, Schwannoma

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<tr>
<td>I</td>
<td>Olfactory</td>
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<td>Interpeduncular cistern</td>
<td>Cavernous sinus, superior orbital fissure</td>
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Alzheimer’s Disease: A Review of the Established and Updated Diagnostic Approaches and the Recent Achievements

M Watanabe¹, K Buch¹, J Thatcher¹, A Fujita¹, C Asai¹, Y Kimura², S Frank¹, O Sakai¹

¹Boston Medical Center, Boston University School of Medicine, Boston, MA, ²Jichi Medical University, Shimotsuke-shi, Tochigi-ken, Japan

Purpose
The diagnosis of Alzheimer's disease (AD) is classically based on clinical assessment. However, with recent advancements in neuropathology and genetics, the revised diagnostic criteria for AD include the role of neuroimaging and CSF biomarkers for AD. Moreover, new imaging biomarkers have been increasingly investigated. Knowledge of these evolving multidisciplinary efforts and new findings in the pathophysiology of AD is essential for proper radiological evaluation and to assist in the clinical diagnosis.

Materials and Methods
We present a review of (1) neuropathophysiological mechanisms of Alzheimer's disease,
established neuroimaging assessment with structural MRI and molecular imaging (amyloid-PET, FDG-PET), and (3) other neuroimaging techniques that may potentially provide specific neurobiological information, including diffusion tensor imaging, functional MRI, and molecular imaging using ligands specific to tau pathology or neuritis.

Results

Alzheimer's disease involves multiple pathological processes related to the abnormal deposition of β amyloid in the form of plaques, as well as, aggregates of hyperphosphorylated tau protein in the form of neurofibrillary tangles. Specific neuroimaging findings on each modality can be explained in connection to characteristic temporal and topographical distribution of those pathologies. Amyloid-PET is a biomarker for β amyloid accumulation, while decreased FDG uptake on PET imaging indicates impaired synaptic function due to tau pathology. Structural MRI evaluates cerebral atrophy, which is thought to reflect microscopic neurodegeneration as a resultant of tau pathology. Diffusion tensor imaging reveals disrupted white matter integrity, while resting-state functional MRI may serve as a potential biomarker for amyloid pathology. In PET imaging, the use of ligands specific to tau or neuritis has been investigated.

Conclusions

Neuroimaging is crucial to exclude potential secondary causes of dementia, most commonly cerebrovascular disease. Conventional MRI has some diagnostic value when the clinical diagnosis is uncertain. With the advent of more recent imaging techniques, the specificity of detecting AD has increased thereby making neuroimaging a definitive diagnostic tool for AD.

KEYWORDS: Degenerative, Molecular Imaging, MR Imaging

eEdE-44

An illustrated guide to the current use of MRI in Idiopathic Intracranial Hypertension: the spectrum of findings and useful techniques

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1St Vincent's University Hospital, Dublin, Ireland

Purpose

Idiopathic intracranial hypertension is a clinical condition characterized by chronically elevated intracranial pressure. Its precise etiology is unknown. It typically occurs in obese young females and symptoms include headache and visual disturbance. It is diagnosed by demonstrating elevated cerebrospinal fluid (CSF) pressure. Historically, the sole purpose of MR imaging (MRI) was to rule out secondary causes of raised intracranial pressures. Advances in MRI now allow the detection of signs supportive of the diagnosis itself. The purpose of this educational exhibit is to illustrate the imaging findings of idiopathic intracranial hypertension.

Materials and Methods

1. We discuss postulated mechanisms resulting in intracranial hypertension. 2. We illustrate the MR findings of idiopathic intracranial hypertension. 3. We describe newer imaging methods, including diffusion-weighted imaging and multidetector CT/MR venography, and their use in diagnosing the condition. 4. A case-based self assessment quiz is included for radiology residents.
Results
The spectrum of typical MR findings of idiopathic intracranial hypertension of empty sella, posterior globe flattening, narrowing of Meckel's cave, tortuosity of the optic nerve and optic nerve sheath distension are shown. Newer described findings including cerebral sinovenous stenosis and restricted diffusion in the optic nerve also are illustrated.

Conclusions
MR imaging is an essential study in idiopathic intracranial hypertension allowing exclusion of secondary causes of intracranial hypertension as well as assessment of signs frequently seen in the condition as outlined above. Novel imaging methods have additive diagnostic value and can identify potential etiology.

KEYWORDS: Idiopathic Intracranial Hypotension

Anatomic Variants: Know the Dangers and Avoid Disasters

E Bonfante¹, E Supsupin¹
¹University of Texas HSCH, Houston, TX

Purpose
This is a pictorial depiction of dangerous vascular anatomical variants in the head and neck, with emphasis on their practical clinical implications.

Materials and Methods
The theme focuses on the importance of recognizing hazardous or potentially dangerous anatomical variants. The cases illustrate how the underlying anatomy may place the patient at an increased risk of injury. Variants that may explain an individual's clinical manifestations and predisposition to morbidity are shown. More importantly, emphasis is made on how these anatomical circumstances may direct surgical approach and clinical management of head and neck pathology.

Results
Certain anatomical variants may predispose to an increased risk of injury. In the surgical setting, variants exemplified by transsphenoidal persistent trigeminal artery, aberrant petrous internal carotid artery (ICA), and anomalies of the jugular bulb may result in life threatening injury if not diagnosed appropriately. An ossified, elongated styloid process may provoke ICA dissection in trauma. Surgical interest in the aberrant course of the ICAs is driven by risk of vascular injury (i.e., transection or pseudoaneurysm formation) and exsanguination or hemorrhage requiring transfusion during tumor resections and other procedures such as tonsillectomy. Retropharyngeal course of the ICAs renders them vulnerable to injury through the oral cavity. Pulsatile sensation in the oropharynx has been described. In extreme cases, compressive symptoms such as hoarseness and upper respiratory distress were attributed to the anomalous course of the ICAs, particularly if bilateral. Anomalous origin and course of the vertebral arteries also have been implicated in posterior circulation strokes. The ability to recognize dangerous anatomical conditions and timely communication of findings to the referring clinician are crucial. Only then can treatment approach be suited accordingly, in order to avoid serious iatrogenic injury and
prevent catastrophe. Clearly, anatomical circumstances may greatly impact surgical planning and procedural course.

Conclusions
Failure to recognize dangerous anatomy may lead to catastrophic consequences. Knowledge of anatomical variants and their practical implications is crucial.

KEYWORDS: Anatomical Variation, Iatrogenic, Internal Carotid Artery

(Filename: TCT_eEdE-76_TranshypophysealPTA.jpg)

eEdE-36

Applications of Dual energy CT in Neuroimaging.

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Purpose
Dual energy CT is a recent advance in CT technology, which allows for rapid acquisition of datasets at two different energies. Current dual energy CT scanners offer improved temporal resolution which may be helpful in CT angiography and increased photon flux, which may be helpful in imaging obese patients. Dual energy CT provides information about how materials behave at different energies, provides capability to generate virtual unenhanced datasets and improves detection of iodine-containing substances on low-energy images. This leads to improved tissue characterization and analyses of chemical composition of materials.

Materials and Methods
In this exhibit we will demonstrate the neuroradiologic applications of dual energy CT for various pathologies in the head, neck and spine using demonstrative examples wherever relevant. In addition the physics of dual energy scanners also will be discussed in this exhibit.

Results
Neuroradiological applications of dual energy CT include differentiation of tumor bleeding from pure ICH, differentiation of hemorrhage from contrast staining in patients postvascular intervention, better quantification of carotid stenosis with removal of hard plaques from the vessels, bone removal on head and neck CT angiography and improved characterization of thyroid nodules. In addition metal artifact reduction by dual energy CT using monoenergetic extrapolation may be helpful in patients with spinal instrumentation including CT myelography.

Conclusions
Dual energy CT capabilities are promising for improved detection and characterization of lesions in the head, neck and spine and for evaluation of vascular structures. Further research is needed to validate these applications before their use becomes widespread. Reductions in radiation dose are possible if the need for true unenhanced datasets is eliminated and if low tube currents are used, radiation doses delivered in dual energy CT are similar to those used in single energy CT.

KEYWORDS: Dual-Energy CT, Neuroradiology Training

eEdE-11

6:30AM - 9:00PM

Autoimmune Mediated Encephalopathy: Why the Confusion and Madness?

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Purpose
Autoimmune mediated encephalopathy (AME) is a recently described entity associated with autoantibodies directed toward the central nervous system (CNS) that often is under-recognized or misdiagnosed. The primary goal of this presentation is to illustrate the MR imaging findings of pathologic CNS conditions associated with paraneoplastic and nonparaneoplastic disorders and present a systematic approach to aid the radiologist in diagnosis.

Materials and Methods
We organize the imaging presentations of AME into five major categories: limbic encephalitis,
cerebellar degeneration, striatal encephalitis, brainstem encephalitis, and leukoencephalopathy. For each imaging presentation, we discuss the pathophysiology and differential diagnoses.

Results
Autoimmune mediated encephalopathy can be divided into paraneoplastic and nonparaneoplastic disorders. Etiologies of paraneoplastic encephalopathy include neoplasms of the breast, lung, prostate, ovary, testicle, and lymphoma. Commonly associated antibodies are anti-NMDAR, anti-Yo, anti-Ri, anti-Hu, and anti-Tr. Nonparaneoplastic encephalopathy etiologies include anti-VGKC, celiac disease, and Hashimoto’s encephalopathy. These entities share common and often overlapping imaging features of limbic encephalitis, striatal encephalitis, brainstem encephalitis, and cerebellar degeneration. The clinical history along with imaging features can help the radiologist direct clinicians to the correct diagnosis through further laboratory and imaging studies.

Conclusions
We illustrate the imaging manifestations of autoimmune mediated encephalopathies and discuss their pathophysiology and differential diagnoses. A good working knowledge of AME is vital to providing early and accurate diagnosis of the paraneoplastic and nonparaneoplastic disorders and improve patient prognosis.

KEYWORDS: Encephalitis, Encephalopathy, Paraneoplastic
Brain & Neck Time of Flight Magnetic Resonance Angiography (TOF-MRA) - Review of methodology with common and uncommon angiographic appearances.

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Purpose
Time-of-flight (TOF) MR angiography (MRA) is a mainstay of noninvasive MR vascular imaging. Familiarity of the underlying physics and acquisition technique is vital for accurate interpretation, particularly when uncommon appearances occur.

Materials and Methods
The physics of TOF MRA is reviewed and applied to common and uncommon imaging appearances.

Results
Time-of-flight MRA relies on partial saturation of stationary tissues with flow related enhancement resulting in high intravascular signal. To avoid flow related enhancement from veins, a saturation band is placed above the imaged slice or slab. This methodology of image acquisition can result in imaging pitfalls related to technique, anatomy, and tissue characteristics. The potential imaging pitfalls discussed include: 1. Overestimation of the degree of stenosis due to turbulent flow; 2. Artificial loss of intravascular signal in the setting of flow reversal or when a tortuous vessel dips into a lower slab in 3D TOF MRA (Figure 1a); 3. Loss of vessel signal due to incorrect ratio of slab thickness and flow velocities; 4. Venous signal when flow direction is caudo-cranial or in the setting of an arterio-venous shunting lesion (Figure 1b); 4. Apparent flow-related enhancement in the absence of flow, when blood clot is present with pronounced T1-shortening.

Conclusions
Familiarity of the technical detail of TOF MRA methodology is necessary for accurate interpretation and differentiation of pathology from artifacts related to imaging technique in order to correctly guide clinical management.

KEYWORDS: MR Angiography, MR Venography
1a
artifactual signal loss

1b
Dural arteriovenous fistula
Bread and Butter: Routine Neuroimaging MR sequences and the Physics Behind Them

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Purpose
As MR has advanced technologically so has its complexity. The purpose of this exhibit is to return to the basics and provide an efficient and practical way to understand the physics of MR, as it relates to neuroradiology. By explaining through images rather than equations and pulse sequence diagrams, this exhibit will be a useful review for current radiologists and a great learning tool for current residents, especially those preparing for the new ABR boards.

Materials and Methods
1. Review concepts behind T1 and T2 contrast. 2. Review concepts behind fluid suppression. 3. Review differences behind gradient echo and spin echo imaging. 4. Review concepts behind diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC), and b-values.

Results
1. Use gray matter heterotopia to demonstrate differences in T1 and T2 relaxation. 2. Use multiple sclerosis to demonstrate the importance of fluid suppression sequences. 3. Use diffuse axonal injury as an example of how gradient echo imaging is useful. 4. Use images of stroke and lymphoma to demonstrate DWI and ADC values.

Conclusions
The physics of MR can be better understood by linking the basic principles of physics with the common pathologies neuroradiologists see on a daily basis. This exhibit aims to help radiology residents learn and practicing radiologists review the basic principles of MR physics related to neuroradiology.

KEYWORDS: Fluid-Attenuated Inversion Recovery, Gradient Recall Echo, MR Imaging/Diffusion

Carotid Artery dissection: how to study this condition using Computed Tomography

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Purpose
The identification of dissection of the carotid artery (DCA) can be complex. One of the most used imaging technique in the analysis of the carotid artery is the computed tomography (CT) and in this exhibit our purpose was to understand the physiopathology of the DCA, to review MDCT and to identify a flow chart that can help to recognize DCA by using MDCTA.
Materials and Methods
In our Institute about 500 CT exams for the study of carotid arteries are performed each year and about 25 cases of dissections of carotid artery are found. We present our experience in this field that is obtained using multiple CT scanners (16 - 40 - 64 slices and multi-energy). In most cases of dissection we will present MR imaging (MRI) and ultrasound correlation.

Results
The eposter will present the following sections: 1) Physiopathology of the DCA, 2) Histopathological classification of DCA, 3) Clinical presentation of DCA in typical and atypical condition, 4) CT imaging findings, 5) pathologic features (intimal tear, intramural hematoma, and dissecting aneurysm), 6) Limits and potentialities of MDCT in the detection of DCA, 7) MDCT-based diagnostic flow-chart for, 8) Causes of misinterpretation of DCA, 9) Comparison of MDCT with MR and US in the detection of DCA, 10) Analysis of advanced techniques like dual-energy and multispectral imaging.

Conclusions
Dissection of carotid artery is a potentially disabling yet probably under-recognized condition that often occurs in young adults and because of the great diversity in the clinical features of cranio-cervical artery dissection, imaging plays a primary role in its diagnosis. Currently, MDCT can identify and characterize DCA and in particular the use of dual-energy and multispectral CT imaging may help in detecting this dangerous condition.

KEYWORDS: Carotid Dissection
Carotid artery plaque: imaging of the remodelling

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Purpose
The concept of "plaque remodelling" indicates the morphological and ultrastructural variation of a plaque in the time. Several investigations have demonstrated that the carotid artery plaques change and it is possible that some determinants of instability are transitory. Moreover, some drugs (such as statins, apolipoprotein) change the composition of the plaque by increasing or reducing its volume. In this exhibit our purpose was to understand the physiopathology of plaque remodelling and to review CT, MR and US imaging findings of this phenomenon.
Materials and Methods
In this exhibit we will present the carotid artery plaque remodelling using our MR-CT-US database to show examples. Several histopathological correlations will be used.

Results
In the exhibit we will organize the work: 1) To review the concept of carotid artery plaque remodelling 2) histology of the plaque according to the AHA classification. 3) The biomechanical effect of plaque eccentricity. 4) MR, CT, and US imaging findings of carotid artery plaque follow up that demonstrate the plaque remodelling. 5) Limits and potentialities of MR, CT and US in the follow up of the carotid artery plaque. 6) The drug effect: how the therapies may change the plaque in terms of regression and progression. 7) presentation of relevant cases.

Conclusions
The unique geometrical configuration and flow properties of the carotid bifurcation contribute to the formation of atherosclerotic plaque that may markedly change over time. Currently, imaging techniques can identify and characterize the plaque remodelling and in particular the use of MR allows to precisely distinguish plaque components and characteristics and to identify the plaque's changes. In the last years it was demonstrated that some dedicated may trigger a regression and progression of the carotid artery plaque and imaging must recognize these changes.

KEYWORDS: Carotid Artery, Carotid Plaque
Carotid artery vulnerable plaque: Multi-modality imaging approach

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Purpose
A "vulnerable plaque" is considered an atherosclerotic plaque that contains a large necrotic lipid core covered by a thin or disrupted fibrous cap and it is characterized by a higher tendency to rupture, resulting in embolization or thrombosis. In this exhibit our purpose was to understand the physiopathology of vulnerable plaque and to review CT, MR, US and Nuclear Medicine (NM) imaging findings of carotid vulnerable plaque with histological correlation.

Materials and Methods
In this work a didactic approach will be used by explaining the vulnerable plaque from the histopathology to the advanced imaging. We will try to explain "what is" a vulnerable plaque and what the different imaging techniques can offer. We will present several diagrams, tables and figures by presenting numerous cases of correlation between histology and imaging findings.

Results
This work will be organized in the following sections: 1) To review the concept of carotid "vulnerable" plaque, 2) Classification of plaque type, 3) Elements associated to the plaque instability: type of plaque, thrombus, intraplaque hemorrhages, ulcerations, fissured fibrous caps. 4) MR, CT, US and NM imaging findings with histological comparison of carotid vulnerable plaque. 5) Limits and potentialities of MR, CT, US and NM. 6) Algorithm for the automated plaque analysis. 7) Presentation of advanced techniques like molecular imaging and multispectral CT imaging.

Conclusions
Carotid plaque morphology and composition play an important role in the embolic risk and should be considered as key parameters for the choice of the therapeutical approach. Nowadays, imaging techniques can identify and characterize a carotid vulnerable plaque and in particular the use molecular imaging and multispectral CT imaging allows to precisely distinguish plaque components and characteristics.

KEYWORDS: Carotid Plaque
Carotid Cavernous Fistula: An interactive module on the diagnosis and treatment of a rare vascular abnormality

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Purpose
Carotid cavernous fistula (CCF) is a rare type of vascular abnormality that can be difficult to diagnose. We aim to use an interactive teaching module to illustrate the anatomy, pathophysiology, epidemiology, clinical presentation, imaging findings, complications, and treatment options of CCF.

Materials and Methods
We will begin with an overview of the anatomy of the cavernous sinus, with attention to the various segments of the cavernous carotid artery utilizing multiple accepted classification systems. An interactive quiz will help strengthen the viewer's anatomical knowledge. We then will differentiate between direct and indirect CCF, with an outline of the pathophysiology, epidemiology, typical clinical presentation, preferred imaging modalities, imaging findings, and treatment options for each one. Finally, we will use an interactive module to demonstrate salient
teaching points with illustrative cases, allowing viewers to employ their clinical and radiological skills to properly diagnose and choose treatment for each patient.

Results
The cavernous sinus is a trabeculated venous cavity located just lateral to the sella turcica. The sinus includes the internal carotid artery (ICA) and cranial nerves III, IV, V1, V2, and VI. Carotid cavernous fistulae are abnormal shunts which allow blood to flow from the carotid artery into the cavernous sinus. Direct CCF is caused by traumatic or aneurysmal rupture of the cavernous ICA, creating a direct high flow connection with the cavernous sinus. Indirect CCF is a low flow vascular malformation, where branches arising from the internal and external carotid arteries connect with the cavernous sinus. While indirect CCF are insidious and nonspecific in clinical presentation, patients with direct CCF often present with specific characteristic signs and symptoms which include proptosis, chemosis, orbital bruits, ophthalmoplegia, and headache.

Although angiography sets the gold standard for diagnosis, CT, CTA, MRI and MRA are usually the primary imaging modalities, providing very high levels of sensitivity and specificity. Imaging can show dilation of the superior ophthalmic vein, proptosis, enlargement of extraocular muscles, and premature contrast filling of the cavernous sinus during the arterial phase of enhancement. Treatment options include conservative management, coil embolization, open surgical intervention, radiosurgery, or more recently, endovascular flow diverting stent placement. Specific clinical and imaging criteria are used to determine the optimal treatment for each patient.

Conclusions
Carotid cavernous fistula is a diagnostically challenging vascular malformation with significant potential for associated morbidity and mortality. Our educational exhibit, with its interactive case-based assessment modules, will help radiologists serve their patients more effectively by becoming more confident in the diagnosis and management of this disease.

KEYWORDS: Carotid Cavernous Fistula, Cavernous Carotid Artery, Cavernous Carotid Fistula
Purpose
To introduce a novel new imaging phantom and review the physics of dual energy CT scanning and cerebral blood flow (i.e., Poiseuille's law).

Materials and Methods
Our carotid CT acquisition (CTA) phantom is an anatomical and physiologic model. U.S. Provisional Patent Serial No. 61/695, 859. It uses the following items: – PVC tubing to mimic the carotid arteries, jugular veins, Circle of Willis and dural sinuses. – Tums® tablets to mimic calcified atherosclerotic carotid plaques. – Helmet to mimic normal head size. – Mandible from a skull. – 5L flow reservoir with flow meter for accurate basal cerebral blood flow. We followed several patients before and after introduction of our scanning and recorded the total scanning and postprocessing time following dual energy CT acquisition. Data then were collected and analyzed to demonstrate the efficacy of our phantom.
Results
• There was 50% reduction in total scanning time after our CTA phantom was introduced to the technologists. • One technologist was quoted saying "All that is required is about 10-20 minutes of downtime a few times per week in between cases in order to gain the comfort level needed for this particular imaging sequence". • Some criticism included incorporating more bone in our phantom and our small study sample size. • With the advent of new imaging modalities and protocols, technologists need to maintain knowledge in proper scanning techniques.

Conclusions
• A significant obstacle in familiarizing technologists with a new imaging modality or technique often is lack of experience. The time to learn is not when a patient is on the table awaiting evaluation. • Our dynamic carotid CTA phantom provides a highly effective way for technologists to practice (in our case dual energy CT), and significantly reduce the total scanning and post-processing time. • Although our sample size is small, we are confident that the phantom is useful. • Our CTA phantom allowed our technologists to master dual energy CT without exposing patients to unnecessary radiation.

KEYWORDS: Carotid Plaque, CT Angiogram, Dual-Energy CT
Image of phantom. Helmet and maxillofacial bones mimicking patient head. Cardboard providing platform for tubing. Tubing mimicking circle of Willis. Calcium tablets attached to tubing to mimic atherosclerotic plaques. *Not shown is fluid reservoir and power injector, which allows for injection of contrast at 1L/min to mimic basal cerebral blood flow.

Pre-processing MIP images of phantom with calcium tablets. Post-processing images available, demonstrating successful "plaque removal" by DSCT.
Cerebral microbleeds: causes, clinical relevance and imaging approach.

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Purpose
1. To discuss in brief physics of susceptibility-weighted imaging (SWI). 2. To discuss the various causes of cerebral microbleeds (CMBs) and discuss their clinical significance.

Materials and Methods
With the development of MR imaging (MRI) techniques (gradient-recalled echo and susceptibility-weighted sequences) exquisitely sensitive to paramagnetic blood products, microbleeds are commonly encountered on routine brain MRI. The clinical significance remains elusive. We retrospectively studied MRI brain of 1200 patients from PACS system. Axial T2, T1 and SWI images were compared and then were correlated with the clinical findings and final diagnosis of the patient.

Results
The incidence of CMBs was highest with prior history of trauma, and intracerebral hemorrhage. Second and third most common causes were in patient with prior history of stroke/hypertensive encephalopathy, and; neurodegenerative diseases such as amyloid angiopathy, and Alzheimer disease, respectively. Various other causes found on our study include CADASIL, CARASIL, CMBs due to cardiac (endocarditis, myxoma and cardiac valve), Fabry's, vasculitis, post RT, moyamoya, PRES, and various blood disorders.

Conclusions
We discuss in brief the physics of SWI sequence and its role in detection of cerebral microbleeds. We give an algorithmic approach in evaluation and mapping of CMBs with respect to their clinical significance.

KEYWORDS: Microbleeds, Susceptibility-Weighted Imaging

Characterization of Intima Media Thickness Variability (IMTV)

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Purpose
Recently a new parameter based on the intima-media-thickness (IMT) was introduced: the so-called Intima-Media-Thickness Variability (IMTV). The purpose of this exhibit is to present the mathematical concept of the IMTV and its potential value and application.
Materials and Methods
Our group developed the concept of the intima media thickness variability that represents the standard deviation of the IMT in the length of the carotid artery. We will explain the mathematical basis as well as the algorithm that allows the analysis of the IMT. Our database is more than 2000 ultrasound patients of the carotid arteries and we will present the different classification of the IMTV.

Results
This electronic poster will cover the following points: 1) histology of the carotid artery wall, 2) algorithm of the IMTV and mathematical basis, 3) difference between IMT and IMTV, 4) Limits and pitfalls of the different imaging modalities (US, CT, MR) in the IMTV analysis. 5) Presentation of cases.

Conclusions
It is well demonstrated that the IMT quantification may play an important role, because the increase in IMT is correlated with coronary and cerebrovascular complications. Some preliminary studies showed that IMTV seems to be a better parameter of IMT in some conditions such as the cerebrovascular events. In this exhibit the IMTV concept will be presented.

KEYWORDS: Carotid Artery

eEdE-52

Clinical Application of PET-MRI in Neuroradiology

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Purpose
The aim of this exhibit will be to provide a comprehensive overview of the physical principles, techniques and clinical applications of the emerging hybrid modality: PET-MRI (positron emission tomography-magnetic resonance imaging). This hybrid modality attempts to provide the functional imaging obtained from a PET study and detailed structural information obtained from an MRI study.

Materials and Methods

Results
1. Physical principles and techniques of PET-MRI: Relevant concepts involving image acquisition, postprocessing and interpretation will be provided. 2. Overview of clinical applications of PET-MRI in neuro-oncology patients: An overview of initial tumor diagnosis, discussion of tumor biology and its effect on tumor imaging (e.g., tumor metabolism, angiogenesis, cellularity, etc.), post-treatment follow-up imaging evaluation and its role in therapy selection will be provided. 3. Role of PET-MRI in evaluation of neurodegenerative and inflammatory conditions (including MS). 4. Pearls and Pitfalls: Common pitfalls and controversies regarding PET-MRI in neuroradiology will be discussed. 5. Future of PET-MRI: A discussion of future applications and challenges facing PET-MRI in neuroradiology, specifically neuro-oncology and neurodegenerative disorders will be provided.

Conclusions
PET-MRI is an emerging hybrid imaging modality offering detailed functional and structural imaging with promising clinical applications especially in the field of neuro-oncology, neurodegenerative and inflammatory CNS conditions. This case-based exhibit provides the viewer an in-depth review of the relevant concepts underlying the technical and clinical aspects along with common pearls and pitfalls of PET-MRI allowing for better integration and relevant usage of this modality in clinical practice.

KEYWORDS: MR Imaging/PET
Clinical utility of “Incomplete-Rim” sign and Uhthoff's phenomenon

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Purpose
The "Incomplete ring sign" aka "open-ring" sign is a fairly specific sign for demyelination and narrows the differential diagnosis in patients with ring-enhancing lesions in the brain. The enhancing component of the lesion represents the most active area of active demyelination within the CNS white matter, whereas the nonenhancing segment represents gray matter. Given the high specificity of this sign, it can be used reliably to forgo brain biopsy and begin empiric therapy with steroids. Another benefit of foregoing brain biopsy is that the histologic findings in active demyelination can mimic neoplastic process such as glioblastoma multiforme and infectious processes such as toxoplasmosis. Therefore, avoiding biopsy not only avoids the obvious risks associated with an invasive procedure, but it also saves clinicians from further clouding the case with perplexing biopsy results. Uhthoff's phenomenon is known to occur in a significant number of patients with multiple sclerosis. It refers to worsening of symptoms (including pain, fatigue, weakness, etc.) when patient's body temperature increases (e.g., from weather, exercise, hot showers, etc.). It is theorized to result from alteration in nerve conduction from temperature changes. The presence of "incomplete rim" sign on imaging along with presence of Uhthoff's phenomenon are two fairly sensitive and specific findings that can essentially confirm diagnosis of a demyelinating process and help forgo biopsy.

Materials and Methods
We present a case-based review of the clinical features, imaging, pathophysiology, histologic features, treatments and prognosis of various demyelinating diseases including multiple sclerosis, neurobehcets, neuromyelitis optica, ADEM, etc. We will describe the characteristic imaging MRI features of these entities. In addition, we will highlight the presence of "open-rim" sign in these entities, which is an extremely helpful sign in distinguishing these mass-like lesions from other tumor-like mimics (glioblastoma multiforme, abscess, lymphoma, toxoplasmosis, tuberculoma, etc.). Clinical presentation, imaging features and histopathologic findings of each of the mimics will be discussed briefly as well.

Results
Multiple different presentations of tumefactive demyelinating entities will be shown, each exhibiting presence of an incomplete-rim sign within the brain and spinal cord. We also will show cases of similar appearing entities on MR imaging (MRI) such as lymphoma, metastases, nocardiosis, tuberculosis, astrocytoma, sarcoma, sarcoidosis, hemangiopericytoma and malignant fibrous histiocytoma, with an emphasis on differentiating these from a demyelinating lesion. Brief discussion of MRI findings (including various other sequences: diffusion-weighted imaging, diffusion tensor imaging, susceptibility-weighted imaging, etc.) of the aforementioned entities highlighting key features will be presented. We also will discuss the presence, utility and/or absence of Uhthoff's phenomenon in each of the aforementioned cases.

Conclusions
The differential diagnosis for ring-enhancing lesions in the central nervous system is broad and includes entities such as abscess, metastasis, glioblastoma multiforme, inflammatory demyelination, and lymphoma. "Incomplete-Rim" sign also referred to as "open-ring" sign is a fairly specific imaging finding for a demyelinating process including Tumefact Multiple Sclerosis and essentially excludes the remainder of the differential. Uhthoff's phenomenon is known to occur in a significant number of patients with multiple sclerosis. It refers to worsening of symptoms (including pain, fatigue, weakness, etc.) when patient's body temperature increases (e.g., from weather, exercise, hot showers, etc.). It is theorized to result from alteration in nerve
conduction from temperature changes. The presence of "incomplete rim" sign on imaging along with presence of clinical Uhthoff's phenomenon are two fairly sensitive and specific findings that essentially can confirm diagnosis of a demyelinating process and help forgo biopsy.

KEYWORDS: Demyelination, Diagnostic Accuracy, Diffusion-Weighted Imaging

eEdE-05

CNS Angiitis: A Brain Tumor Mimic with a Characteristic Branching Vascular Abnormality on Susceptibility Imaging

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Purpose
Central nervous system (CNS) angiitis may present as a large brain mass lesion that is indistinguishable from a malignant brain tumor on imaging, a presentation that can lead to unnecessary and aggressive surgical resection. The purpose of our exhibit is to present several examples of CNS angiitis that mimic brain tumors on MR imaging with emphasis on the key imaging features on susceptibility imaging which can help differentiate these lesions from malignant brain tumors.

Materials and Methods
MR imaging features of primary CNS angiitis mimicking a large aggressive brain tumor will be reviewed with discussion of the clinical presentation, imaging course, treatment, pathology, and clinical follow up. Special emphasis will be made on characteristic vascular features on susceptibility imaging of CNS angiitis that help to differentiate from brain tumors, hence avoiding misinterpretation and unnecessary surgical resection.

Results
Central nervous system angiitis is a vascular inflammatory disease of the brain involving small arteries and veins of various sizes. Due to exuberant inflammatory changes within the brain, CNS angiitis can present as a large mass lesion with surrounding edema and mass effect indistinguishable from a malignant brain tumor. Differentiation between CNS angiitis and brain tumor is essential for proper medical management and, more importantly, avoidance of unnecessary and potentially harmful surgical resection. On MR imaging, CNS angiitis may demonstrate a characteristic branching pattern of magnetic susceptibility outlining the florid inflammatory process involving the vasculature that can serve as an important diagnostic clue to its non-neoplastic nature.

Conclusions
Central nervous system angiitis may present as a mass lesion with an MR imaging appearance indistinguishable from a malignant brain tumor. A characteristic branching pattern of a vascular abnormality on susceptibility imaging can aid in the accurate diagnosis of CNS angiitis and in avoiding unnecessary and potentially harmful surgical intervention. After reviewing this exhibit attendees will be familiar with this entity and what features help distinguish it from a brain tumor.

KEYWORDS: Tumor-Like Conditions
Crime Scene Investigation, Neuroradiology Unit: Can you solve the case?

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Purpose
Crime Scene Investigation (CSI) is a crucial discipline in law enforcement which has captured the public imagination, with a multitude of legal and criminal dramas in the media and popular culture. The viewer of this exhibit, as an integral member of the investigative team, will solve a series of fictitious scenarios inspired by actual cases, both common and unusual. He or she must sift through a vast amount of detailed information, replete with potential detractors. We present complex story lines, and through active participation, the neuroradiologist will learn to optimize a search pattern and consider the mechanism of injury.

Materials and Methods
We retrospectively reviewed the interesting case logs at our level 1 trauma center, choosing studies (CT/CTA, MR/MRA) which illustrate the spectrum of traumatic brain injury (TBI). Maxillofacial and spine imaging, 2-D reformatted images and 3-D reconstructions may be provided. Each CSI episode is founded on an actual clinical history, for which we further envision a plausible narrative. Imaging studies will be combined with corroborative evidence, including police and witness testimonials, and photographic documentation. We challenge the viewer to determine if the injury was accidental or intentional, to establish the credibility of eyewitness accounts, and to deduce the sequence of events. As the case unfolds a vivid reconstruction will emerge.

Results
Cases are organized by mode of injury. Penetrating injuries include gunshot and knife wounds. Considerations for firearms include trajectory and missile migration, fragmentation and deformation, entrance and exit wounds, and position of the victim or shooter. Secondary fractures result from an explosive increase in intracranial pressure. Placement of skull fragments can demonstrate the temporal sequence of events. Stabbing can produce vascular compromise such as pseudoaneurysms, A-V fistulas, and carotid occlusions/transections. Domestic violence includes child and elder abuse. Pediatric intracranial hemorrhages and complex skull fractures from "short falls" and "accidental" facial bone fractures without associated massive trauma are suspicious. Shaking injuries are due to rotational and acceleration forces. Regarding the fragile elderly, it can be difficult to demonstrate abuse with multiple comorbidities and osteoporosis. Maxillofacial fractures and defensive injuries are common. Falls are the most common cause of TBI overall and display characteristic patterns. They may be intentional or accidental, low or high, intrinsic (postural control) or extrinsic (environmental). Injuries to the head and cervical spine are more common in falls up to 20 feet, while body trauma tends to occur above that. Our series of blunt object assaults examines associations of maxillofacial fractures and intracranial hemorrhages. Uncomplicated facial fractures herald more ominous injury. Motor vehicle accidents are the second most common cause of TBIs and occur from deceleration/acceleration or direct impact. In diffuse axonal injury the severity correlates with the velocity of the accident. Contusions, cerebral edema, and extra-axial hematomas, may occur with musculoskeletal and blunt cervical vascular injuries. Anoxic injuries include hanging, drowning, strangulation, and poisoning by carbon monoxide or drug overdose. MR imaging can demonstrate toxic damage and acute encephalopathy.

Conclusions
The radiologist is by nature a detective - an investigator with a penchant to unravel the mystery of an unknown case. The simulations we provide are intended to help the viewer filter out the misleading evidence from the many pertinent clinical and radiological clues. Awareness of injury
mechanisms and appropriate study utilization is essential for optimal triage and management of trauma patients.

KEYWORDS: Abusive Head Trauma, Hemorrhage, Hypoxia

eEdE-22

Cruetzfeldt Jakob Disease: Etiopathology, Genetics And Imaging

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Purpose
This educational exhibit aims to: 1. Discuss the etiopathogenesis of Creutzfeldt-Jakob disease (CJD) with enumeration of diagnostic clinical criteria. 2. Describe pertinent findings on MR imaging (MRI) with analysis of different MR sequences. 3. Illustrate evolution of radiological findings on follow-up imaging. 4. Identify common imaging differentials to be considered and pitfalls to be avoided. 5. Briefly discuss genetics and genetic susceptibility in Creutzfeldt Jakob disease.

Materials and Methods
We retrospectively evaluated MR imaging findings in more than 30 patients with diagnosis of CJD confirmed on biopsy and/or positive CSF prion protein 14-3-3 present to radiology departments of authors/co-authors over a period of 10 years. A thorough correlation with clinical profile and other investigations also was performed. We present the important imaging findings in the form of an educational exhibit describing • Etiopathogenesis of CJD: Sporadic, New Variant, Iatrogenic, Genetic. • Diagnostic Criteria: WHO(1998), MRI-CJD Consortium criteria(2009). • Imaging findings: Role of different imaging sequences, sequential imaging for follow up to observe evolution of findings. • Pattern of involvement on MRI: Basal Ganglia, Cortex, Thalami. • Pathological correlation where possible. • Common imaging differentials: Postictal changes, toxic/metabolic encephalopathy, autoimmune /infectious encephalitis. •Genetic aspects of CJD in brief.

Results
Creutzfeldt-Jakob disease is a fatal infectious disease characterized by rapidly progressive neurodegeneration. Definitive diagnosis can be made only on brain biopsy or autopsy. MR imaging findings are typical and can settle diagnosis in a suggestive clinical scenario. Diffusion-weighted imaging (DWI) is most sensitive in picking up signal changes in cortex as well as basal ganglia. False negative cases can show positive findings on follow up. Pattern of involvement of brain structures can point to diagnosis as sporadic versus new variant CJD. Isolated bilateral thalamic involvement points to new variant CJD. Distribution of abnormal signal intensity areas may differ in different genetic types of sporadic CJD as well. A knowledge of common imaging differentials can help prevent overdiagnosis and alter management as many such diseases are treatable.

Conclusions
MR imaging may play an important role in guiding diagnosis of CJD if radiologist is aware of
common imaging findings, imaging differentials and pitfalls. A knowledge of underlying etiopathology and genetic aspects will ensure better understanding of the disease process.

KEYWORDS: Creutzfeldt-Jakob Disease, Genetics, MR Imaging

eEdE-10

Demonstration of cerebral venous collaterals by using susceptibility weighted images

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Purpose
Susceptibility-weighted imaging (SWI) depicts veins due to susceptibility effects of relatively deoxygenated blood and thus can be used to identify normal and abnormal blood vessels. Our purpose is to demonstrate the utility of SWI in the detection of cerebral venous collaterals in various disorders.

Materials and Methods
We searched our SWI database for the terms: collateral circulation, abnormal veins, venous thrombosis, developmental venous anomalies, and vascular malformations. We then classified our results as showing either decreased or increased veins, segmental or general, cortical or deep, or generalized. We also correlated the SWI findings with those of other sequences especially the postgadolinium T1 images and time of flight MR venograms.

Results
Susceptibility-weighted images better demonstrate venous collaterals of the brain, which appear diffusely throughout the brain or focally in some area. Increased venous collateral of the brain is caused mostly by venous obstruction, especially in dural venous sinus thrombosis with cerebral venous congestion or dural AV fistula with retrograde flow through venous collaterals. In our cases, there are prominent and dilated cortical veins on SWI accompanying with evidence of venous congestion in cases of superior sagittal sinus thrombosis and diffusely dilated venous collaterals in cases of dural AV fistula. Focal venous collateral is seen in case of cortical vein thrombosis as well as focal dilated deep medullary veins in case of Sturge Weber syndrome. The degree of prominence and dilatation of cortical veins is better demonstrated on SWI compared with other conventional MRI sequences such as T2-weighted or postcontrast images.

Conclusions
Susceptibility-weighted imaging is the excellent MRI technique to early depict and better demonstrate cerebral venous collaterals due to magnetic susceptibility effects of intravascular deoxyhemoglobin in cerebral veins. The degree of prominent and dilated cerebral veins is better visualized on SWI. Therefore, SWI is useful in detection of venous collaterals in setting of cerebral venous obstruction, AV shunting and/or venous congestion.

KEYWORDS: MR Imaging, Susceptibility-Weighted Imaging, Venous Obstruction
Diffusion Imaging of the Brain– Is Kurtosis the Next Frontier?

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Purpose
The purpose of this electronic educational exhibit is to review the principles and applications of diffusion imaging in the brain, as well as introduce diffusion kurtosis imaging (DKI). While the basic premise of diffusion imaging is easily grasped, the technical considerations are commonly misunderstood. This presentation will include a basic primer on diffusion weighted imaging (DWI) and diffusion tensor imaging (DTI) as well as review the basis, technical requirements, and potential applications for an emerging diffusion technique, DKI.

Materials and Methods
Through a variety of illustrations and animations the basic components of diffusion imaging are reviewed. A number of real-life cases will be presented to reinforce important concepts and emphasize the clinical utility of these techniques.

Results
Measuring the free movement of water molecules is the basis for all diffusion imaging. In its simplest form, DWI, strong motion sensitizing gradients are used measure this motion, which is recorded in a scalar form known as the 'apparent diffusion coefficient'. Although there are numerous clinical applications, it is most classically used in the diagnosis of acute infarction. Diffusion tensor imaging applies a directional component, where diffusion measurements are made in at least 6 non-collinear directions. The resultant information can be displayed as a three-dimensional ellipsoid known as the 'diffusion tensor.' When diffusion is equal in all directions, or isotropic, this is reflected as a sphere. When diffusion is heavily skewed in a particular direction, or anisotropic, the resultant tensor becomes elongated and exhibits a specific orientation. Fractional anisotropy is a scalar measurement of how skewed in a given direction the diffusion for a given voxel is. The clinical applications for DTI are varied and far-reaching throughout.
neuroradiology. One of the most visually appealing applications is tractography, which allows
the ability to model major white matter tracts within the brain. DWI and DTI calculations assume
the Gaussian diffusion of water molecules, which is not typical in biological systems. Kurtosis is
a mathematical term used to describe non-Gaussian behavior, or variation from a normative
distribution. DKI attempts to provide a more accurate model of diffusion while determining the
extent of variation from a Gaussian distribution (mean kurtosis). The clinical significance of
these measurements is yet to be determined. However, this information seems to offer insight
into the microstructural environment and cellular heterogeneity of tissue beyond that of
traditional imaging techniques.
Conclusions
Diffusion imaging has become a mainstay in neuroradiology with numerous applications from
the rapid evaluation of stroke to assessment of traumatic brain injury to the pre-operative
mapping of white matter tracts in neurosurgical patients. DKI is a recent expansion of this
technique focused on the non-Gaussian diffusion properties of tissue, which appears to offer
distinct and complimentary information to traditional methods. This exhibit should reacquaint
the user with many familiar terms as well as explore potential future applications of this exciting
MR technique.

KEYWORDS: Diffusion Kurtosis Imaging, Diffusion MR Imaging, Diffusional Kurtosis
Imaging,
information in addition to that obtained with static contrast-enhanced MRA images. Cases include arteriovenous malformation, dural arteriovenous fistula, subclavian steal, pseudoaneurysm, luxury perfusion, arterial and venous stenoses and occlusions.

Conclusions
After reviewing this exhibit, radiologists will: 1. Understand the basic principles of time-resolved MRA (TWIST). 2. Recognize the clinical utility of this technique through multiple representative cases and know how to integrate this technique into neuroradiology practice.

KEYWORDS: Dynamic Imaging, MR Angiography, Parallel Imaging

eEdE-47

Dual Energy CT And Intra arterial Stroke Therapy

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Purpose
To demonstrate the usefulness of dual energy computed tomography (DECT) in patients who have undergone intra-arterial stroke therapy in allowing reliable detection of hemorrhagic transformation a known complication of reperfusion therapy.

Materials and Methods
A dual-energy CT scanner was used for imaging at 80 and 140 kV, and a three-material decomposition algorithm was used to obtain virtual unenhanced images and iodine overlay images. Follow-up single energy CT images were reviewed and correlation performed.

Results
There was 100% agreement in detection of intracranial bleeding on virtual and conventional unenhanced images.

Conclusions
Dual-energy CT is highly accurate in distinguishing intracranial hemorrhage from iodinated contrast staining and has many advantages over MR imaging (MRI) including time and cost benefits patients who have contraindications to MRI. It can play a major role in management of acute stroke management and in guiding future antithrombotic therapy.

KEYWORDS: Acute Ischemic Stroke, Acute Stroke, Dual-Energy CT

eEdE-72

Dural-based Tumors and Mass-like Lesions: Five Imaging Clues to Diagnose Meningioma Mimics

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Purpose
The purpose of this education exhibit is to present various dural-based brain lesions that can
mimic meningioma on imaging and to illustrate key imaging features that can help to
differentiate these potential mimics from meningiomas.

Materials and Methods
This exhibit will provide a brief overview of several dural-based intracranial lesions and their
imaging features. Pathologies including hemangiopericytoma, solitary fibrous tumor,
plasmacytoma, lymphoma, chloroma, chondrosarcoma, schwannoma, astroblastoma, and
epidural empyema will be presented in a case-based format along with relevant clinical
information. Characteristic imaging features that help distinguish these potential mimics from
meningioma will be emphasized along with important teaching points.

Results
A wide spectrum of dural-based masses can mimic meningioma on both clinical presentation and
imaging appearance thus a high index of suspicion should be maintained when evaluating extra-
axial masses. Distinguishing these mimics from meningioma has great clinical and prognostic
implications but at times can be extremely challenging for radiologists since the vast majority of
dural-based masses are meningiomas. Based on our review, the following five key differential
imaging clues on both computed tomography (CT) and MR imaging (MRI) can be extremely
helpful in differentiating other dural-based masses from meningiomas: 1) lack of dural tail, 2)
osseous destruction. 3) very dark T2 signal, 4) high T2 signal, 5) leptomeningeal extension

Conclusions
Meningioma accounts for up to 20% of all intracranial tumors and is the most common type of
brain tumor. There are, however, a wide variety of intracranial mass lesions, both benign and
malignant, that can closely mimic meningioma on imaging. It is essential to maintain a high
index of suspicion and evaluate for key imaging features to differentiate meningioma and its
mimics for proper surgical and medical management of patients. This educational exhibit
demonstrates several pathologic entities that can mimic meningioma and provide key imaging
features to facilitate differentiation.

KEYWORDS: Brain Neoplasms, Extra-Axial, Meningioma

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eEdE-14

Early white matter tract involvement in global hypoxic injury following cardiac arrest
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Purpose
Global brain ischemia during cardiac arrest results in heterogeneous injury to the brain. Large projection neurons of the cerebral cortex, cerebellar Purkinje cells, and the CA-1 area of the hippocampus are the most vulnerable areas. Basal ganglia may be involved but areas such as the brainstem and thalamus are more resistant to injury. White matter involvement is documented less well. We describe a case series of patients with out-of-hospital cardiac arrest who demonstrate early involvement of the white matter tract.

Materials and Methods
A retrospective case series study was performed on four patients with postcardiac arrest hypoxic brain injury who underwent MR imaging (MRI) with additional diffusion-weighted imaging (DWI) between day 4 to 10 after initial insult. The imaging findings were reviewed with specific attentions to the cortex, deep gray matter and white matter.

Results
Case 1 shows high T2 signal within the cortical ribbon of the posterior frontal, parietal and occipital lobes bilaterally. On DWI, whilst, the cortex does not appear particularly restricted in diffusion, there is restricted diffusion within the deep white matter of the centrum semiovale, closely related to the anatomical distribution of the cortical high signal. Case 2 shows abnormal signal over most cortical areas and both hippocampi. There is ground glass appearance to the deep white matter. Diffusion-weighted imaging demonstrates restricted diffusion within the deep white matter particularly in the posterior frontal-parietal lobes, extending into the splenium of the corpus callosum. Case 3 shows high T2 signal within the cortical ribbon of both parietal and occipital lobes bilaterally. There is slightly reduced apparent diffusion coefficient (ADC) within the immediately subadjacent white matter. Case 4 shows extensive high signal within the cortex of both hemispheres and the basal ganglia bilaterally. There is subtle increased signal within the subcortical white matter. On DWI, there is restricted diffusion within the hemispheric white matter and the splenium of the corpus callosum. Follow-up MRI at 26 months following initial insult shows gross cerebral and cerebellar atrophy.

Conclusions
In this case series, DWI obtained during subacute phase show diffuse hyperintensity with decreased ADC (restricted diffusion) in the white matter, although the changes are not as obvious on the conventional MR images. The white matter changes are either localized to the subcortical region immediately adjacent to cortical lesion, along the deep white matter or to the entire white matter. The exact mechanism for white matter changes is unclear. Energy failure is thought to be the initial insult during global hypoxia. This can cause excitotoxic brain injury; secondary degeneration such as Wallerian degeneration may occur as a result of excitotoxic mechanisms propagating through axons or synapses. As such, the white matter change seen may represent the early phase of Wallerian degeneration where restricted diffusion demonstrated on DWI represents axonal intramyelinic swelling. This case series demonstrates that early cortical involvement with subsequent subcortical or deep white matter change may be the typical pattern of progression of global hypoxic injury following cardiac arrest before the surviving patients go on to develop diffuse atrophy.
Evaluation and comparison of open-source DTI processing software

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Purpose
Diffusion tensor imaging is an important clinical and research tool, providing insight into the white matter structure and integrity. Processing diffusion tensor imaging (DTI) data to obtain parameters such as axial diffusivity, radial diffusivity, fractional anisotropy, and tractography information is not available in all DTI software packages. Several open-source DTI software packages exist; however, each has different features, may or may not have been validated, and may be limited to specific computing platforms. We performed a review of existing open source DTI processing packages to compare the functionality and feature set to allow researchers to quickly find the package that best serves their needs.

Materials and Methods
Twenty separate freely available DTI software packages were evaluated. We evaluated the software platforms and hardware requirements for each. The ability to calculate axial diffusivity, radial diffusivity, mean diffusivity, fractional anisotropy, directionally-encoded fractional anisotropy maps was evaluated. The ability to perform fiber tracking by both deterministic and probabilistic methods was evaluated, as well as coregistration with structural images. The ability to perform histogram analysis, data resampling, as well as diffusion kurtosis processing is evaluated. The usability of software, including ease of installation, ability to uninstall, and availability of online documentation was assessed.

Results
Information regarding the features and differences between different software packages will be presented.
Conclusions
Multiple freely available software packages for DTI processing exist; however, each has
different strengths and limitations, and different packages may be more appropriate for certain
research projects. We feel that this comparison will allow researchers to more rapidly identify
the appropriate software package for their needs, allowing research time to be spent on research
and not software evaluation.

KEYWORDS: Diffusion Tensor Image, Postprocessing

eEdE-26
6:30AM - 9:00PM

Everything you want to know about frontotemporal dementia

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Purpose
The purpose of this exhibit is: 1) To familiarize the recent classification of frontotemporal
dementia (FTD), 2) To review the imaging characteristics of FTD, and 3) To demonstrate the
functional assessment of FTD by using the novel techniques such as diffusion tensor imaging
and resting-state functional magnetic resonance imaging (MRI).

Materials and Methods
We demonstrate classification of FTD highlighting recent progress in genetic and pathologic
prospects. 1) Review of the clinical, genetic, and pathological classifications of FTD; Clinical
syndrome (e.g., behavioral variant FTD, semantic dementia, and progressive nonfluent aphasia),
genetic mutations (e.g., MAPT, GRN, and C9ORF72), and pathology (e.g., tau, TDP-43, and
FUS). 2) Neuroimaging gallery of FTD with anatomopathological correlation. 3) The structural
connectivity map of FTD using the diffusion tensor imaging and functional connectivity map
using resting-state functional MRI.

Results
Frontotemporal dementia is a clinically and pathologically heterogeneous spectrum of non-
Alzheimer dementias. Because FTD classification is complicated and evolved, many
neuroradiologists may not be familiar with how to approach this disease. The knowledge of the
classification and characteristic imaging findings with pathological correlation will be helpful for
the better understanding of FTD to allow the appropriate patient management.

Conclusions
This exhibit will be a practical tool and resource not only for radiology residents and
neuroradiology fellows but broader neuropsychiatric professionals and neuroscience researchers
to better understand the basic concept and current status regarding FTD.

KEYWORDS: Cognitive Deficit, Diffusion Tensor Image, Resting-State FMRI

eEdE-48
6:30AM - 9:00PM

Functional Motor Neuroanatomy - What Every Neuroradiologist Needs to Know.
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Purpose
The purpose of this interactive electronic educational exhibit is to review the anatomy of motor function from the primary motor cortex through the spinal cord. In addition to anatomical landmarks used on conventional imaging, the exhibit will include a basic primer on blood-oxygen-level dependent functional magnetic resonance imaging (BOLD fMRI) and diffusion tensor imaging (DTI) with a discussion on the increasing role of these advanced imaging techniques.

Materials and Methods
Utilizing a case-based approach, the exhibit will review relevant anatomy with an emphasis on the somatotopic organization of the primary motor cortex. Discussion of advanced MR techniques including BOLD fMRI and DTI will be geared towards the general radiologist. The exhibit will utilize numerous pathologic processes including stroke, tumor, trauma and neurodegenerative disorders to exemplify and reinforce these important concepts.

Results
Relying on the intrinsic discrepant magnetic properties of oxyhemoglobin and deoxyhemoglobin, blood-oxygen-level dependent contrast (BOLD) imaging is used to indirectly measure neuronal activity by observing regional changes in cerebral blood flow. This technique has allowed researchers and clinicians to localize neural tissue involved in a variety of different functions. Mapping of the brain with BOLD fMRI has confirmed the somatotopic organization of the motor homunculus in the precentral gyrus and activation of the supplementary motor area in the planning phases of complex movements. While fMRI has changed functional neuroimaging of gray matter, diffusion tensor imaging has revolutionized the visualization of white matter tracts. Diffusion tensor imaging utilizes the same principles of DWI, but incorporates a directional component. Predicated on the idea that water diffuses most easily parallel to white matter tracts, the process of tractography is used to connect diffusion tensors, thus serving as a surrogate for white matter tracts in the brain. These techniques have not only improved our understanding of the complex inner workings of the brain, they now are being employed commonly clinically as part of the pre-operative assessment for patients with a variety of neurosurgical diseases.

Conclusions
Although functional neuroimaging is still in its infancy when one considers their potential applications, it is already being used to guide therapy and provide a reliable method of assessing motor function in the diseased brain. While the technology will inevitably evolve, the anatomy will not. A firm grasp of the functional motor neuroanatomy should aid the radiologist over the entire course of his/her career.

KEYWORDS: Functional Brain Mapping, Functional Diffusion Maps, Motor Mapping

eEdE-67

Carotid ultrasound is a frequently used tool to screen and stratify patients at risk for thromboembolic complications related to atherosclerotic disease primarily at the carotid bulb. This exhibit aims at reviewing important technical concepts and common pitfalls of vascular ultrasound examinations of the neck. Correlation to CTA/MRA studies will be provided to emphasize the advantages and limitations of sonographic examinations.

Materials and Methods
A series of cases will be selected from institutional teaching files and will be presented in a quiz format to highlight important concepts and pitfalls of cervical vascular ultrasound studies. Diagrams and cross-sectional imaging correlations will be added to emphasize advantages and limitations of the sonographic examinations.

Results
Selected cervical vascular ultrasound cases will illustrate the typical appearance of atherosclerotic disease (e.g., noncalcified, calcified, ulcerated, unstable) and its resulting degrees of carotid artery stenosis as determined by velocity measures as well as by grayscale and color Doppler images. In addition, more rare disease processes such as subclavian steal phenomenon, pseudoaneurysm formations and postsurgical changes/complications also will be discussed. This exhibit will particularly focus on frequently encountered technical challenges and pitfalls of sonographic examinations of the neck vasculature. Emphasis will be placed on findings that are concordant or discordant to computed tomography (CT)/MR angiography (MRA) correlates and key pearls will be provided to address the mismatch.

Conclusions
Vascular ultrasound remains the most commonly used screening tool for detection of carotid atherosclerosis. There are published guidelines that aim at standardizing interpretation and appropriate stratification of patients. However, some of the vascular ultrasound studies are compromised by inherent limitations of the sonographic technology. This exhibit provides key pearls for addressing commonly encountered limitations of vascular ultrasound studies resulting in discordant CTA/MRI findings, thus allowing for interpretation of these studies with a higher degree of confidence.

KEYWORDS: Carotid Plaque, Carotid Stenosis, Ultrasonography
hereditary optic neuropathy (LHON) and multiple sclerosis (MS). It was first described in 1970 by Dr. Wallace in which he presented a case of patient LHON who had additional neurologic findings of spasticity with increase deep tendon reflexes and encephalopathy. In 1992, Dr. Harding and colleagues presented a case series of patients with LHON who presented MS-like symptoms, which led to the coining of the term Harding's syndrome. We aim to shed light on this rare clinical entity with detailed review of clinical findings, imaging feature, pathophysiology, treatment and prognosis.

Materials and Methods
We present a case-based review highlighting clinical features, imaging findings, pathophysiology, histologic features, treatments and prognosis of Harding's syndrome. We will describe the characteristic imaging (CT and MRI) features of Harding's syndrome. Information will be presented on the various conditions that mimic Harding's syndrome including neuromyelitis optica, neurobehcet's, CADASIL disease, etc. Clinical presentation, histopathologic discussion and key imaging findings of each entity will be reviewed.

Results
Clinical findings of Harding's syndrome will be detailed including primary involvement of the optic nerves resulting in bilateral acute-to-subacute vision loss (usually before the age of 30), plus triad of circumpapillary telangiectatic microangiopathy, pseudoedema resulting from swelling of the peripapillary retinal nerve fiber layer and negative staining on fluorescein angiography. Additional key clinical finding is that these patients respond little, if at all, to immunosuppressive therapy. Characteristic CT and MRI findings of Harding's syndrome will be discussed including early cerebrocortical volume loss and marked bilateral optic nerve involvement. Mimics of Harding's syndrome include MS, neuromyelitis optica, neurobehcets amongst other inflammatory CNS disorders. Imaging findings in conjunction with patient's clinical course and treatment response can help narrow the differential diagnosis.

Conclusions
Harding's syndrome is a rare disorder characterized by presence of both Leber's hereditary optic neuropathy and multiple sclerosis. It presents in young patients, with slight female predilection, resulting in acute-to-subacute vision loss with additional neurologic symptoms including encephalopathy and spasticity. Although MS is much more common than Harding's syndrome, it should be strongly considered in the differential diagnosis of patients with progressive vision loss plus other neurologic deficits that are not responding to immunosuppressive therapy. For equivocal cases, genetic tests can be performed to isolate the mitochondrial mutation(s) resulting in Harding's syndrome. It is important to arrive at the correct diagnosis as this has significant cost (health and financial) and prognostic implications.

KEYWORDS: Demyelination, Optic Nerve
Purpose
The purpose of this poster is to illustrate the imaging appearances of Parkinson's disease (PD) and the Parkinson's plus syndromes (PPS) and other common movement disorders on 123I-FP-CIT single photon emission computed tomography (SPECT) molecular imaging of dopamine transporters (DaT) so that they may be recognized by a neuroradiologist in practice. In particular, it will outline the quantitative SPECT analysis techniques utilized in our institution to increase diagnostic accuracy in this patient cohort. The poster also will provide MR imaging (MRI) correlation in relevant cases.

Materials and Methods
The current literature on the utility of 123I-FP-CIT imaging in PD and PPS will be reviewed with regard to the accuracy of clinical diagnosis and the utility of 123I-FP-CIT SPECT in identifying patients with PD or PPS. Examples from our own practice will be used to illustrate the patterns that are seen on 123I-FP-CIT in PD and PPS including multiple-system atrophy, progressive supranuclear palsy and corticobasal degeneration, with MR correlation where applicable.

Results
Movement disorders are among the most common neurologic illnesses, with the parkinsonian syndromes (PSs) playing a predominant role. PS is a syndromal umbrella term that comprises four etiologically different entities: Parkinson disease (idiopathic parkinsonian syndrome, or PD; Parkinson disease with dementia (PDD), familial PS, atypical PS (PS caused by other neurodegenerative diseases, or aPS), and symptomatic (secondary) parkinsonism, including common differential diagnoses such as specific tremor syndromes. The group of aPS includes multiple system atrophy (parkinsonian and cerebellar types), progressive supranuclear palsy, corticobasal degeneration, spinocerebellar atrophy, and Lewy body-type dementia (DLB). Vascular, drug-induced, toxic, and metabolic parkinsonism; parkinsonism associated with inflammation, trauma, and tumor; and normal-pressure hydrocephalus belong to the category of secondary parkinsonism. Essential tremor (ET) and other tremor syndromes are further common differential diagnoses additional to PD and aPS. The main clinical application of 123I-FP-CIT imaging is the differentiation of degenerative parkinsonism from conditions not associated with dopamine deficit, such as essential tremor and drug-induced, vascular, or psychogenic parkinsonism. Most authors state that, in individual cases, DAT imaging does not allow for reliable discrimination of a PD subject from an aPS subject or for further discrimination of the latter. The use of quantitative analysis in 123I-FP-CIT shows great promise as a tool to facilitate this process.

Conclusions
123I-FP-CIT is a useful imaging tool for the diagnosis of patients with movement disorders. We have found a combined approach of visual assessment and quantitative analysis of tracer binding to be useful in analysis of 123I-FP-CIT imaging.

KEYWORDS: Molecular Imaging, Motor Impairment

Figure 1
Axial 123I-FP-CIT (below left) showing abnormal, period-shaped striatal uptake bilaterally supporting a diagnosis of a Parkinsonian syndrome.
Axial T2W image (below right) from subsequent MRI demonstrates normal middle cerebellar peduncles, making MSA an unlikely diagnosis.

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eEdE-69

Image Artifacts In Neuro MRI: What The Neuroradiologists Need To Know

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Purpose
MR imaging (MRI) artifacts can pose a diagnostic challenge for neuroradiologists as they can simulate pathology and interfere with image interpretation. Our aim is to illustrate the different types of MRI artifacts encountered in neuroimaging in a pictorial review format. We also
examine the origin of each artifact and suggest optimal imaging methods to minimize these artifacts.

Materials and Methods
A review of the imaging database was performed to depict examples of different types of MRI artifacts. Each MRI artifact was classified by causative mechanism, and subsequently potential solutions or strategies to minimize each artifact were analyzed.

Results
Artifacts can be classified into broad categories, as those easily explained by k-space sampling errors (aliasing, truncation, radiofrequency external interference, raw data spike artifact), timing and flow related errors (slice-to-slice crosstalk, flow void artifact, flow enhancement artifact, ghosting due to motion or pulsation), and radiofrequency or main field inhomogeneity errors (B1 shading, metal artifact, fat saturation inhomogeneity, Dixon fat-water separation error, chemical shift, susceptibility). Other miscellaneous artifacts also are discussed.

Conclusions
MR imaging artifacts can obscure abnormalities, mimic pathology, decrease the image quality and lead to diagnostic dilemmas in neuroimaging. However, knowledge of these artifacts and how they can be prevented or minimized can improve diagnostic effectiveness in neuroimaging.

KEYWORDS: Artifacts

Imaging Findings in Primary Central Nervous System Vasculitis.

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Purpose
Primary central nervous system vasculitis (PCNSV) is a rare primary vasculitis limited to the brain and spinal cord. Clinical manifestations are nonspecific. Brain biopsy is the diagnostic gold standard, but may be falsely negative when unaffected tissue is sampled. Imaging procedures are a key part of the investigation of PCNSV patients. This review discusses the state-of-the-art of current imaging techniques in the workup of PCNSV patients and highlights future prospects.

Materials and Methods
Over the period of 2002 to 2012, we have listed at the CHUM (Centre Hospitalier de l'Université de Montréal) eight patients with confirmed PCNSV proven by stereotaxic cerebral biopsy in seven cases. We also realized systematic review of the literature about PCNSV articles in databases (MEDLINE, PubMed, EMBASE, Cochrane Library and Scopus).

Results
MR is extremely sensitive but nonspecific. The most common findings are multiple bilateral ischemic lesions often involving white and gray matter. Conventional or magnetic resonance angiography (MRA) typically shows segmental narrowing and dilation in multiple cerebral arteries. However, atypical findings also have been described both with magnetic resonance and angiography. Imaging techniques can be used to document the extent and type of lesions, to gauge response to treatment, and sometimes as surrogates for brain biopsy.
Conclusions
Accurate and early diagnosis of PCNSV is mandatory in order to prevent complications. Imaging techniques can contribute to establish the diagnosis and to evaluate disease activity with the extent of the disease in various vascular regions.

KEYWORDS: Arteriography, Arteriopathy, MR Imaging/MR Angiography

Imaging of Status Epilepticus with Emphasis on Diffusion-weighted Imaging

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Purpose
To review the imaging findings of patients with status epilepticus in the acute postictal period with emphasis on diffusion-weighted imaging primarily through a pictorial essay format. These imaging findings will be discussed in conjunction with pathology and pathophysiology in order to improve understanding and reinforce findings.

Materials and Methods
Using a pictorial essay format, imaging findings, pathology and pathophysiology related to status epilepticus will be illustrated in a logical and stepwise fashion through graphics, diffusion-weighted images (DWI) and gross pathology images. The key findings will be reinforced in tables with bulleted points.

Results
Status epilepticus has a complicated pathophysiology as evidenced by the ever evolving guidelines for diagnosis. In its most basic form, it can be thought of as neuronal injury that results from a hyper-excitatory state mediated by activation of excitatory receptors, primarily glutamate receptors. The cause of status epilepticus is diverse which includes congenital anomalies, mesial temporal sclerosis, neoplasm, trauma, inflammation/infection, toxic/metabolic disease, autoimmune disease, and many special syndromes. Clinically, this manifests as seizures lasting longer than five minutes and biochemically as a self-sustaining metabolic cascade. In the acute postictal phase diffusion restriction typically is seen representing neuronal injury in the form of cytotoxic edema. This at least can be partially reversible, unlike in cerebral ischemia where cytotoxic edema is secondary to irreversible failure of oxidative metabolism. Areas most vulnerable to injury include the hippocampus, amygdala, pyriform cortex, thalamus, cerebellum and cerebral cortex. Cytotoxic edema may extend to the subcortical white matter. It also may involve the entire hemisphere. Although the absolute time course for diffusion-weighted imaging and normalization are unknown, some experimental models showed ADC was decreased at about three hours to 48 hours and normalized or increased after this. In addition to accurately differentiating cytotoxic from vasogenic edema, diffusion-weighted imaging has the added benefit of being more sensitive to gray and white matter involvement. Multiple studies have showed positive correlation between electroencephalographic findings and diffusion-weighted imaging in terms of localization and lateralization.
Conclusions
Status epilepticus is a complex hyper-excitable and self-sustaining neurologic state resulting in neuronal injury. This typically manifests as diffusion restriction in the acute postictal period representing cytotoxic edema. In addition to differentiating cytotoxic edema from vasogenic edema, diffusion-weighted imaging has the added benefit of increased sensitivity for gray and white matter involvement. Diffusion-weighted imaging abnormalities correlate with electroencephalographic findings in terms of localization and lateralization. These findings illustrate the potential future role of diffusion-weighted imaging in the diagnosis and evaluation of status epilepticus.

KEYWORDS: Apparent Diffusion Coefficient, Diffusion-Weighted Imaging, Status Epilepticus

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**eEdE-04**

*Imaging spectrum of brain microhemorrhages on SWI*
Purpose
Microhemorrhages (MH) in cerebral and cerebellar parenchyma are due to various underlying causes. Conventional MR sequences and CT are not sufficient for their detection and determination of their distribution. Susceptibility-weighted imaging (SWI) is a new, full velocity compensated high-resolution three-dimensional (3D) gradient echo (GE) sequence, useful for the evaluation of various pathologies including MH. Our aim is to present and discuss various pathologies that present with brain MH and their distinctive imaging features on SWI.

Materials and Methods
We discuss various pathologies associated with brain MH and their distinctive imaging findings on SWI. For it, we searched in our teaching files for the following keywords: SWI, microhemorrhages, hemorrhage, trauma, brain injury, hypertension, stroke, infection, radiation therapy, amyloid angiopathy, vasculitis, encephalitis, cavernoma, embolus, PRES, fat emboli, sickle cell disease, tumor, and metastasis and evaluated the images for size, distribution and locations and number of MH. When available, we also compared the SWI to other MR sequences and/or CT. A literature review also is provided regarding the value of SWI in the detection and evaluation of the MH in different pathologic settings.

Results
In the evaluated brain MR examinations, the following entities were characterized by brain MH on SWI were identified, including traumatic brain injury, diffuse axonal injury (DAI), systemic hypertensive hemorrhages, invasive mucormycosis, postradiation MH, metastasis, tumors, multiple cavernomas, amyloid angiopathy, stroke, fat embolism, sickle cell disease, hemorrhagic PRES, and hypoxic ischemic encephalopathy. Susceptibility-weighted imaging is particularly helpful for detection and determination of distribution of MH which are more conspicuous than on CT or conventional MR imaging sequences. Some MH have a distinctive pattern such as the deep subcortical white matter, posterior corpus callosum and midbrain location of DAI; cortical distribution of amyloid angiopathy; peripheral distribution in sickle cell disease, basal ganglia and cerebellar location of hypertensive MH, perivascular distribution of invasive mucor, and diffuse involvement in fat emboli. However, in some entities the distribution of MH was not characteristic. In these cases, the clinical information and patient history were helpful in reaching the correct diagnosis.

Conclusions
Susceptibility-weighted imaging provides additional useful clinical information that is often complementary to conventional MR imaging sequences, and it can be used in the evaluation of various neurologic disorders especially in entities characterized by MH. Susceptibility-weighted imaging has higher sensitivity than conventional T2*GE sequences for detecting the size, number, and distribution of microhemorrhages in brain.

KEYWORDS: Hemorrhagic Angiopathy, Microbleeds, MR Imaging Susceptibility
The Ottawa Hospital, University of Ottawa, Ottawa, Ontario, Canada, Medimagem - Hospital Beneficenci Cencia Portuguesa de São Paulo and Hospital São Jose, São Paulo, Brazil, Brasilia Children's Hospital, Brasilia, Brasilia, Distrito Federal, NM Medical Centre, Mumbai, Mumbai, Maharashtra, India, Montreal General Hospital, McGill University Health Centre, Montreal, Quebec, Canada, Bombay Hospital, Mumbai, Mumbai, Maharashtra, India

Purpose
To highlight the imaging features and presentation of various metabolic, degenerative, vascular, infectious and inflammatory pathologies involving the dentate nucleus.

Materials and Methods
We intend to describe the diverse CT and MR imaging (MRI) features of a wide spectrum of central nervous system (CNS) conditions involving the dentate nucleus. The pictorial includes a collection of common and rare metabolic, neurodegenerative, infectious/inflammatory and vascular pathologies.

Results
Among the several deep cerebellar nuclei, the dentate is the largest and most laterally situated nucleus and forms part of the neo-cerebellum. Its primary functions include skilled voluntary motor co-ordination and has strategic connections with the red nucleus, thalamus and premotor cortex and communicates with the contralateral side through the ponto cerebellar fibers. Dentate nucleus pathologies can be seen in several common and uncommon leukodystrophies, toxic/metabolic, neurodegenerative conditions, vascular pathologies, infectious/inflammatory conditions and few congenital anomalies. The educational exhibit will have a wide spectrum of diseases like maple syrup urine disease, cerebrotendinous xanthomatosis, metronidazole toxicity, aceruloplasminemia, glutaric aciduria type 1, mitochondrial diseases, hypertrophic Olivary degeneration, neurofibromatosis type 1, Fahr's disease, Langerhan's histiocytosis, postradiation, lupus vasculopathy, amyloid angiopathy, progressive multifocal leucoencephalopathy, cryptococcosis, rhombencephalosynapsis, Alzheimer disease with myoclonus and T2 hypointensity in dentate nucleus in multiple sclerosis patients.

Conclusions
The radiologist has to be aware of several entities involving the dentate nucleus and their varied clinical and imaging appearances which can be seen in different age groups.

KEYWORDS: Degenerative, Metabolic, MR Imaging
Imaging Spectrum of Intracranial Meningiomas

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Purpose
While the diagnosis of meningioma usually poses minimal diagnostic challenge, in certain instances meningiomas may deviate in several imaging parameters, reflective of the various histological subtypes. Variation in signal intensity, perfusion characteristics, diffusion attributes, location, size and morphology can lead to diagnostic difficulty. Recognition and appreciation of this variation is crucial for accurate radiographic diagnosis.

Materials and Methods
Various presentations of intracranial meningiomas will be reviewed in a multimodality case-based format. The cases will emphasize the range from classic to atypical morphological appearances as well as the multitude of tumor locations.

Results
The spectrum of imaging appearances of intracranial meningiomas will be displayed according to the following outline: 1. Tumor location, Supra or infratentorial, Intraventricular, Optic nerve, Cerebellopontine angle. 2. Growth patterns, En plaque, Intra-osseous. 3. Histologic grade, Relationship between histology and imaging findings. 4. MR imaging (MRI) signal characteristics. 5. Specific radiographic features, Dural tail sign, cerebrospinal fluid (CSF) cleft sign, "Mother-in-law sign", "Tram-track sign".

Conclusions
Although common and frequently characteristic in radiographic appearance, meningiomas may present with a wide spectrum of imaging characteristics, the familiarity of which is essential in diagnosis. After reviewing this exhibit, radiologists will recognize the spectrum of appearances and locations of meningiomas and integrate this knowledge into practice.

KEYWORDS: Intracranial, Intraosseous, Meningioma
Imaging Spectrum of the “P and M” Visual Pathways and the “What and Where” Doctrine and Related Disorders.

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Purpose
This pictorial review illustrates the relevant anatomy, connections, and diseases affecting the higher cortical visual pathways. Radiologic and clinical neuro-ophthalmologic correlation is emphasized.

Materials and Methods
A specific group of patients suffering damage to higher cortical visual areas may have normal visual field and acuity, but suffer from inability to read or recognize colors, objects, faces, motion, etc. These association areas (V2-V5) are divided anatomically and functionally into ventral (occipitotemporal) and dorsal (occipitoparietal) pathways. The ventral pathway is an extension of the parvocellular (P) pathway, helping individuals to recognize objects ("What"). The dorsal pathway represents continuation of the magnocellular (M) pathway, responsible for object location ("Where"). Damage to these areas produces specific localizing signs and symptoms that tremendously help the neuroradiologist focus on particular anatomical structures. We present this pictorial review by utilizing CT, MR imaging (MRI), diffusion tractography, functional MR imaging (fMRI) and simplified diagrams superimposed on CT/MRI in order to elucidate the anatomy, function, and related diseases.

Results
The cerebral anatomy of the visual association areas is mapped on 3D MR imaging (MRI) reformatted reconstructions (Figure 1) and functional MRI (fMRI). The connections of the ventral and dorsal pathways to the primary visual cortex are demonstrated using diffusion tractography. Characteristic clinical syndromes and their corresponding structural damages include alexia without agraphia (left occipital lobe and splenium of corpus callosum), hemiachromatopsia (contralateral occipitotemporal lobe in the fusiform and lingual gyri), Balint syndrome (bilateral parieto-occipital lobes), visual hemi-inattention (right inferior parietal lobule), etc. Diseases vary by location to include neoplasms, demyelinating diseases, infection, and strokes. Imaging characteristics of each disease and differential diagnostic clues are discussed.

Conclusions
Recognizing the characteristic clinical and neuroimaging findings of higher cortical visual disorders is invaluable for neuroradiologists in providing accurate diagnoses and management guidance.

KEYWORDS: MR Imaging Brain, Visual Pathways

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Purpose
To review the basics of inferior petrosal sinus sampling (IPSS) including definition, conventional anatomy and anatomical variants, indications, procedural technique, accurate sampling, pitfalls, complications, interpretation of the angiographic results as well as pathology results and clinical outcomes after surgery.

Materials and Methods
From our computerized radiology information system (2008-2013), we identified patients who
were referred for IPSS. All medical charts, initial cross-sectional studies, diagnostic venogram and IPSS were reviewed.

Results
Ten patients (1 male, 9 females, and age range 19-75 years old) were included. All patients presented with clinical findings of Cushing syndrome. All patients had initial MRI sella with contrast; four showed no evidence of pituitary mass, three had inconclusive studies and the rest of them had a positive MR imaging (MRI) for pituitary microadenoma. All patients had a positive IPSS (either desmopressin or acthrel stimulation), seven of them (70%) had pathological proven pituitary microadenoma. Two of them showed no evidence of micro on pathology; however, one of these showed a good clinical outcome while the other one (male patient) has not had a follow up at our institute. One patient decided to not have surgery and has not followed at our institute. We will demonstrate conventional anatomy and anatomical variations of the inferior petrosal sinus (IPS). We will review indications and contraindications of the procedure. Procedural techniques and how to obtain an accurate sample with pharmacologic stimulation test as well as common pitfalls during the procedure will be discussed. Result interpretation and clinical outcomes will be reviewed.

Conclusions
1. Inferior petrosal sinus sampling is a useful diagnostic technique to localize adrenocorticotropic hormone (ACTH)-producing tumors in patients with normal or equivocal MR imaging studies, and it is considered a gold standard test. 2. With bilateral simultaneous sampling, it is an extremely sensitive, specific, safe and accurate test to diagnose Cushing disease. 3. Anatomical variants in the IPS are not rare and a complete understanding of these variants is required. The basic concepts of the procedure can help management of Cushing disease.

KEYWORDS: Pituitary Adenoma, Venous Anatomy, Venous Drainage

eEdE-78

Intracranial Hypotension: Often overlooked under pressure

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Purpose
Headache is one of the most common patient complaints, with an estimated overall lifetime prevalence of 0.2-60% for headache of any kind. The ACR Appropriateness Criteria for workup of headache based on certain features almost all include cross-sectional imaging of some kind to evaluate for devastating emergencies (for example subarachnoid hemorrhage) versus chronic issues (i.e., migraine). Intracranial hypotension is a cause of chronic headache that waxes and wanes and often is overlooked as the imaging findings are subtle and radiologists who are not provided with relevant history may overlook as a treatable cause of patient ailment. This exhibit will explore the world of intracranial hypotension with its clinical presentation, imaging findings, recommended follow-up imaging, and treatment of several causes.

Materials and Methods
Diagnosis of intracranial hypotension has been proven to be challenging as there are several
subtle, commonly overlooked findings. Common imaging findings on cross-sectional imaging will be reviewed, as well as recommended follow-up imaging. In addition, pertinent information elicited from a thorough clinical history would best provide guidance to further diagnostic workup as there are several different causes of intracranial hypotension.

Results
Most patients with intracranial hypotension will present with headache and first line imaging usually involves computed tomography (CT) or MR imaging (MRI). Findings on baseline cross-sectional imaging include enlargement of the extra-axial spaces disproportionate to ventricular size, ‘sagging’ of the corpus callosum, effacement of the basal cisterns, as well as downward displacement of the posterior fossa into the foramen magnum. In addition, the etiology of intracranial hypotension varies and this exhibit will review the common causes of intracranial hypotension which are spontaneous versus iatrogenic. Elucidating the cause is important for both follow-up imaging as well as for treatment. For example, a cerebrospinal leak from prior lumbar puncture may require a simple epidural blood patch, versus a patient who has a history of a transphenoidal resection who may require preoperative cisternography before surgical intervention. Lastly, treatment of intracranial hypotension will be discussed, which is predictably heavily based on etiology of its causes. This can involve something as simple as a blood patch versus a fat packing procedure performed by the otolaryngologists or neurosurgeons.

Conclusions
Headache caused by intracranial hypotension often is a difficult diagnosis to make without familiarity with this entity and its possible causes. Our role as radiologists include recognition of the common imaging findings and proper follow-up evaluation to elucidate and help guide patient management and treatment.

KEYWORDS: Idiopathic Intracranial Hypotension, Intracranial Hypotension

eEdE-50
6:30AM - 9:00PM

Intracranial Manifestations of HIV disease: A Pictorial Review with Diagnosis Algorithms

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Purpose
In the era of highly active antiretroviral therapy (HAART) mortality has decreased substantially among human immunodeficiency virus (HIV)-infected people with access to HAART. However, there is still a large contingent currently undergoing treatment, recently diagnosed or undiagnosed HIV positive individuals that present with atypical manifestations of intracranial disease. Evidence to the severity of this was offered by the ART Collaboration Cohort study in 2006 with a retrospective 10-year cohort of 1,876 deaths amongst 40,000 HIV positive patients in Europe and the U.S., which led authors to conclude that at less than four years of HAART, HIV patients were still more likely to die of an HIV/AIDS-related illness. This educational exhibit will review the pathophysiology, clinical presentation and characteristic imaging findings to aid in the diagnosis of HIV-associated infections, neoplasms and neurodegenerative disease.
Materials and Methods
Radiological images and relevant clinical information was extracted from our PACS station and MEDITECH™ integrated healthcare system at our supratertiary hospital network. Images were retrieved from recent imaging studies to review a wide spectrum of the major central nervous system (CNS) pathologies afflicting patients with confirmed HIV/AIDS.

Results
In this educational exhibit we intend to present a wide range of CNS pathologies frequently encountered in confirmed HIV/AIDS patients at our institution. Particular attention was paid to the differential diagnosis from the clinical interpretation of corresponding CT and MR images. Diagnostic algorithms were created to aid in the discrimination of the main differential diagnostic considerations based on their typical imaging features.

Conclusions
Opportunistic infections, neoplasms and HIV-associated neurodegenerative disease occurring secondary to immunodeficiency are still a major cause of morbidity and mortality among HIV positive patients even in the era of HAART. Proper differentiation among these pathologies may prove to be difficult. Radiologists must be able to use neuroimaging in conjunction with a complete clinical evaluation to obtain the best possible diagnosis to guide subsequent therapy for optimal patient outcomes.

KEYWORDS: Highly Active Antiretroviral, HIV, Human Immunodeficiency Virus

eEdE-38
6:30AM - 9:00PM

Intracranial Venous System and its Diseases on TOF- vs CE MR Venography

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Purpose
The venous system of our brain is an important part of the vascular tree and gets affected in a number of disease processes. There are a number of variations in the normal venous anatomy. The best way to avoid misdiagnosis is to know all the possible variations of the venous anatomy as some of the pathological states may mimic the normal variation of the venous anatomy. Some of the examples of the venous pathologies that may mimic the normal venous anatomical variations are venous stenosis in idiopathic intracranial hypertension, venous sinus thrombosis, etc. This requires a good imaging technique. Magnetic resonance venography (MRV) is one of the preferred imaging tools to study the normal venous anatomy, its variations and the pathological state of the venous system. Two techniques of acquiring MRV are (i) contrast-enhanced MR Venography (CEMRV) and (ii) time-of-flight MR Venography (TOFMRV). Both of these tools have been used extensively and CEMRV has been described as a better tool in demonstrating the normal anatomy, variations as well as pathology. The aim of this exhibit is to demonstrate normal venous anatomy, its variations and different pathologies on both TOF and CE-MRV. The secondary aim of this exhibit also is to show that CEMRV is significantly better than TOFMRV in this demonstration.
Materials and Methods
The CEMRV was acquired using a timing sequence with 2 cc of multihance followed by an intravenous injection of 15 cc of multihance using a MedRad injector to deliver the contrast at a rate of 2 ml/sec followed by 25 cc of saline injected at a rate of 2 ml/sec. Maximum intensity projection images were created and sent to PACS. Both TOF and CE-MRV images were compared for depiction of normal anatomy, variations, different venous pathologies and confidence level of neuroradiologist in diagnosing a venous pathology. From Dec 2011, we prospectively collected patients where both TOF and CE-MRV were acquired at the same time for various clinical indications. All patients were scanned on a 1.5 T magnet with an 8-channel head coil. The TOFMRV and the CEMRV sequences were acquired with the para. The CEMRV was acquired using a timing sequence with 2 cc of multihance followed by an intravenous injection of 15 cc of multihance using a MedRad injector to deliver the contrast at a rate of 2 ml/sec followed by 25 cc of saline injected at a rate of 2 ml/sec. Maximum intensity projection images were created and sent to PACS. Both TOF and CE-MRV images were compared for depiction of normal anatomy, variations, different venous pathologies and confidence level of neuroradiologist in diagnosing a venous pathology. Meters shown in the Table.

Results
Each case example will prompt the viewer to anticipate and recognize a specific anatomical variation or disease of the venous system. This also will demonstrate the superiority of the CEMRV in demonstration of venous anatomy, variation and pathologies. This will highlight the false positivity on TOFMRV in many different cases.

Conclusions
The different case examples will demonstrate different anatomical variations and pathologies of the venous system. This also will demonstrate the superiority of CEMRV over TOFMRV in demonstrating this.

KEYWORDS: Contrast-Enhanced MR Imaging, MR Venography

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eEdE-08

6:30AM - 9:00PM

Introduction to Segmentation, Registration and Volume Analysis for Imaging Genomics

O Ashour¹, A Chaddad¹, P Zinn¹, R Colen¹
¹MD Anderson Cancer Center, Houston, TX

Purpose
Image processing is essential for extracting data for any type of research study dealing with quantitative imaging variables. Before any type of volumetric analysis, the volumes in question should be well defined and presented as data types that are easy to deal with. In this exhibit we look at the methodology for image registration, segmentation and model building that we used for our study imaging genomic mapping in GBM.

Materials and Methods
We used Slicer software for the purposes of all the image analysis, manipulation and segmentation. 3D Slicer (www.slicer.org) is a free open source software platform for medical image processing and 3D visualization of image data. The platform provides functionality for segmentation, registration and three-dimensional visualization of multimodal image data, as well as advanced image analysis algorithms for diffusion tensor imaging (DTI), functional magnetic resonance imaging (fMRI) and image-guided therapy. FLAIR series was used for segmentation of edema and postcontrast T1-weighted imaging (T1WI) for segmentation of enhancement (defined as tumor) and necrosis. These sequences thus were selected to compute and obtain quantitative edema/invasion volumetry. Each sequence was loaded in Slicer as a volume. The “Parse Directory” function was used to parse the series and show all the series available in the data. We selected all the desired series separately to be opened in the volume module. The Volume module loads, saves and adjusts the display parameters of volume data. A volume can
be set for raw images of a certain sequence or label map and various options are available to adjust the way a volume is displayed.

Results
Registration: Different scans may be recorded at different angles, at different voxel thicknesses and use different number of slices. We need to register these scans, so that they correspond and are rigidly aligned to each other. Modules used: A. Transformation module: It helps to create and edit Slicer transformation nodes. Transformation nodes are matrices of data that map the voxels of every volume and are used to map different volumes, they can be both linear (expressed as 4 by 4 matrix) or nonlinear warp transformations. The transformation module allows you to edit only linear transformation nodes. We usually specified the T1 volume as the fixed base volume, and the FLAIR as the moving "transformed" volume. We used the "Translation" and "Rotation" tools to manually align every two volumes in space coordinates. B. Resample Scalar/Vector/DWI Volume: This module implements image and vector-image resampling through the use of ITK transforms. Resampling is performed in space coordinates, not pixel/grid coordinates. It is quite important to ensure that image spacing is properly set on the images involved. Segmentation: The segmentation was carried out in a simple hierarchical model of anatomy, proceeding from peripheral to the central. Edema, necrosis and tumor were segmented and later modeled. Segmentation Module (Editor): This is a module for manual segmentation of volumes. The overall goal is to precisely define structures within their volumes as "label map volumes". These label maps can be used for building models or for further processing. We used the single label map approach to create models of different tumor volumes on the same label map. Model Making: Using the "Make Model" tool of the "Editor" module, the models of edema, tumor and necrosis are generated from the previously performed segmentation. Data Display: It gives a complete view of the hierarchical (tree) representation of the MRML Scene.

Conclusions
Manual segmentation provides the advantage of higher accuracy compared to automated methods, especially if performed or supervised by an experienced radiologist. It is however more time consuming and has intersegmenter variability. Automated methods include: - Thresholding: Using set gray-scale levels as cut-offs for inclusion or exclusion of image elements and regions. - Region-growing: Uses a group of seed points to initiate an expansion of the segmented region through neighboring pixels to cover the desired tissue element. - Atlas-based techniques: - Clustering: By grouping voxels of similar properties into groups.

KEYWORDS: Image Processing, Image Registration, Imaging Genomics

eEdE-31

6:30AM - 9:00PM

Is it recurrent, or residual, or radiation necrosis or pseudoprogression? What physician expects and what radiologist can deliver.

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Purpose
1. To highlight the limitations of the conventional imaging techniques in evaluation of recurrent
brain tumor. 2. To demonstrate the importance of cellular and molecular techniques (MR spectroscopy, DWI-ADC, MR perfusion/permeability and DTI) in evaluation of posttreatment brain tumor.

Materials and Methods
We retrospectively studied 114 patients from our oncology data which formed the basis for this exhibit. All patients were treated for brain tumor with surgery and radiation therapy. Sixty-nine patients also had received chemotherapy. Pre and multiple posttreatment contrast-enhanced MR images (MRIs) including stealth study were available for analysis. Depending on the need, some of these patients also had higher end imaging techniques like MR spectroscopy, MR perfusion/permeability. Sixteen patients also had DTI of the brain while 11 patients had PET imaging.

Results
In this exhibit we discuss the various cellular and molecular imaging techniques in respect to angiogenesis, recurrent tumor, radiation necrosis, pseudoprogression and perilesional hyperintensity. We also discuss in brief the effect of angiogenesis inhibitor on imaging.

Conclusions
1. Diagnosis of recurrent brain tumor is always challenging. The combination of newer cellular and molecular imaging techniques has increased the sensitivity in the diagnosis of early recurrent tumor. 2. Combinations of these techniques (e.g., MRS + MRP or MRS + DTI/PET) are more sensitive and specific in differentiating recurrent from radiation necrosis, than single advanced imaging techniques.

KEYWORDS: MR Perfusion-Weighted Imaging, MR Spectroscopy, Radiation Necrosis

eEdE-63

Meckel's Cave Dwellers: A Review of Tumors and Tumor Mimickers

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Purpose
Meckel's cave, or the trigeminal cave, is a cerebrospinal fluid (CSF) filled pouch arising from the posterior cranial fossa which houses the gasserian ganglion. There are a myriad of pathologic processes which can arise primarily within this area or may infiltrate it secondarily. It is important for the radiologist to be familiar with not only true tumors but also various pseudolesions which can lead to unnecessary surgery if there is a misdiagnosis.

Materials and Methods
We will review the axial and coronal MR anatomy of Meckel's cave and provide a case-based review of various lesions including benign and malignant masses, granulomatous lesions, perineural tumor spread, and metastasis. We also will discuss the appearance of various pseudolesions which can mimic tumors such as cephalocele, aneurysms and postradiation enhancement.

Results
Meckel's cave is a dural recess in the medial posterior and inferior portion of the middle cranial fossa with the dura and temporal bone as the lateral boundary, the precavernous ICA as the
medial boundary, and the cavernous sinus as the anterosuperior boundary. On MR imaging (MRI), it appears as ovoid, smooth CSF-filled cisterns on axial and coronal scans resembling "open eyes" which appears as symmetrically hypointense on T1, and hyperintense on T2. When pathology occurs within the cave, one may see a "winking" sign, in which one side becomes filled with soft tissue rather than CSF, leading to an asymmetric appearance which may appear with increased signal intensity on the contrast-enhanced imaging. Our review will discuss in greater detail the characteristic imaging findings of pathologic lesions which occur in this space. Conclusions

Familiarity with the anatomy and imaging characteristics of lesions within Meckel's cave will help the radiologist to establish the diagnosis and not mistake tumors from the tumor mimickers.

KEYWORDS: Meckel’s Cave, Trigeminal Nerve

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eEdE-54

Meningiomas and Mimics: A "Tail" of Extraaxial Masses

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Purpose

Meningiomas are the most common nonglial primary intracranial tumor accounting for approximately 25% of all primary intracranial neoplasms. They often are diagnosed easily by typical imaging findings. The purpose of this exhibit is to review typical features of meningioma, atypical imaging features, mimicking extraaxial neoplasms, and review advanced imaging techniques that may aid in differentiating benign from atypical/malignant meningiomas.
Materials and Methods
Typical and atypical imaging features of meningioma will be reviewed. Imaging of grade II and III meninogiomas will be discussed with emphasis on advanced imaging techniques (DWI, DSC perfusion) and whether these tools can reliably differentiate meninogiomas by grade. The histologic subtypes and histologic grading of meninogiomas will be correlated with imaging. Subsequently, other extraaxial masses that can mimic meninogioma will be reviewed.

Results
The typical imaging appearance of meninogioma is a hemispheric extraaxial mass that is slightly hyperattenuating to gray matter, T1/T2 isointense to gray matter, homogeneously enhancing, with a reactive dural tail and hyperostosis of the adjacent calvarium. Atypical imaging features include intratumoral or peritumoral cysts, ring enhancement, fatty metaplasia, heterogeneity, T2 hyperintensity, and bone destruction. A reactive dural tail is seen in up to 80% of meninogiomas, but is a nonspecific finding that can be seen in any extraaxial mass that involves the dura. Peritumoral edema is seen in up to 60% of meninogiomas and is associated with pial blood supply, tumor size, irregular tumor margins, loss of peritumoral T2 hyperintense cleft, and T2 hyperintensity of the tumor. The clinical implications of peritumoral edema are increased operative morbidity and increased tumor recurrence. Benign meninogiomas cannot be differentiated from atypical or malignant meninogiomas by conventional imaging features. Recent studies show decreased apparent diffusion coefficient (ADC) values in atypical and malignant meninogiomas compared to benign meninogiomas. Dynamic susceptibility contrast perfusion-weighted MR does not differentiate benign from malignant meninogioma, though CBV within the peritumoral edema has been noted to be higher with malignant meninogiomas. A pictorial display of extraaxial masses that can mimic meninogiomas including metastases, lymphoma, hemangiopericytoma, granulomatous disease, hemangioblastoma, solitary fibrous tumor, cavernoma, melanocytoma, and mesenchymal tumors will be included.

Conclusions
While meninogiomas often are diagnosed easily by typical imaging features, the radiologist must be aware of the various atypical imaging features of meninogioma and multiple other extraaxial processes that can mimic meninogiomas.

KEYWORDS: Extra-Axial, Meningioma

eEdE-09
MR imaging of Mild cognitive impairment: State of art
6:30AM - 9:00PM

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Purpose
The aim of this work is to review basic background about mild cognitive impairment (MCI), to illustrate the anatomical, morphometric and functional changes in MCI and to discuss role of MR imaging in patients with MCI.

Materials and Methods
1-Consensus criteria and guidelines of MCI. 2-Clinical, genetic and CSF biomarkers of MCI. 3-Neuropathology and neurobiology of MCI. 4-Normal anatomy of hippocampus and temporal
region. 5-Anatomical and morphometric MR imaging changes in MCI. 6-Diffusion MR, perfusion MR and MR spectroscopy findings in MCI. 7-MR imaging biomarkers for subtyping of amnestic from nonamnestic MCI. 8-MR imaging biomarkers and longitudinal study that predict conversion to Alzheimer disease (AD). 9-MR imaging findings differentiate MCI from other causes of dementia. 10-MR imaging of special forms such as MCI with Parkinson and depression. 11-Imaging biomarkers used to predict patient response to therapy and outcome. 12-Future directions and summary.

Results
MR imaging biomarkers are used for subtyping of amnestic from nonamnestic MCI. MR imaging biomarkers as ADC metabolites and longitudinal study are used to predict conversion to Alzheimer disease (AD). Also, MR imaging findings differentiate MCI from other causes of dementia and diagnose special forms such as MCI with Parkinson and depression. Finally, MR imaging biomarkers used to predict patient response to therapy and outcome.

Conclusions
We concluded that anatomical, morphometric and functional MR images, MR neuroimaging biomarkers has a role in subtyping of MCI, predict conversion to AD and differentiation from other causes of dementia.

KEYWORDS: Advanced MR Imaging, Degenerative, Diffusion MR Imaging

eEdE-27

MRI Artifacts in the Brain and Spine: The Good, the Bad, and the Ugly

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Purpose
Magnetic resonance imaging (MRI) is the primary diagnostic workhorse in neuroradiology. Yet despite its capabilities, MRI remains prone to a number of artifacts, which often are compounded today by the use of higher field strength magnets. The purpose of this exhibit is to explore the full spectrum of artifacts encountered in MR imaging of the brain and spine, including causes and potential solutions, which will enable the neuroradiologist to more readily recognize and correct potential issues.

Materials and Methods
Using our case files, we will show examples of various artifacts encountered in MR imaging of the brain and spine. • Artifacts that will be discussed will include those related to: 1) MR hardware (e.g., zipper artifact and inhomogeneity artifacts); 2) Physiologic factors (e.g., patient motion, CSF pulsation, blood flow); 3) Foreign bodies (e.g., susceptibility artifact); and 4) Signal Processing (e.g., wrap around, Gibbs phenomenon). • Specific emphasis will be placed on artifacts that mimic pathology (e.g., pseudo-enhancement, false syrinx, pseudo-infarcts on diffusion-weighted imaging, flow void artifacts mimicking carotid stenosis, aortic pulsation artifact mimicking spinal cord pathology), as well as those that enhance pathology (blooming "artifact" of hemosiderin on susceptibility-weighted images). In addition, we will discuss specific pitfalls of particular imaging sequences (e.g., flow artifacts on FLAIR images), as well
as how choice of MR sequence may mitigate or enhance pathology. • For each artifact, we will discuss the underlying cause, as well as potential methods to correct the artifact.

Results
Artifacts in MRI of the brain and spine are not uncommon and typically can be classified as related to MR hardware or processing issues, physiologic factors, and the presence of foreign bodies. Aside from the obvious detrimental effects on image quality, artifacts can potentially play an important role in study interpretation, both for the good (e.g., use of susceptibility-weighted imaging to detect microbleeds) and the bad (artifacts mimicking pathology). Despite the potential limitations that artifacts introduce into MR interpretation, in the appropriate hands, these issues can be recognized easily and often corrected.

Conclusions
MR imaging of the brain and spine is an essential tool in neuroradiology today. However, despite its diagnostic capabilities, MR remains susceptible to a number of artifacts that can diminish its usefulness, and in some instances, actually lead to incorrect diagnoses. As such, it is essential that neuroradiologists have a strong understanding of the artifacts commonly encountered in imaging of the brain and spine, as well as appropriate steps to correct the artifacts. This case-based exhibit will explore the good, the bad, and the ugly of MR artifacts, strengthening the viewer's understanding of those artifacts commonly encountered in everyday practice, as well as providing the necessary steps to improve or correct the problem.

KEYWORDS: Artifacts, MR Imaging Brain, MR Imaging Spine

eEdE-49

Neuroimaging Appearances and Positioning of Mini-craniotomies for Endoscopic Neurosurgery Compared with Traditional Craniotomies: A Pictorial and Educational Review

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Purpose
There is an increasing drive for minimally invasive surgery across all surgical disciplines. Within neurosurgery this trend has manifested particularly in the increasing use of endoscopic methods for intraparenchymal tumor resection. Neuroradiologists are familiar with standard surgical approaches, craniotomy flaps, and their postoperative appearances. However, with rapid developments and increasingly innovative strategies in minimally invasive neurosurgery, many neuroradiologists may not be familiar with cross-sectional imaging appearances of mini craniotomies used for endoscopic neurosurgery. We present and discuss a series of images and their 3-D reconstructions that demonstrate the positioning and normal postoperative appearances of mini craniotomies for endoscopic neurosurgery. We also provide useful educational perspectives by comparing these images to the 'traditional' bone flaps that would have been required for removal of the same tumor.

Materials and Methods
As part of an ongoing development of neuroendoscopic tumor surgery at our institution a
database of patients undergoing minimally invasive surgery was available. All patients in this series underwent imaging with CT on the first postoperative day. We retrieved images that showed good alternatives to common approaches for traditional surgery. 3-D reconstruction was performed using BrainLab iPlan 3.0 software and the traditional craniotomy flap representation overlaid.

Results
We present the neuroimaging findings in a series of mini craniotomies with pre- and postoperative imaging and reconstructions. These include alternatives to the traditional frontal, pterional, temporal, convexity and suboccipital craniotomies. We provide a detailed educational review of mini craniotomies both from this series and in the literature, examining the relative differences with traditional approaches.

Conclusions
As neuroendoscopic techniques improve it is likely that traditional craniotomy flaps will be seen less frequently. It therefore is essential that neuroradiologists be familiar with the rationale, positioning and normal postoperative imaging appearances of newer minimally invasive approaches. In this exhibit we present a series of common mini craniotomies used at our institution for neuroendoscopic surgery in comparison to their traditional counterparts. We also review some of latest innovative types and locations of mini craniotomies that have been adopted for minimally invasive endoscopic neurosurgery.

KEYWORDS: Minimally Invasive Surgery, Postoperative Findings
3-D reconstruction from the post-operative CT of a patient who underwent an endoscopic resection of an occipital meningioma. The standard craniotomy that would have been required is overlaid in red.
Neuroimaging Manifestations of Radiation-Related Injuries to the Brain: Emphasis on Imaging Appearance and Radiobiology

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Purpose
Radiotherapy and radiosurgery are used as primary and adjuvant modalities in the treatment of central nervous system disorders. There are a variety of unintended complications which can arise from radiation therapy ranging from ischemic to neoplastic. The diagnosis of a radiation-induced condition (i.e., radiation-induced meningioma) can significantly impact patient care as the radiation-induced condition may not respond similarly to standard treatment strategies. This education exhibit illustrates, in a case-based manner, a variety of conditions that may arise following intracranial radiation and highlights the clinical scenarios when these conditions are likely to arise.

Materials and Methods
A spectrum of imaging manifestations of radiation-induced intracranial conditions will be presented in a case-based manner with accompanying clinical vignettes. Some of the entities which will be presented include: 1. White matter radiation changes. 2. Treatment response, radiation necrosis and pseudoprogression. 3. Radiation-related vasculopathy. 4. Radiation-related cavernomas. 5. SMART syndrome (FIGURE 1 shows areas of cortical enhancement involving the medial aspect right frontal lobe and right insular region (arrowheads) in this case of SMART syndrome). 6. Radiation-induced meningiomas, gliomas and sarcomas. 7. Intravascular papillary endothelial hyperplasia/Masson's tumor [Figure 2 shows a hemorrhagic right parietal mass (arrowhead) and vasogenic edema in this case of Masson's tumor]. In addition to the stereotypical imaging findings, emphasis will be placed on the typical radiation doses and latencies associated with these manifestations to facilitate differentiation of the radiation-induced condition from the alternate nonradiation-related counterparts.

Results
There are a variety of MR manifestations of radiation-related conditions. While some are benign and beneficial (treatment-related response), other conditions portend significant morbidity (i.e., radiation-induced optic neuritis and SMART syndrome) and some can potentially be fatal (radiation-induced gliomas). As treatment for these conditions varies from their nonradiation-induced counterparts, knowledge of the expected latency is important to guide clinicians as to whether or not the condition is likely to be radiation-induced. Furthermore, knowledge of the site of treatment, the employed radiotherapeutic modality and delivered radiation dose also affects the likelihood of whether or not a condition is radiation-related.

Conclusions
This interactive review highlights conditions encountered after intracranial radiotherapy/radiosurgery. Knowledge of treatment history, imaging appearance of
complications and temporal relationship of these complications related to their treatment is essential in management of these patients.

KEYWORDS: Radiation Effects, Radiation Injury, Radiation Necrosis

1. SMART syndrome
2. Mass lesion

Neuroimaging of Degenerative Diseases of the Brain: A Review of Imaging Findings and the Updates in Diagnostic Criteria
Purpose
The diagnosis of neurodegenerative diseases is primarily based on clinical assessment. However, with recent advancements in neuropathology and genetics, neuroimaging has been playing an increasingly important role in the diagnosis of such diseases. Over the past several decades, there has been much improvement in the scientific and clinical understanding of the disease concepts, diagnostic criteria, and neuroimaging techniques of neurodegenerative diseases. The knowledge of these advancements in conjunction with the underlying pathophysiology and genetics of neurodegenerative diseases is essential for appropriate radiological evaluation to assist in the clinical diagnosis.

Materials and Methods
We present a review of (1) the neuropathophysiological and genetic mechanisms involved in degenerative diseases of the brain, such as Alzheimer disease, dementia with Lewy bodies, Parkinson's disease, frontotemporal dementia, Creutzfeldt-Jakob disease, Wilson's disease, progressive supranuclear palsy, corticobasal degeneration, Huntington's disease, and multiple system atrophy, (2) multimodality neuroimaging findings, including structural MRI, and molecular imaging (PET, SPECT), and (3) advanced neuroimaging techniques that may provide increased specificity for diagnosis.

Results
Neurodegenerative diseases encompass a wide spectrum of disorders with the specific neuropathological findings. Specific neuroimaging findings of each disease can be explained in connection to characteristic temporal and topographical distribution of those pathologies. For example, in Alzheimer disease, abnormal accumulation on amyloid-PET is correlated with the distribution of amyloid pathology, and can be seen prior to symptomatic phases of the disease. FDG-PET in Alzheimer disease reflects density of disrupted synaptic activity as a resultant of tauopathy. In Parkinson's disease, dopamine transporter SPECT is a specific biomarker to assess the presence of presynaptic dopaminergic denervation. Structural MRI demonstrates a characteristic pattern of cerebral atrophy which is thought to reflect microscopic neurodegeneration (loss of synapses, dendritic processes, and neurons), while diffusion tensor imaging can visualize disrupted white matter and gray matter integrity.

Conclusions
While conventionally, the role of neuroimaging has been to exclude potential secondary causes of neurodegenerative diseases, recent advances in neuroimaging with improved specificity for detecting these diseases have made neuroimaging play a more central role in diagnosis.

KEYWORDS: Degenerative, Molecular Imaging, MR Imaging

Neuroimaging of Vascular Dementias

A Agarwal¹, S Kanekar²
Purpose
Vascular dementia (VaD) is the second most common cause of dementia, following Alzheimer disease (AD) and remains a diagnostic challenge in clinical settings all over the world. As a clinical syndrome, vascular dementia relates to different vascular mechanisms and changes in the brain and has different causes and clinical manifestations. This type of dementia represents a diagnostic challenge because of its various clinical manifestations and different vascular causes. This challenge is illustrated by the number of clinical diagnostic criteria that have been published and used over the past 30 years. The pathophysiology, diagnostic criteria, genetics and classification of vascular dementias are covered in depth in this exhibit. This exhibit also examines the role of conventional and advanced neuroimaging in VaD.

Materials and Methods
At least eight different clinical diagnostic criteria sets for vascular dementia or multi-ischemic dementia have been used in clinical and research settings including the original Hachinski Ischemic Scale, the criteria proposed by the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV), by the California Alzheimer's Disease Diagnostic and Treatment Centers (CAD–DTC) , and by the National Institute of Neurological Disorders and Stroke-Association Internationale and the Association Internationale pour la Recherche et l'Enseignement en Neurosciences (NINDS–AIREN). Two tools have been used successfully for the diagnosis of VaD with high specificity. They are the criteria developed by the NINDS–AIREN and by the California Alzheimer's Disease Diagnostic and Treatment Centers (CAD–DTC). These criteria, which have been validated by some neuropathological studies and a centralized imaging rater, have provided increased consistency in the diagnosis of VaD.

Neuroimaging is required for confirmation of cerebrovascular disease in VaD and provides information about the topography and severity of the vascular lesions.

Results
The traditional view has been that computed tomography (CT) and magnetic resonance imaging (MRI) are performed to exclude other abnormalities that are potentially amenable to surgical treatment, such as a tumor, hematoma, or hydrocephalus. However, in the recent practice parameter on the diagnosis of dementia, structural neuroimaging in the routine initial evaluation of patients with dementia is recommended as a guideline. Functional imaging provides insight into the operational aspects of the brain, and since it appears that brain pathology in dementia begins long before there is clinical evidence of disease, functional imaging is attractive for the early detection of dementia. Single-photon emission computed tomography (SPECT), positron emission tomography (PET), and functional MRI (fMRI) are becoming increasingly relevant to the study of dementia. To enhance their clinical implementation, operational definitions for the radiological part of the NINDS-AIREN criteria subsequently were defined (Table 1). To be considered as evidence in favor of VaD (probable VaD), the radiological findings should fulfill minimum standards of the NINDS-AIREN criteria for both severity and topography (large vessel and small vessel). Imaging appearance of vascular dementia can be broadly divided into: 1) large-vessel vascular dementia; 2) small-vessel vascular dementia and 3) microhemorrhage and dementia.

Conclusions
Cerebrovascular disease currently is viewed as a distinctly secondary cause of dementia that is of
uncertain importance. Although it is commonly cited as the second leading cause of dementia, a lack of well validated diagnostic criteria, makes accurate epidemiology difficult. Among the tools available to help clinicians diagnose and monitor VaD progression, neuroimaging is especially useful for confirming the diagnosis and identifying specific VaD subtypes.

KEYWORDS: Memory, MR Imaging/Diffusion

Table 1. Operational definitions for the radiological part of the NINDS-AIREN criteria (2003)


(A) Topography

**Large-vessel stroke**

- Large-vessel stroke is an infarction defined as a parenchymal defect in an arterial territory involving the cortical gray matter
  - ACA—Only bilateral ACA infarcts are sufficient to meet the NINDS-AIREN criteria
  - PCA—Infarcts in the PCA territory can be included only when they involve the following regions:
    - Paramedian thalamic infarct
    - Inferior medial temporal lobe lesions
- Association areas—MCA infarcts need to involve the following regions:
  - Parietotemporal lobe (e.g., angular gyrus)
  - Temporo-occipital cortex:
- Watershed carotid territories (between the MCA and PCA or the MCA and ACA)

**Small-vessel disease**

- Multiple basal ganglia and frontal white matter lacunes
- Extensive periventricular white matter lesions (leukoaraiosis)
- Bilateral thalamic lesions

(B) Severity

- Large-vessel disease of the dominant hemisphere
- Bilateral large-vessel hemispheric strokes
- Leukoencephalopathy involving at least 25% of the total white matter.
Fulfillment of radiological criteria for probable VaD

- Large-vessel disease—both the topography and severity criteria should be met (a lesion must be scored in at least 1 subsection of both topography and severity).

- Small-vessel disease—for white matter lesions, both the topography and severity criteria should be met

**eEdE-13**

**Neurovascular Emergencies: The Usual, Unusual and Unbelievable**

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**Purpose**

Neurovascular emergencies encompass a broad spectrum of pathology that can lead to significant morbidity and mortality. While many of these pathologies can have classic presentations, an atypical presentation or a complicated clinical course can make the diagnosis more challenging. Imaging plays a pivotal role in the diagnosis and management of neurovascular emergencies, and radiologists must be aware of the imaging findings of disease as well as possible complications. By reviewing a series of neurovascular emergencies from our institution, ranging from the common to the uncommon and frankly bizarre, we hope to enhance the radiologists' awareness of the spectrum of neurovascular pathologies to allow for prompt diagnosis and treatment.

**Materials and Methods**

A retrospective, pictorial review of a wide spectrum of neurovascular emergencies at our institution will be presented. We will categorize the different types of neurovascular emergencies into (1) anatomical/congenital, (2) traumatic (self-inflicted, iatrogenic), (3) neoplastic, and (4) nontraumatic/sequela of chronic disease. This exhibit will be a multimodality review, with emphasis on computed tomography (CT), MR imaging (MRI) and angiography.

**Results**

We will present a spectrum of neurovascular emergencies ranging from common entities, such as stroke and dissection, to rare pathologies including cervical dural AVFs and venous sinus thrombosis, to frankly bizarre cases including a self-inflicted cerebral nail gun injury. We also will present neurovascular complications of surgery including an ICA dissection with subsequent thrombosis and stroke following resection of a large carotid body tumor. Pre- and postoperative cross-sectional and angiographic imaging will be shown. An additional section will be dedicated to posttraumatic neurovascular emergencies including direct penetrating trauma to the neck and spine with resultant vascular injury and epidural hematoma. We also will delineate the anatomical considerations involved in some of these neurovascular emergencies including
hypertrophic olivary degeneration as a consequence of an acute pontine hemorrhage and hemiatrophy of the tongue as a consequence of an acute 12th nerve palsy following acute ICA dissection. Important diagnostic implications for treatment and management also will be described.

Conclusions

Neurovascular emergencies encompass a wide spectrum of pathology, from the usual, to the unusual, and frankly unbelievable. Radiologists are integral in the diagnosis of neurovascular emergencies, and having an awareness of common complications and common pitfalls can have an impact on prompt management and treatment.

KEYWORDS: Dissection, Iatrogenic, Venous Sinus Thrombosis

eEdE-03

Not So Clueless: Differentiating Diseases Involving White Matter in Adults beyond Multiple Sclerosis (MS) and Small Vessel Disease (SVD).

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Purpose

1. Categorize diseases that affect white matter in adults with MR imaging (MRI) using a systematic approach to narrow the differential diagnosis. 2. Show "clues" that suggest when white matter signal abnormalities are not typical for multiple sclerosis (MS) or small vessel ischemia.

Materials and Methods

> Discuss importance of characterizing white matter disease. > Describe imaging features suggesting diagnosis other than MS or small vessel disease (SVD): Pattern, Location, Signal Characteristics, Enhancement, Diffusion, Calcifications, Cysts, Atrophy, Susceptibility, and Clinical presentation. > Provide an algorithm for approaching white matter disease in adults. > Show case-based examples emphasizing differentiating features.

Results

Many of the following imaging features, while not be diagnostic for a signal diagnosis, can raise suspicion for certain entities and narrow the differential diagnosis. Examples of when these "clues" are helpful are listed: > Pattern: GBM, radiation, lymphoma, ADEM. > Location: Behcet, CADASIL. > Signal Intensity: Toxoplasmosis, Wilson's. > Enhancement: metastases, carbon monoxide, IRIS, TB. > Diffusion: Wernicke, Osmotic demyelination, PRES. > Calcifications: Fahr, thyroid disorders. > Cysts: Cryptococcus. > Atrophy: Wernicke, Marchiafava–Bignami syndrome. > Susceptibility: Cerebral Amyloid Disease, DAI. > Clinical: Lupus, HIV encephalitis.

Conclusions

Although it is true that multiple sclerosis and chronic small vessel ischemia dominate as the most prevalent entities affecting white matter in adults, suggesting alternative diagnoses based on imaging characteristics has an important impact on patient work up and care. Radiologists should have a systematic approach to interpreting white matter signal abnormalities and know when to be "clued-in" to alternative diagnoses.
Patterns of Bevacizumab (Avastin) Failure and Complications of Treatment

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Purpose
Bevacizumab (Avastin) is an angiogenesis inhibitor that blocks the action of vascular endothelial growth factor and frequently is used alone or in combination with radiation therapy or chemotherapy, for treatment of recurrent glioblastoma. The imaging features of tumor following bevacizumab therapy have been well described, with the most common findings being marked decrease in enhancement on contrast-enhanced MR images and decrease in vasogenic edema. It also has been suggested that bevacizumab may unmask the presence and extent of infiltrative disease best seen on FLAIR images. In this educational exhibit, we review our experience and demonstrate the major patterns of tumor progression and non-neoplastic complications following bevacizumab therapy.

Materials and Methods
We retrospectively reviewed MR imaging in 42 patients with suspected recurrent glioblastoma from 2006 to 2013 who underwent bevacizumab therapy and then had subsequent tumor recurrence and/or treatment complications. Serial MR imaging characteristics were analyzed while patients were on bevacizumab. Imaging patterns were analyzed for degree of enhancement, edema, infiltration, and presence of reduced diffusion within or remote from tumor.

Results
Four patterns of bevacizumab failure were identified: first, local tumor progression at site of original disease with enlarging area of reduced diffusion and FLAIR abnormality without much enhancement; second, development of diffuse tumor infiltration on FLAIR images in a gliomatosis-like pattern with minimal enhancement; third, decrease in FLAIR abnormality and enhancement at the site of original disease, but development of distant unifocal or multifocal enhancing tumor, either with or without subependymal spread; and fourth, continued progression of local or multifocal disease with increase in FLAIR and enhancement despite Avastin treatment. We also reviewed cases of diffusion abnormality in patients treated with Avastin, some of which represent ischemic injury, hypoxic or hypercellular tumor, or blood products.

Conclusions
In this educational exhibit we demonstrate imaging characteristics of recurrent glioblastoma following bevacizumab therapy with special emphasis on four imaging patterns suggestive of therapeutic failure. We also present bevacizumab-related complications with focal acute infarcts being the most common. Recognition of various imaging changes following bevacizumab therapy will be essential for assessment of therapy response and tumor progression in patients with recurrent glioblastoma.

KEYWORDS: Antiangiogenic Therapy, Glioblastoma, Glioma Recurrence

eEdE-45

Pearls and Pitfalls of Imaging in Neurodegenerative Disorders: What the Radiologist and Clinician need to know?

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Purpose
1. Review the anatomy, pathophysiology, and imaging findings including PET-MRI, SPECT imaging (DATscan), PET-CT, CT, and MRI of various neurodegenerative disorders including Parkinson's disease, supranuclear palsy, Alzheimer's dementia. 2. Review pearls and pitfalls of various imaging techniques including PET-MR imaging, SPECT Imaging, PET imaging and susceptibility-weighted imaging (SWI).

Materials and Methods
1. Review study technique and clinical indications of various imaging modalities available to evaluate neurodegenerative disorders including PET-MRI, nigrostriatum I-123 Ioflupane imaging, SWI, etc. and approach to study interpretation. 2. Review characteristic imaging findings of various neurodegenerative disorders in the aforementioned modalities and their respective differential diagnoses. 3. Review radiological pitfalls and emphasize key points which can help in avoiding these pitfalls. 4. Review clinical and radiological pearls that can help narrow the differential diagnosis.

Results
1. Detailed physiologic and pharmacologic discussion of various PET and SPECT agents including I-123 ioflupane, 11C-PIB PET, etc. 2. Case-based discussion of clinical features, pathophysiology, histology features, imaging findings (SPECT, CT and/or MRI) highlighting radiological pearls, treatments and prognosis of various neurodegenerative disorders including Parkinson's disease, multisystem atrophy, progressive supranuclear palsy, vascular dementia, Alzheimer's dementia, Lewy body dementia, corticobasilar degeneration, etc. 3. Case-based discussion of various pitfalls of these imaging modalities will be discussed along with reviewing clinical and radiology findings that can help in arriving at the correct diagnosis.

Conclusions
Neuroimaging is key in diagnosis of various neurodegenerative disorders. Functional imaging obtained via PET-MRI, PET-CT, SPECT imaging, etc. play key role in conjunction with routine structural neuroimaging (CT and MRI) in accurately diagnosing patients and guiding proper patient management. Although the differential diagnosis is broad, it can be narrowed utilizing age, clinical findings and imaging characteristics on functional imaging. By the conclusion of this presentation, the viewer should have a better understanding of various movement disorders and know the appropriate imaging modalities that are most cost- and time-effective in diagnosing the patient.

KEYWORDS: MR Imaging Susceptibility, MR Imaging/PET, MR Plaque Imaging
Phase-Contrast Cerebrospinal Fluid (CSF) Flow Imaging: Basic Technique and Clinical Applications

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Purpose
During the last two decades, flow-sensitive MR imaging (MRI) techniques have been applied increasingly to quantitatively and qualitatively assess cerebrospinal fluid (CSF) flow dynamics. In this pictorial review, we emphasise phase-contrast (PC) MRI technique, CSF physiology and cerebrospinal space anatomy, congenital and acquired disorders that can alter the cerebrospinal fluid dynamics, and the use of PC MRI in the assessment of various central nervous system (CNS) abnormalities.

Materials and Methods
The PC MRI generates signal contrast between flowing and stationary nuclei by sensitizing the phase of the transverse magnetization to the velocity of motion. Two data sets are acquired with opposite sensitization, yielding opposite phase for moving nuclei and identical phases for...
stationary nuclei. Magnitude and phase images can be generated for anatomy and velocity information, respectively. The result is that the grayscale intensity of each pixel is related directly to the velocity of CSF. Caudal flow of CSF is conventionally represented as shades of white on phase images, whereas cranial flow is by shades of black. Since it reflects the phase shifts, PC velocity image is far more sensitive to CSF flow than is the magnitude image. Two series of PC imaging techniques are applied in the evaluation of CSF flow, one in the axial plane, with through-plane velocity encoding in the craniocaudal direction for flow quantification, and one in the sagittal plane, with in-plane velocity encoding in the craniocaudal direction for qualitative assessment.

Results
Cerebrospinal fluid flow MRI can be used to discriminate between communicating hydrocephalus and noncommunicating hydrocephalus, to localize the level of obstruction in obstructive hydrocephalus, to determine whether arachnoid cysts communicate with the subarachnoid space, to differentiate between arachnoid cysts and subarachnoid space, to discriminate between syringomyelia and cystic myelomalacia, and to evaluate flow patterns of posterior fossa cystic malformations. This imaging method also can provide significant information in pre-operative evaluation of Chiari 1 malformation and normal pressure hydrocephalus and postoperative follow up of patients with endoscopic third ventriculostomy (ETV) (Figure 1) and ventriculoperitoneal (VP) shunt.

Conclusions
Phase contrast cine MR is a useful imaging technique in evaluating CSF dynamics that affects various disease processes. In evaluation, follow up, surgical decision and postoperative survey of these disease processes, PC cine MR can provide valuable additional information to conventional MRI. Cerebrospinal fluid pulsatility and stroke volume through the aqueduct has been correlated with a positive response to shunting in patients with normal pressure hydrocephalus. Cerebrospinal fluid flow studies can be used to differentiate posterior fossa cystic malformations from each other. It also has a role in assessing the functioning of surgical interventions. Finally, pulsatile CSF flow within a cystic cord lesion may help to discriminate a syrinx from myelomalacia.

KEYWORDS: Cerebrospinal Fluid, Flow, Phase Contrast Imaging
Purpose
To provide a neuroimaging review of pineal region tumors and correlation with neuropathological findings to assist the radiologist in developing an appropriate differential diagnosis.

Materials and Methods
A retrospective review of the pineal region tumor cases discussed during the previous 10 years of brain tumor board at our institution. Analysis of neuroimaging findings is correlated with the neuropathological findings from a variety of pineal region tumors.

Results
Pineal region tumors, including primary tumors and metastases, constitute 1% of all central nervous system (CNS) tumors. Primary pineal region tumors generally fall into two categories: Germ cell origin and Pineal cell origin. Neuroimaging (mostly brain MRI) for each category of pineal region tumor will be present along with pathologic correlation. The cases will include:
germinoma, pineocytoma, pineoblastoma, yolk sac tumor, astrocytoma, teratoma, papillary tumor, lymphoma and metastases. All of the cases have neuropathologic correlation.

Conclusions
This pictorial review of the neuroimaging for a variety of pineal region tumors should help familiarize the radiologist with the differential diagnosis for pineal region neoplasms and their respective imaging characteristics.

KEYWORDS: Pineal Cell Tumor, Pineal Gland

A) Sagittal T1W without Gadolinium and B) Axial T1W with Gadolinium. These images demonstrate a tumor of the pineal region which is isointense on the precontrast T1 weighted image and demonstrates ring contrast enhancement. This is an unusual appearance as this tumor is typically characterized by increased T1 signal intensity according to the literature.

Predicting the Spread of Glial Tumors: Insights from “Gliography” of the Cingulate
Purpose
After studying >1000 cases of cerebral hemispheric diffuse gliomas (grade II-IV), our group observed that based on the locations of brain tumors there is asymmetric growth shaped by the underlying anatomy. We call this process "gliography" where numerous cases are put together to identify the interlocking three-dimensional shapes which form the basis of glial tumor spread. This technique is used for cingulate gliomas to better understand the anatomy and connections to other areas.

Materials and Methods
Preoperative Mr images (MRIs) from 65 cingulate gliomas were assessed by neuradiologist consensus for shape and position of bulk tumor. Additional cases involving the callosum and "supra-cingulate" neocortical areas were studied to show the gliographic borders from the other side. Cingulate was divided into 4 parts (Figure 1): Anterior (Brodman area [BA] 24,32, and 33) Subgenual (BA 25), Posterior (BA 23 and 31), and Retrosplenial (BA 28-30).

Results
Traditionally the cingulate forms a "C" shape in the sagittal plane around the callosum. However, cingulate tumors often form a "C" shape in a coronal (radial) plane, extending superficial to the cingulate sulcus while being contained laterally by the "C" shaped medial callosal fibers. When callosal invasion does occur, it is at the lateral ventricular margin where subcallosal fibers and vessels perforate the callosum. Tumor growth can lead to herniation (with a pushing border) rather than invasion through callosum, especially at the callosal isthmus. Spread to the supra-cingulate, superficial "neocortex" occurs via callosal more than cingulate connections. Supplementary motor and primary visual cortex do not connect to the cingulate directly. In the sagittal plane, the rostral and caudal ends of the cingulate are not bound by callosal fibers, allowing subgenual and retrosplenial cingulate tumors to wrap around the callosum or spread laterally. Within the cingulate itself, tumors rarely spread under the plane of the paracentral gyrus to cross between anterior and posterior cingulate (BA 23 and 24).

Conclusions
These observations have important implications for neurosurgical and radiation therapy planning by knowing the most likely and unlikely sites for invasion. For instance, it is important to carefully inspect the callosum at the lateral ventricular margin as this is the likely location of callosal invasion and the most common way to spread to the medial neocortex. Similarly extension to the caudal aspects of the cingulate can predispose for more lateral cerebral extension or subependymal/CSF spread (Figure 2). By understanding these patterns, neurosurgical approach and radiation plans can be altered to minimize morbidity while improving mortality. Several specific examples will be given. Knowing the shape and location of cingulate tumors reveals the pertinent underlying anatomy, with important implications for therapeutic planning.

KEYWORDS: Functional Brain Mapping, Glioma, Limbic System
Primary CNS lymphoma: What the radiologist needs to know.

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Purpose
Primary central nervous system (CNS) lymphoma is the fourth most common primary CNS neoplasm and as such, its imaging findings are important for radiologists to know. Primary CNS lymphomas have wide ranging imaging features but also have characteristic imaging findings that help narrow the differential diagnosis and distinguish them from other masses. As the treatment for CNS lymphoma is nonsurgical, it is imperative that the neurosurgeon is aware that lymphoma is suspected so that the appropriate pre-operative counseling and planning can be performed. We aim to review both the common and atypical imaging features of primary CNS lymphoma.

Materials and Methods
The medical records, cross-sectional images and pathology reports were reviewed in patients with primary CNS lymphoma that were imaged at our institution over the past five years. The clinical presentation, and CT and MR imaging manifestations were reviewed retrospectively.

Results
Primary central nervous system lymphoma (PCNSL) is the fourth most common primary CNS neoplasm (following glioblastoma multiforme, meningioma and low grade CNS astrocytoma).
PCNSL is most frequently a diffuse large B cell lymphoma, composed of blue cells with a high nucleus to cytoplasm ratio packed tightly together in the perivascular (Virchow-Robin) spaces. This histology directly correlates with the classic imaging appearance of hyperdensity on noncontrast CT, hypointensity on T2-weighted images, and restricted diffusion on DWI. They also characteristically have solid enhancement and little mass effect for size of the lesions. There is a predilection for the periventricular region and if subependymal spread is present, lymphoma should be strongly suspected. In immunocompromised patients, the imaging appearance changes to reflect the increased incidence of necrosis, often appearing as ring-enhancing lesions. Multifocality is also more common in this patient population. Despite the typical imaging characteristics of primary CNS lymphoma, however, the radiologist also should be aware that hemorrhage, multifocality, and central necrosis can occur in immunocompetent patients.

Conclusions
Primary CNS lymphoma is not an uncommon primary brain neoplasm. It is important for the radiologist to be well versed in its typical and atypical imaging features so that the diagnosis can be suspected at presentation. We present a comprehensive review of the imaging features of primary CNS lymphoma that the radiologist needs to know.

KEYWORDS: Brain, Lymphoma, Primary CNS Neoplasms

Principles, Techniques and Clinical Applications of Phase Contrast MRI Cerebrospinal Fluid Imaging

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Purpose
1. To understand the principles of cerebrospinal fluid (CSF) flow dynamics. 2. To learn the technical aspects, challenges and limitations of CSF flow studies. 3. To discuss alterations in CSF hydrodynamics in disease and explore clinical applications of CSF flow dynamics with illustrated examples.

Materials and Methods
Methods/Content organization: Normal CSF flow dynamics. • Intracranial, • Spine, • Bulk flow versus pulsatile flow. Principles of phase contrast MR imaging. Technical parameters and challenges of PC MRI. Clinical applications: • Normal pressure hydrocephalus, • Chiari I malformation, • Syringomyelia, • Endoscopic third ventriculostomy. CSF flow results from the complex distribution of hydrostatic and dynamic pressure acting within the ventricles and intracranial venous and arterial system. The resulting CSF flow can be quantified in terms of: 1) "bulk" CSF flow that is driven by hydrostatic pressure acting between the ventricles and arachnoid granulations and 2) "pulsatile" CSF flow that is primarily driven by cerebral blood pulsations due to the cardiac cycle and also influenced by unsteady intrathoracic pressures due to respiration that act on the epidural venous plexus. 2D Phase Contrast MR imaging (PC MRI) is a robust technique in measuring CSF flow and is dependent on the detection of moving spins by alteration of transverse magnetization to the velocity of motion. Single slice 2-D sequences in the
axial and sagittal planes are a standard for evaluation of CSF, especially at the aqueduct and the foramen magnum. CSF flow measurements typically are carried out for 14-16 phases of the Cardiac cycle timed retrospectively to coincide with the RR interval. Velocity is encoded in one direction (1D) within the measurement plane (2D), with a typical velocity encoding value of 10 and 20 cm/s for CSF flow at the foramen magnum and aqueduct of Sylvius, respectively. Research has shown that CSF flow within a region of interest, such as at the foramen magnum, can be heterogeneous with relatively small concentrated regions of elevated CSF velocities termed “jets”. Recent advances in MRI imaging technology have enabled quantification of the CSF flow field in 3D with respect to time over a volume of interest in what is called “Time-resolved 4D phase contrast MR imaging”.

Results
Clinical application of PC MRI in CSF alterations in disease will be discussed in the exhibit. • Chiari 1 malformation: Research has been conducted to investigate abnormal CSF flow patterns associated with tonsillar descent in addition to typically used morphometric parameters, such as the degree of tonsillar descent, associated with this malformation. Measurement and analysis of CSF velocities and flow at the foramen magnum and aqueduct is an ongoing theme for research. The outcome of decompression surgery and the techniques of decompression surgery also are being correlated with pre-operative CSF flow measurements. • Syringomyelia: Formation and extension of spinal cord cavities, or syrinx, is a fascinating aspect of CSF hydrodynamics in the spinal canal. Demonstration of pulsatile flow within a syrinx helps in defining a cyst from myelomalacia. 4D PC MRI in the spinal subarachnoid space is the basis of new research to understand CSF flow in the vicinity of syringes. • Endoscopic Third Ventrilostomy. Determination of patent alternate CSF pathways following endoscopic third ventriculostomy for the treatment of acquired and congenital third ventricular obstruction is best done by observation of pulsatile CSF flow at the site of the ventriculostomy, created in the floor of the third ventricle. • Normal Pressure Hydrocephalus: The evaluation of the pattern of CSF flow curves in this condition is a challenge. Increased pulsatility at the aqueduct is thought to indicate better response to shunting in these patients.

Conclusions
Phase-contrast MR imaging of CSF flow is a versatile, noninvasive technique to assess the pathophysiology of CSF hydrodynamics in the brain and spinal cord. Understanding the physical principles behind the technique helps in the tailored assessment of disorders of CSF flow and the results of the procedures used to treat them.

KEYWORDS: Cerebrospinal Fluid, MR Imaging, Phase Contrast Imaging

Recent advances of MR imaging in relation to phylogenetic anatomy of the cerebellum in spinocerebellar ataxia

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Purpose
This presentation will review clinical presentations and imaging findings from conventional MR imaging (MRI) to advanced diffusion and volumetric imaging in relation to phylogenetic anatomy of the cerebellum among different types of spinocerebellar ataxia (SCA).

Materials and Methods
Spinocerebellar ataxia previously called hereditary spinocerebellar degeneration (SCD), is a progressive autosomal inherited disease that results in ataxia due to degeneration of the cerebellum, the brainstem, and the spine. Differential diagnosis is sporadic SCD such as multiple system atrophy, newly recognized as synucleinopathy, and cortical cerebellar atrophy. The main affected region is different depending on diseases or types of SCA. We will present imaging findings and symptoms of SCA in relation to phylogenetic anatomy which would help differential diagnosis of them.

Results
Spinocerebellar ataxia is an autosomal inherited disease associated with CAG repeat expansion. Thirty-six different types of SCA have been found. This study will describe the most common types including SCA1, 2, 3, 6, 8, and 31. The cerebellum has three regions derived from different phylogenetic origins (Fig. 1). They have connections with other regions of the brain and believed to have association with symptoms. The archicerebellum is the oldest region connected to the vestibular nuclei. The paleocerebellum have connections to the spine. The neocerebellum is the newest region and has cortico-ponto-cerebellar connections. MR imaging (MRI) is an excellent noninvasive tool to study SCA phylogenetic anatomy and to better understand the infratentorial neural networks involvement. We will discuss: (1) Pathogeneses of SCA; CAG repeat (polyglutamine expantion), RNA repeat, and conventional mutation (2) Conventional MRI and volumetric MRI findings among different types of SCA. (3) Advanced diffusion imaging including tractography and diffusion analysis.

Conclusions
This review would improve understanding of MR imaging in relation to phylogenetic anatomy of the cerebellum in SCA, a progressive neurodegenerative disease that is found to have increased number of diagnosis in recent years.

KEYWORDS: Cerebellum, Diffusion Tensor Image, Spinocerebellar Ataxia Type
Fig. 1 Phylogenetic anatomy of the cerebellum. The cerebellum has three regions derived from different origins, the archicerebellum, the paleocerebellum, and the neocerebellum.

Simple Breath-holding Task for Cerebrovascular Reactivity Scans in Clinical fMRI

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Purpose
Functional MR imaging (fMRI) is a powerful tool for presurgical mapping of cerebral language and motor activity. The technique is based on local augmentation of cerebrovascular perfusion in response to increased neuronal metabolism, creating a rise in blood oxygenation level dependent (BOLD) T2* signal. However, the link between neuronal activity and BOLD signal can be
severed by cerebral pathology that causes neurovascular uncoupling (NVU) or by local magnetic susceptibility artifact. To correctly interpret clinical fMRI studies, it is important to know if all brain regions are capable of vasoreactivity and free of signal-altering magnetic susceptibility. Simple breath-hold scans provide an excellent means to assess one's ability to detect BOLD signal throughout the brain. During breath holding, carbon dioxide buildup in the blood leads to a global increase in cerebral vasodilatation. Consequently, brain cortical regions that do not demonstrate elevated BOLD signal during a breath-hold task are concerning for sites of potential NVU or altered magnetic susceptibility. We have developed and report on a simple breath-holding fMRI task that allows for consistent mapping of cerebrovascular reactivity during clinical fMRI studies.

Materials and Methods
The visually presented block design task interleaves a series of six 21 second normal breathing periods, with five 21 second periods of breath holding. Patients are instructed to transition between the breathing and breath-holding blocks without taking abnormally deep inspirations. A respiratory belt monitors inspiratory movements to ensure patient compliance. Functional MRI is performed using an EPI/GRE technique with a TR/TE of 3000/25, flip angle 90, 20 cm x 20 cm FOV, 5 mm slice, and 64 x 64 matrix. For analysis, the first 21 sec period of normal breathing is discarded. The data can be processed with any number of statistical methods including simple t-test or correlation analysis. However, during statistical processing the lengthy hemodynamic lag between the onset of breath holding and the onset of cerebral vasodilatation must be accounted for in the statistical model design. BOLD signal peaks about 30 seconds after initiation of a 21 second breath hold, compared with a delay of about 6 seconds for a nonrespiratory stimulus.

Results
Normal patients demonstrate a global, uniform distribution of BOLD signal throughout the cortex with the exception of signal drop out near the skull base consequent to magnetic susceptibility from the petrous bones and sinuses. Some tumors and arteriovenous malformations may be associated with regions of absent or negative BOLD signal, indicating potential NVU (Figure 1). Similarly, cerebrovascular diseases can cause regions of absent or altered cerebral vasoreactivity. These cerebrovascular reactivity maps then can be used to assess for sites of potential false-negative BOLD activation during routine fMRI tasks.

Conclusions
Breath-hold tasks are a useful adjunct to any fMRI study given that they provide insight into the cerebrovascular substrate that influences the interpretation of routine fMRI tasks. The method described previously provides a simple means of introducing this technique into a clinical fMRI practice.

KEYWORDS: BOLD FMRI, FMRI, Postprocessing
Spectrum of Imaging Manifestations of Melanoma in the Central Nervous System
Purpose
Melanoma accounts for less than 5% of skin cancer cases, but the vast majority of skin cancer deaths. It is the only cancer among top seven whose incidence is increasing by 1.9% annually. The USA holds the third highest national rate for melanoma only after Australia and New Zealand. Because of aggressive nature it has widespread metastatic potential with central nervous system (CNS) being the fourth most common metastatic site after lymph node, lung and liver. It also accounts for the third most common metastasis to brain in U.S. after lung and breast. Despite its distinctive imaging features, the presentation of melanoma within the central nervous system is variegated and seemingly boundless. This exhibit will review the spectrum of imaging findings of both common and uncommon presentations of melanoma in the central nervous system, primary and metastatic.

Materials and Methods
Various presentations of central nervous system melanoma will be reviewed in a multimodality case-based format (CT, MRI and PET) with emphasis on advance imaging techniques. Cases will be grouped and presented according to anatomical location.

Results
Cases will include the following neuroimaging presentations of melanoma: Head: 1. Parenchymal. 2. Leptomeningeal/pachymeningeal. 3. Extracranial. Face and Neck: 1. Nodal. 2. Orbits. 3. Perineural spread. 4. Paranasal sinuses. 5. Spine: 1. Vertebral body metastasis. 2. Intramedullary. 3. Extramedullary intradural. Three different recognized MRI intensity patterns will be shown: 1. Melanotic. 2. Amelanotic. 3. Hemorrhagic. Histopathological and imaging correlation will be done for different types. A brief discussion will be made on mimics.

Conclusions
After reviewing this exhibit, radiologists will: 1. Identify the imaging findings of melanoma in the central nervous system on CT scans and MR images and provide a valid differential diagnosis using a pattern-based approach. 2. Recognize the appearance and locations of lesions in the spectrum of presentations of melanoma. 3. Integrate these concepts into practice through review of multiple representative cases. 4. Able to utilize the advanced imaging techniques in clinical practice.

KEYWORDS: Leptomeningeal Disease, Melanoma, Metastases
SUSCEPTIBILITY WEIGHTED IMAGING OF CEREBRAL SINUS THROMBOSIS

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Purpose
Imaging plays a dominant role in the diagnosis of cerebral sinus thrombosis. Yet, it is one of the well known conditions often overlooked on imaging. Generally, a combination of MR sequences is utilized to diagnose cerebral sinus thrombosis. Susceptibility-weighted imaging (SWI) is a 3D high resolution gradient sequence with higher sensitivity to detect clot in vessels and hemorrhage in the brain and cerebrospinal fluid (CSF) spaces. Familiarity with the imaging features of cerebral sinus thrombosis on SWI sequence can help improve the diagnosis of this condition.

Materials and Methods
Imaging anatomy of the venous system and variants will be used to understand the imaging features of cerebral sinus thrombosis. A basic physics of susceptibility-weighted imaging will be highlighted to enhance the understanding of the appearance of normal brain and venous signals. The pathophysiology of cerebral sinus thrombosis will be discussed. Relevant clinical cases will be used to emphasize the imaging features of cerebral sinus thrombosis in various locations and the associated secondary changes including venous collaterals and hemorrhagic changes in the brain and sulci.

Results
Cerebral sinus thrombosis in acute stage contains deoxyhemoglobin and can be identified with higher sensitivity on susceptibility-weighted imaging in the cerebral sinuses. The cortical veins with clot will show blooming effect and tend to appear larger in caliber than normal cerebral veins. Further, the collateral venous channels can be recognized on SWI. Underlying parenchymal changes particularly the hemorrhagic venous infarct can be identified with higher sensitivity and attention to the distribution of these parenchymal changes can aid the diagnosis and management of cerebral sinus thrombosis. Also, secondary changes in the CSF spaces such as subarachnoid hemorrhage can be identified with higher sensitivity with susceptibility-weighted imaging.

Conclusions
A review of the exhibit will help one to understand the physics of susceptibility-weighted imaging and its utility in the diagnosis and management of cerebral sinus thrombosis.

KEYWORDS: Susceptibility-Weighted Imaging, Venous Sinus Thrombosis

Thalamo-amygdala and subthalamo-amygdala connections of the human brain using high resolution diffusion tensor tractography on 3T.
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Purpose

Hippocampal-hypothalamic pathway is part of stria terminalis and limbic system of the human brain which play an important role in emotion, behavior and long-term memory. Lack of adequate neuroimaging sensitivity and spatial resolution, so far, impeded depiction of small limbic structures such as hippocampal-hypothalamic and fornix trajectories within the human brain. The purpose of the current study is to demonstrate the feasibility of parcellation and quantification of different limbic structures (fornix, cingulum, stria terminalis) in relation to the gray matter nuclei (amygdala, hippocampus, and hypothalamus) using fiber tractography by deterministic approach and high spatial resolution diffusion tensor imaging (DTI) data on 3 T.

Materials and Methods

Subjects: Five healthy men (age range 24-37 years) were studied and written informed consent was obtained from all subjects. Conventional and DT-MRI Acquisition: Data were acquired using a Philips 3.0 T Intera system using a SENSE receive head coil. Diffusion-weighted image (DWI) data were acquired axially using single-shot multi-slice 2-D spin-echo diffusion with the balanced Icosa21 tensor encoding scheme. The $b$-factor = 500 sec mm$^{-2}$, TR/TE = 14460/60 msec, FOV = 256 mm x 256 mm and slice thickness / gap / #slices = 1 mm/0 mm/120. The EPI phase encoding used a SENSE k-space undersampling factor of two, with an effective k-space matrix of 112x112 and an image matrix after zero-filling of 256x256. Fiber Tracking: We used the FACT algorithm (DTIStudio) to reconstruct limbic structure fiber tracts with a fractional anisotropy (FA) threshold of 0.22 and angle threshold of 60 degrees.

Results

To our knowledge, the current study is the first to present the whole limbic structures using high spatial resolution DTI measurements on 3 T. The fornix and hippocampal-hypothalamic tracts are clearly distinguishable in relation to the amygdala, hypothalamus, and hippocampus nuclei. Using high spatial resolution specially reduced slice thickness (1mm) in this study reduced the partial volume effect as well as incoherence due to the fiber intercrossings within each voxel and we were able to reconstruct and show even the small limbic trajectories such as hippocampal-hypothalamic and the whole fornix structures using deterministic approach. In our experiment the high resolution DTI method increased the detectable anisotropy within the gray matter structures and helped to trace the thin white matter fibers passing through the hippocampus and hypothalamus nuclei.

Conclusions

In this report we demonstrate for the first time, in vivo 3D reconstruction of the major limbic circuits using high resolution diffusion tensor tractography on 3 T.

KEYWORDS: Brain Mapping, Diffusion Tensor Image
The application of 18 F FDG PET in the diagnosis of Alzheimer disease: A practical guide for the neuroradiologist.

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Purpose
The purpose of this poster is to illustrate the imaging appearances of Alzheimer disease (AD) and other common dementias on FDG PET so that they may be recognized and differentiated from one another by a neuroradiologist in practice.

Materials and Methods
The current literature in AD will be reviewed with regard to the accuracy of clinical diagnosis and the utility of FDG PET in identifying patients with AD. Examples from our own practice will be used to illustrate the different patterns that are seen on FDG PET in AD and the other common dementias including dementia with Lewy bodies, frontotemporal dementia and corticobasilar degeneration with MR correlation where applicable.
Results
Alzheimer disease (AD) is the fourth leading cause of death in persons over 65 years of age and is characterized by a progressive decline in memory. Apraxia, agnosia and aphasia are also features. Clinical diagnosis of AD often is made using scoring systems such as the National Institute of Neurologic and Communicative Disorders and Stroke-Alzheimer Disease and Related Disorders Association criteria. In patients with 'probable' AD based on clinical scoring systems the sensitivity has been reported to be 80% but with a specificity of 70%. In those labelled 'possible' AD the sensitivity was 93% but the specificity was 48%. Thus, the clinical diagnosis of AD is an imperfect tool. Functional imaging of the brain shows great promise with marked reduction in brain glucose utilization in specific regions of the brain noted in patients with AD using FDG PET. A recent metaanalysis has reported the overall accuracy of FDG PET in differentiating AD from healthy subjects at 93% with sensitivity 96% and specificity of 90% (Figure 1). Figure 1 Axial (A) and sagittal (B) FDG PET from a 57-year-old male with progressive cognitive decline shows reduced FDG uptake within the parietal lobes bilaterally (A) and throughout the temporal lobes (B, right side shown) with sparing of the frontal and occipital lobes. This pattern is typical of AD.

Conclusions
FDG PET is a useful imaging tool for the identification of AD in patients with cognitive decline and for the differentiation of AD from other neurodegenerative disorders.

KEYWORDS: PET/CT
The Faces of CNS Lymphoma

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Purpose
Central nervous system lymphoma (CNSL) presents a diagnostic challenge to both radiologist and clinicians, as its imaging appearance and symptoms often are nonspecific. On imaging, it is often difficult to distinguish CNSL from a variety of infectious, demyelinating, and other neoplastic entities. Also, its variable appearance is further complicated by such factors as the patient's recent treatment (e.g., steroid) and immunocompetence. This can leave the radiologist unsure of when to appropriately include CNSL in the differential diagnosis, and can potentially lead to delays in work up, diagnosis, and treatment. This electronic educational exhibit provides an overview of the typical and various atypical presentations of CNSL. Additionally, it includes an interactive quiz that emphasizes key imaging findings which can aid in distinguishing CNSL from its common mimics. The goal is to improve the viewer's understanding of the highly variable appearance of CNSL, and to assist them in including this entity in a concise differential diagnosis when appropriate.

Materials and Methods
Images from biopsy proven cases of CNSL are identified by retrospective case review of a large tertiary referral center and its network hospitals. Of these, cases are selected that represent the breadth of appearance of CNSL in both immunocompromised and immunocompetent patients. From these cases, a PowerPoint presentation is generated that provides a pictorial review of both the typical and atypical appearances of CNSL, in addition to other CNS lymphoproliferative disorders such as posttransplant lymphoproliferative disorder. Additionally, comparison cases of disease entities that closely resemble CNSL are included for the interactive quiz.

Results
After viewing this presentation, the viewer will have greater familiarity with the various presentations of CNSL, and of the imaging features that can aid in distinguishing it from common mimics. The viewer will also have greater ability to appropriately include or disclude CNSL in the differential diagnosis when imaging findings are nonspecific.

Conclusions
Central nervous system lymphoma is diagnostically challenging. By reviewing this exhibit, the viewers will become more familiar with its "classic" and other potential appearances. The goal is to assist the viewers in including CNSL in a concise differential diagnosis when appropriate.

KEYWORDS: CNS Lymphoma

The Human Connectome Project and the Promise of High B-value Imaging

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¹ 6:30AM - 9:00PM
Purpose
The purpose of this education exhibit is: - To increase radiologists' understanding of the Human Connectome Project (HCP) and associated technical advances. - To describe current research applications of high b-value imaging techniques. - To explore the role of high b-value imaging with the HCP. - To review potential future clinical and research applications of high b-value diffusion imaging.

Materials and Methods
The objectives of the HCP, as well as the current progress and associated technological advances will be reviewed. High b-value diffusion imaging and its role in the HCP will be described. Representative images obtained with high b-values will be shown to illustrate the advantages of this technique. The current clinical and research applications, future prospects, and limitations of high b-value imaging will be discussed.

Results
The HCP intends to map the complete structural and functional neural connections of the human brain in vivo. With data from 1200 healthy individuals, comprehensive structural connection data sets will be created to enhance the understanding of neuronal connections and the relationship between structural and functional connectivity. In the future, this information will serve as a model to study the evolution and disease of connectomes. With the primary goal of optimizing the available technology to enhance the HCP, great advances in imaging and research technology have been attained. One of the most significant advances is that of high b-value diffusion imaging (>1900 s/mm2). The higher the b-value, the stronger the diffusion weighting and the greater the tissue contrast will be. This increased sensitivity also permits exceptional neuroanatomical resolution of white matter tracts, which is crucial for mapping structural connectivity. Although primarily envisioned for the HCP, high b-value diffusion imaging also could be applied to traumatic brain injury, vascular disorders, epilepsy and inflammatory brain disorders, among others.

Conclusions
The HCP is a collaborative study which aims to map the structural and functional connectivity of the human brain, and will serve as the structural basis for the study of brain function in health and disease. Numerous technological advances have arisen from the project. High b-value diffusion imaging allows depiction of neuroanatomical structures with exceptional resolution, which is critical for the HCP. The applications of high b-value imaging, however, go far beyond the HCP and appear promising in other fields such as trauma, epilepsy and vascular disease.

KEYWORDS: Advanced MR Imaging, Diffusion MR Imaging, Fiber Tracking
Title: The diagnostic challenge of diffuse axonal and cerebral fat embolic injuries: overlapping imaging findings and features.

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Purpose
Diffuse axonal injury (DAI) and cerebral fat emboli (CFE) syndrome often demonstrate overlapping imaging findings by MR imaging (MRI) including restricted diffusion and/or foci of susceptibility signal. The purpose of this exhibit is to compare and contrast the varying imaging features of DAI and CFE and highlight the differentiating features.
Materials and Methods
We retrospectively reviewed all MRI studies at our institution for the last two years where DAI and/or CFE were diagnosed.

Results
Diffuse axonal injury and CFE can have overlapping imaging findings including restricted diffusion and foci of susceptibility signal. While restricted diffusion in the setting of DAI characteristically involves the gray/white matter junction and that of CFE tends to involve the white matter either in a confluent or "starfield" pattern, we note that involvement of the corpus callosum can make this differentiation difficult, given that shear injury along the falx and early cytotoxic edema in CFE both present in this location. Foci of susceptibility signal can help differentiate these entities if there is a clear pattern of gray/white matter or white matter involvement thereby indicating DAI or CFE respectively. However, the differentiation can be particularly difficult when susceptibility signal is not present in a patient presenting with long bone fracture and other traumatic brain injuries. In addition, these two entities are not mutually exclusive and can be found in the same patient. We found the clinical presentation to be important discriminator given that patients with DAI are obtunded at initial presentation whereas CFE patients often develop neurologic symptoms after admission.

Conclusions
Diffuse axonal injury and cerebral fat embolism syndrome can demonstrate overlapping imaging features in severely traumatized patients. The various patterns of DAI and CFE and their overlap will be reviewed.

KEYWORDS: Cerebral Infarction, Diffuse Axonal Injury, Emboli

eEdE-62

Trapped in a Tunnel!! - MR Neurography Technique and Imaging Approach to Peripheral Nerve Entrapment

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Purpose
Most peripheral nerves pass through anatomically confined fibro-osseous and fibro-muscular tunnels along their course. At these sites the nerves are particularly susceptible to entrapment and compressive neuropathy. Peripheral nerve entrapment syndromes are characterized by distinct motor and sensory neuropathy; however, on many occasion the clinical and electrophysiological findings are inconclusive. High resolution MR neurography (MRN) is an excellent adjuvant tool that allows for accurate anatomical localization of the entrapment site and assessment of the underlying cause of neuropathy. We will illustrate MRN technique, MR imaging anatomy of the common sites of nerve entrapment and the MRN appearances of nerve entrapment in various upper and lower extremity fibro-osseous and fibro-muscular tunnels.

Materials and Methods
Our presentation will be a didactic electronic exhibit that will include an introductory section on MRN technique, followed by a discussion of the pathophysiology of nerve entrapment syndrome, an overview of direct and indirect MR imaging features of entrapment neuropathy,
and finally MRN cases demonstrating common upper and lower extremity sites of entrapment neuropathy.

Results
The MRN images will illustrate common anatomical sites of nerve compression in upper and lower extremity, such as radial tunnel, cubital tunnel, Guyon's canal, carpal tunnel, peroneal tunnel, tarsal tunnel. We will demonstrate MRN characteristics of the entrapped nerve as well as the secondary denervation changes in specific group of muscles that are useful in identifying and localizing peripheral nerve lesions.

Conclusions
The teaching point of the exhibit is to demonstrate how the understanding of imaging anatomy of common fibro-osseous and fibro-muscular upper and lower extremity tunnels along with knowledge of the normal and abnormal appearances of the peripheral nerves on MRN enables accurate diagnosis of entrapment neuropathy.

KEYWORDS: MR Neurography, Neurography

eEdE-70

Traumatic Brain Injury (TBI) Re-visited: A Pictorial Review

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Purpose
Traumatic brain injuries (TBIs) are a very common cause of hospital admission following trauma, and are associated with significant long-term morbidity and mortality. Every year, at least 1.7 million TBIs occur either as an isolated injury or along with other injuries. In addition, TBI contributes as much as a third (30.5%) of all injury-related deaths in the United States. This educational exhibit will review the pathophysiology, mechanism of injury (MOI), characteristic imaging findings, management strategies and classic signs of traumatic brain injuries by examining computed tomography (CT) and MR imaging (MRI) findings in patients at our institution. We also will provide a review of the indications for radiological evaluation and the most common associated complications of brain trauma.

Materials and Methods
We extracted all CT and MR images from PACS station with relevant clinical information extracted from our MEDITECH\textsuperscript{TM} integrated healthcare system at Puerto Rico's Trauma Center. Images were retrieved for recent brain imaging studies to review a wide spectrum of the major intracranial pathologies found in patients admitted for trauma.

Results
In this educational exhibit we intend to review a wide range of intracranial pathologies encountered in brain trauma patients at our institution to include, but not limited to: subarachnoid hemorrhage, diffuse axonal injury, epidural hematoma, subdural hematoma, contusion, intraventricular hemorrhage, penetrating brain injury, depressed fractures, microhemorrhages, etc. Secondary effects of TBI also will be presented. Particular attention was paid to noncontrast
head CT and MRI findings as this is usually the most appropriate study in this setting. Discussion of pathophysiology, MOI, classic signs, management, common complications and characteristic imaging findings with pertinent radiological illustrations will provide adequate exposure to the most commonly encountered and some less common scenarios in TBI. Conclusions

TBIs are a very common cause of hospital admission following trauma, and are associated with significant long-term morbidity and mortality. Reviewing the pathophysiology, MOI, classic signs, management, common complications, indications for radiological evaluation and characteristic imaging findings of TBIs will help improve the outcome of patients presenting with acute head trauma.

KEYWORDS: Brain, Brain Hemorrhage, Brain Trauma

Uncommon and Unusual Lesions of the Pineal Region

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1University of Miami Miller School of Medicine, Miami, FL, 2Jackson Memorial Hospital/University of Miami, Miami, FL, 3Jackson Memorial Hospital/University of Miami Miller School of Medicine, Miami, FL

Purpose

- Discuss the differential diagnosis of lesions in the pineal region focusing on uncommon and unusual masses encountered in this region.
- Describe the salient imaging findings of uncommon pineal region lesions.
- Review the literature in regard to CT and MR imaging (MRI) findings associated with the pineal region masses discussed.

Materials and Methods

A retrospective review of pineal region lesions in adults and children in our institution was performed, spanning a time range of approximately 10 years. Their respective pathologies were ascertained and catalogued. Finally, the associated CT and MRI imaging findings were reviewed and compared with those previously described in the literature in each instance.

Results

Lesions of the pineal region include a diverse variety of histologies and vary widely in behavior, from the benign, such as pineal cysts to the highly malignant, like the pineoblastoma. The most common of these are the germ cell tumors, in particular the germinomas which typically present as a solid or partially cystic mass, with central calcifications, avid enhancement and, in some cases, restricted diffusion. Teratomas also are commonly encountered and classically demonstrate foci of fat, calcifications, cystic areas as well as avid enhancement of the soft tissue components. The neoplasms arising from the pineal parenchyma are seen less frequently and include the low-grade pineocytoma, pineal parenchymal tumor of indeterminate differentiation, and the pineoblastoma. It is impossible to differentiate theses masses solely based on imaging due to the significant overlap of their findings. Nonetheless, they typically are noted to contain peripheral calcifications giving the gland an "exploded" appearance. Uncommon lesions also are encountered in the pineal region such as the papillary tumor of the pineal region, a rare neuroepithelial neoplasm without a histologic grading criterion, likely due to its rarity. Other rare
lesions such as arachnoid cysts, trilateral retinoblastomas, and atypical teratoid-rhabdoid tumors also may be encountered and should be kept in mind. In addition, neoplasms also may arise from the structures in the vicinity of the pineal gland, such as tectal gliomas and pilocytic astrocytomas, and may thus mimic pineal gland masses. Furthermore, metastases to the pineal gland are seen in up to 5% of patients referred for surgical management. Therefore, due to the variety of lesions that can be encountered in the pineal region, it is important for the radiologist to be cognizant about the common and uncommon etiologies of these lesions and their imaging characteristics in order to optimize patient management and avoid unnecessary interventions.

Conclusions
The exhibit demonstrates the imaging characteristics of lesions in the pineal region with special emphasis on uncommon and unusual masses which may be encountered. It is clear that the possible etiologies are numerous and their imaging characteristics often overlap. In addition, lesions in the vicinity of the pineal gland also may mimic pineal gland masses further confounding the differential diagnosis. Therefore it is important to possess a working familiarity with these entities since it can greatly inform the appropriate subsequent management of the patient and even help prevent unnecessary procedures in certain cases.

KEYWORDS: Pineal Gland
Sagittal contrast enhanced T1 weighted MR image of a 12 y/o male patient who presented with recurrent headaches and visual disturbances, demonstrates an enhancing large lobulated pineal region mass which is encasing the interthalan cerebral veins and demonstrates isointense signal on T1 and FLAIR and associated mild restricted diffusion (not shown). Pathology confirmed that this was a metastatic rhabdomyosarcoma.
Vascular Causes of Ischemic Stroke in the Young Adult: A Pictorial Review

D Boulter¹, P Schaefer¹
¹Massachusetts General Hospital, Harvard Medical School, Boston, MA

Purpose
1. To review the arterial causes of ischemic stroke in young adults. 2. To discuss clinical and radiological features that help narrow the differential diagnosis. 3. To present representative stroke cases which highlight the range of vascular etiologies.

Materials and Methods
A search of the electronic medical record identified cases of ischemic stroke in young adult patients that best demonstrate the range of vascular etiologies and associated imaging findings. Representative cases are presented in an educational format with an emphasis on differentiating clinical and radiographic features.

Results
Approximately 15% of strokes occur in adults under the age of 45. Ischemic stroke etiology in the young is heterogeneous, with higher frequency of causes that are uncommon in the general adult population. Nonatherosclerotic arteriopathies are collectively among the most common causes of ischemic stroke in young adult patients. These can be subdivided into cerebral artery dissections, reversible cerebral vasoconstriction syndromes, moyamoya disease and syndrome, illicit drug abuse, radiation-induced arteriopathy, infectious arteritis, inflammatory or immunologic vasculitis, and genetic or inherited vasculopathies. Many of these disorders have characteristic patterns of arterial involvement and stroke topologies that can help narrow the differential diagnosis.

Conclusions
Nonatherosclerotic arteriopathies are a more frequent cause of ischemic stroke in young adults relative to the general adult population. Although a heterogeneous group of disorders, the correct diagnosis often can be suggested on imaging by considering the stroke topology and pattern of vascular involvement.

KEYWORDS: Arteriopathy, Stroke

Vascular diseases of the head and neck for the non-interventional Neuroradiologist.

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¹UTMB Health, Galveston, TX, ²Ludvik Maximillian Universitat, Munich, Germany

Purpose
Vascular pathology is initiated at the vessel wall. Stroke is the main clinical outcome of all vascular illnesses in the central nervous system. Stenosis is the end-stage finding and can be
evaluated easily using angiographic methods. However, such luminographic methods often are insufficient to identify or differentiate vascular diseases. This exhibit will review the supra-aortic arteriopathies with an emphasis on the use of black blood MR imaging (MRI) for vessel wall imaging.

Materials and Methods


Results

Traditional noninvasive luminographic methods such as CTA and conventional MRA are optimized to demonstrate the vessel lumen and try to copy digital subtraction angiography results. Newer methods such as black blood imaging permit imaging and visualization of the vessel wall allowing further characterization of disease processes affecting vessels. Two major breakthroughs in this area include the ability to characterize atherosclerotic plaque in the carotid bulb and the ability to differentiate inflammatory from noninflammatory causes of vessel stenosis in the remaining of the circulation by evaluation of contrast enhancement. Future developments likely will be targeted at the evaluation of nonstenotic vascular disease which may permit earlier diagnosis and higher resolution which will permit the study of smaller, more distal vascular beds.

Conclusions

The objective of this exhibit is to improve the noninterventional neuroradiologist's understanding of arteriopathies affecting the supra-aortic vessels with emphasis on the use of black blood MRI to assess vessel wall composition and enhancement.

KEYWORDS: Black-Blood Technique, Black-Blood Vessel Wall

eEdE-06

What you need to know to go with the flow: A primer on MR perfusion

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Purpose

1. To describe the technical aspects, postprocessing techniques and challenges of MR perfusion imaging. 2. To present clinical examples of application of MR perfusion imaging in stroke, brain tumors and head and neck cancer.

Materials and Methods

• Principle of MR perfusion. • Technical aspects and challenges of MR perfusion: o Dynamic susceptibility contrast, o Dynamic contrast-enhanced, o Arterial spin labeling. • Clinical applications: Acute ischemic stroke, Brain tumors. o Identification of optimal site for biopsy. o Differentiation of radiation necrosis from recurrent brain tumor. o Identification of pseudoprogression and pseudoresponse. o Grading of brain tumors. • Head and neck cancer: o
Differentiation of malignant from nonmalignant lesions. o Differentiation of recurrent tumors from post-therapy changes. o Monitoring and prediction of response to therapy.

Results
MR perfusion is being employed increasingly across various institutions, especially in the setting of acute ischemic stroke and evaluation of brain tumors. A thorough understanding of the principles of MR perfusion as well as the differences and similarities between the different techniques of acquiring MR perfusion data is essential for proper integration of perfusion data into the clinical context. In this exhibit, we discuss the technical aspects, challenges and clinical application in brain, and head and neck imaging. We will elaborate on each clinical application and present illustrated examples to emphasize the concept.

Conclusions
The radiologist should be aware of the benefits, challenges and limitations of MR perfusion imaging in order to incorporate pertinent information into their clinical interpretation and provide a comprehensive evaluation.

KEYWORDS: MR Perfusion-Weighted Imaging
What’s DaTscan all about?: Review of Ioflupane I-123 DaTscan Brain Imaging.

W Altmeyer¹, D Metter¹, A Schneider¹, B Winegar¹, A Singh¹

¹University of Texas Health Science Center at San Antonio, San Antonio, TX
Purpose
Purpose: - Review ioflupane I-123 (DaTscan) SPECT brain imaging technique. - Discuss current clinical application and utility of DaTscan imaging. - Illustrate DaTscan interpretation method.

Materials and Methods
The educational exhibit starts with a discussion of pertinent basal ganglia anatomy and physiology with an emphasis on the coordination of body movement. Normal and pathologic dopamine physiology will be reviewed. We will discuss the biodistribution of the radiopharmaceutical ioflupane I-123 and basics of DaTscan SPECT brain imaging technique. Finally, the educational exhibit will explain Ioflupane I-123 scintigraphy interpretation method and the role of imaging in the diagnosis of Parkinsonian syndromes. The exhibit will utilize clinical vignettes with examples of both normal and abnormal ioflupane I-123 scintigraphy to help emphasis the clinical utility of scintigraphy in the evaluation of movement disorders.

Results
Ioflupane I-123 (DaTscan) brain imaging is an emerging technology for the imaging of movement disorders. FDA approval for ioflupane I-123 scintigraphy was obtained in early 2011. Often, it can be difficult for clinicians to diagnosis the etiology of tremor, particularly early in the course of the disease. Ioflupane I-123 can be helpful in differentiating Parkinson's disease from other causes of movement disorder (especially essential tremor).

Conclusions
Our educational goal is to provide a concise and informative review of Ioflupane I-123 (DaTscan) imaging technique, clinical application and interpretation with imaging correlation.

KEYWORDS: Neurodegenerative, Parkinson Disease

(Filename: TCT_eEdE-74_essentialtremor.JPG)

eEdE-37

Where's the Stroke? What's the Deficit?
Purpose
To demonstrate functional brain anatomy and deficit localization through cross-sectional imaging of stroke, using an interactive quiz and discussion format.

Materials and Methods
An interactive quiz and discussion format is used to teach localization of brain deficits, reinforced by two complementary approaches. In part 1, CT brain studies with difficult to visualize strokes are presented for review, followed by clinical descriptions of associated neurological deficits. Multiple questions provide choices for the location of vascular insults, followed by MRI confirmation and discussion of relevant brain functions and dysfunctions. In part 2, the clearly visible locations of strokes at CT and/or MRI are presented. Multiple questions provide choices of expected neurological deficits based on stroke location, followed by discussions of relevant brain functions and dysfunctions.

Results
With development of the electronic medical record, neuroradiologists now more than ever have access to clinical deficits associated with stroke. Consequently, an understanding of stroke deficits and associated locations within the brain can be reinforced day-to-day in clinical practice. Studying deficits associated with localized strokes of gray and white matter structures can provide significant insights into brain function and dysfunction. The interactive quiz and discussion presented here bridges educational and clinical aspects of brain imaging. The exhibit seeks to educate neuroradiologists to the locations of neurological brain deficits, and while doing so reinforce an understanding of normal brain functions and dysfunctions. The educational approach also should help to improve search patterns for detecting subacute strokes when interpreting CT brain imaging. Moreover, the knowledge gained from the exhibit will provide a more sophisticated understanding of deficits associated with other brain diseases, as well as discussions with referring clinicians.

Conclusions
A thorough understanding of deficit location within the brain can improve search patterns, provide more sophisticated understanding of brain diseases, and promote more effective communication with referring clinicians. Such an understanding is within the domain of neuroradiology, and once learned can be reinforced in daily practice.

KEYWORDS: Anatomy, Functional Networks, Stroke

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Education Exhibits (eEdE) - Anatomy
eEdE-94

"Little Brain": Evaluation of Sporadic Cerebellar Atrophy

D Pechersky¹, D Reede², W Smoker³, J Nath¹
Purpose
1. Review the function and normal anatomy (gross and imaging) of the cerebellum. 2. Learn the sporadic causes of cerebellar atrophy and their clinical manifestations. 3. Discuss etiologies based on the location of findings in the cerebellum and other associated imaging findings.

Materials and Methods
Cerebellar atrophy often is encountered on imaging incidentally or in the evaluation of ataxia. After a discussion of the normal anatomy and function of the cerebellum, cases are presented in a quiz format. Common sporadic causes of cerebellar atrophy, as well as their relevant clinical histories are discussed. Etiologies include alcoholic degeneration, toxicity from medications, paraneoplasia, multiple system atrophy-cerebellar predominant (MSA-C), and age-related atrophy. Cases are organized based on the location of cerebellar atrophy (focal versus global) and presence of additional associated imaging findings (brainstem, cerebral hemisphere, basal ganglia, and calvarium).

Results
The cerebellum ("little brain" in Latin) plays an important role in movement and motor coordination. Special attention to this region is required in the work-up of ataxia. Familiarity with different atrophy patterns, associated imaging features and clinical findings can aid in the development of an appropriate differential diagnosis.

Conclusions
Cerebellar atrophy may be an incidental finding or clinically suspected. An algorithm is provided using atrophy patterns, clinical presentation, and other associated imaging findings to aid in determining the etiology of cerebellar atrophy.

KEYWORDS: Alcohol, Cerebellum, Drugs
Phenytoin

Axial and sagittal T1-weighted images demonstrate global cerebellar atrophy, as demonstrated by enlargement of the fourth ventricle, interfolial spaces and supracistern. There is no significant involvement of the brainstem or cerebellar hemisphere. Additional finding of bone marrow expansion is noted (white arrow).


J Nair¹, J Chankowsky², C Torres², R del carpio³
¹McGill University Health Centre, Montreal, Quebec, Canada, ²Montreal General Hospital, McGill University Health Centre, Montreal, Quebec, Canada, ³Montreal General Hospital, McGill University Health Centre, Montreal, Quebec
Purpose
To highlight rare but increasingly recognized causes of neck pain, backache and progressive myelopathy of the spinal cord commonly misinterpreted due to ignorance of the entities. To review the characteristic CT/ MRI findings and salient features which should raise suspicion on imaging.

Materials and Methods
PACS search will be undertaken to identify selected cases. Using an interactive model, representative images and multiple choice questions an attempt will be made to familiarize with the not so frequent but important spinal lesions/pathologies on imaging.

Results
We shall use a case-based approach focused on clinical impression, CT and MR imaging (MRI) to discuss unusual cases like calcific tendinitis of the longus colli muscle, Spontaneous spinal cord herniation, Hirayama disease, extramedullary hematopoiesis, epidural hematoma and Guillain-Barre syndrome (amongst others). Salient features of two of the pathologies are described below: 1) Spontaneous spinal cord herniation: Mainly, thoracic spinal cord dural defect (congenital/acquired), Prolonged CSF pulsations cause the herniation, Unusual case of progressive myelopathy, Arachnoid cysts associated. 2) Guillain-Barre syndrome: Thickening of spinal nerve roots along the length of the cauda equina. Enhancement of anterior spinal nerve roots on postcontrast study (posterior roots also may be involved), Cranial nerve involvement-Children. Most common abnormal findings: Laboratory findings, Elevated CSF protein level without cells (pleocytosis), Electrophysiological findings, Nerve conduction slowing.

Conclusions
Knowledge of the characteristic imaging findings of these uncommon spinal abnormalities would help in early and correct diagnosis allowing prompt treatment. Ignorance to these entities re-emphasis the fact "The Eyes See Only What The Mind Knows".

KEYWORDS: Cord

3D Interactive and Stereotactic Atlas of the Skull Base Region: Bone, Vessels, Cranial Nerves, and Head Muscles

W Nowinski¹, B Chua¹, S Hnin Wut Yi¹, G Qian¹, T Shoon Let Thaung¹, Y Yang¹, N Nowinska¹, R Chrzan², A Urbanik²
¹ASTAR, Singapore, Singapore, ²Jagiellonian University, Cracow, Poland

Purpose
The skull base region is anatomically complex. Our objective is to construct a three-dimensional (3D), interactive, stereotactic, detailed and parcellated atlas of the skull base region correlated spatially with the existing brain atlas which comprises structure, vasculature, cranial nerves and head muscles, among others. This atlas allows the user to explore any region of interest along with its surroundings with just a few clicks.

Materials and Methods
We had previously developed a 3D brain atlas (1) from 3/7 T multiple in vivo scans (MPRAGE,
TOF, SPGR and SWI) of a single brain specimen with a virtual cerebral model containing structure (2), vasculature (3) (presented at ASNR 2009), cranial nerves and nuclei (4), and muscles (5). A high resolution spiral CT scan (526 slices of 0.75 mm thickness, 0.5 mm increment; 512 x512 matrix) of the same specimen was acquired. The skull and vertebrae were segmented, parcellated, reconstructed in 3D, and spatially registered with the cerebral model. A user friendly and efficient application was developed with functions for structure selection (brain, neck and/or head compositing and decompositing), spatial manipulation (rotate, zoom, pan and set view), identification (3D labeling and component highlighting), context exposure (3D virtual model cutting and MR triplanar display), quantification (distance measurement and stereotactic coordinates) and presentation (image saving).

Results
This atlas is rich in content (about 2,400 components) with all 3D structures labeled with names and, in addition, diameters for the vessels. It also provides powerful tools for studying and understanding the skull base and surrounding anatomy. A real-time manipulation with rotate, zoom, pan, set view and 3D cut facilitates a user-friendly exploration of the anatomy with a few clicks. A cutting plane technique along with texture mapping allows combining surface and sectional anatomy. Measurement of 3D distances and stereotactic coordinates enable quantitative analysis.

Conclusions
This novel atlas is valuable to medical students and residents to easily get familiarized with the skull base and surrounding anatomy with a few clicks. The atlas also is helpful to educators to prepare teaching materials. It may potentially serve as a reference aid in the reading room.

KEYWORDS: Brain, Cranial Nerves, Skull

A Method to Detect M2 Branch Occlusion Using Axial Time-of-Flight Source Images – The Empty Dot Sign

J Lee1, B Yoo1, N Salamon1
1David Geffen School of Medicine at University of California Los Angeles, Los Angeles, CA

Purpose
Time-of-flight (TOF) MR angiography commonly is used to detect thrombotic occlusion of the Circle of Willis in the setting of acute stroke. Proximal occlusions of the M1 segment of the middle cerebral artery (MCA) are detected readily by rotational 3-D maximal intensity projection (MIP) images. However, detection of distal M2 branch occlusions can be both subtle and challenging. The aim of this study is to review M2 branch anatomy. There will be a specific focus on the M2 anatomy within the Sylvian fissure, and we will illustrate a novel technique that quickly and accurately identifies the common M2 branches using axial TOF MRA source images to assess for thrombotic occlusion (“the empty dot sign”).

Materials and Methods
A multimodal, pictorial review of M2 branch anatomy will be performed, illustrating the 12 major M2 branches supplying the MCA territory. The territories supplied by each M2 branch will be depicted and specific anatomical landmarks and associated clinical deficits for each
territory will be displayed. A particular focus will be placed upon anatomical opercular landmarks in relation to the major M2 branches normally seen in the Sylvian fissure. We will illustrate a novel technique to quickly assess the patency of the five major M2 branches in the Sylvian fissure, by counting from anterior to posterior the presence of five hyperintense "dots" on axial TOF MRA source images, corresponding to the prefrontal, precentral, central, angular, and parietal M2 branches. The absence of flow-related signal in one of the 5 "dots" indicates M2 branch occlusion ("the empty dot sign").

Results
Representative examples of different M2 branch occlusions on axial TOF source images in the Sylvian fissure will be presented, using the technique described above. Diffusion-weighted images (DWI) will be presented to demonstrate the area of infarction. Perfusion-weighted images (PWI) will be shown to illustrate specific M2 branch vascular territories. Corresponding angiographic images also will be provided. Examples of M2 branch occlusion recanalization after thrombolytic treatment also will be presented.

Conclusions
Evaluation of distal MCA branches can be challenging. A knowledge of MCA branch anatomy and use of the "empty dot" sign potentially can be useful to quickly assess the patency of M2 branches in the setting of stroke, and have important implications on therapeutic decisions.

KEYWORDS: Anatomy, MCA, Stroke

(Filename: TCT_eEdE-92_EmptyDot.jpg)
A Pattern Based Approach to Pathology on Susceptibility Imaging

M Mabray, J Villanueva-Meyer, A Kansagra, S Cha

University of California San Francisco, San Francisco, CA

Purpose

Susceptibility imaging sequences are powerful clinical tools that are sensitive to deoxygenated blood products and detect pathology in an increasing number of conditions. The purpose of our exhibit is to present a pictorial review of the large number of clinical conditions with findings on susceptibility imaging and to group these conditions into a framework of common patterns.

Materials and Methods

MR imaging including susceptibility sequences will be presented from a large number of cases depicting a variety of clinical conditions, some of which have not been reported previously or frequently in the literature. Relevant case history, pathology, and follow up will be provided as well as a review of the depicted clinical entity. We will present a pattern-based approach to thinking about the pathology depicted on susceptibility imaging and will attempt to group imaging findings and conditions accordingly.

Results

Susceptibility sequences depict findings in a large and expanding number of clinical conditions. While there is some overlap it is useful to arrange these conditions into common and rare conditions and to consider the following patterns: 1. Innumerable scattered foci, 2. Few to multiple scattered foci, 3. Linear/branching vascular lesions, 4. Other. Conditions that tend to demonstrate the innumerable scattered foci of susceptibility pattern include coagulopathy, DIC, thrombocytopenia, fat emboli, cerebral malaria, hemorrhagic encephalitis, sickle cell anemia, severe hypertension, and PRES. These tend to be diffuse processes that produce tiny petechial hemorrhages. Conditions that tend to demonstrate the few to multiple scattered foci of susceptibility pattern include amyloid angiopathy, axonal shear injury, prior radiation, prior lacunar infarct hemorrhage, dystrophic calcification, cavernous malformations, and prior hypertensive or traumatic hemorrhage. These are conditions that are less diffuse and may have single to multiple lesions or time points of the same process. Conditions that demonstrate linear and/or branching susceptibility characteristic of blood vessels include developmental venous anomalies, capillary telangiectasia, AV malformations, Sturge-Weber, CNS angiitis, arterial thrombus, and venous thrombus. Susceptibility imaging powerfully depicts the vascular nature and anatomy of these lesions. Conditions that depict other characteristic patterns based upon their location and clinical situation include superficial siderosis, pneumocephalus, mineralization, and hemorrhages related to tumor, infarction, aneurysms, and trauma.

Conclusions

Susceptibility sequences depict pathology in a large and expanding number of clinical
conditions. A pattern-based approach to forming a differential diagnosis is a useful framework for thinking about these entities and arriving at the correct diagnosis. Attendees will become familiar with the patterns of pathology on susceptibility sequences and the respective differential considerations after reviewing this exhibit.

**KEYWORDS:** Gradient Recall Echo, GRE, Susceptibility-Weighted Imaging

<table>
<thead>
<tr>
<th>Susceptibility</th>
<th>Diffuse Innumerable Foci</th>
<th>Few to Multiple Scattered foci</th>
<th>Vascular</th>
<th>Other</th>
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<tr>
<td><strong>Common</strong></td>
<td>• Coagulopathy/DIC/Thrombocytopenia&lt;br&gt;• Severe Hypertension/PRES</td>
<td>• Prior Lacunar Infarct/Hypertensive Hemorrhage&lt;br&gt;• Amyloid Angiopathy&lt;br&gt;• Axonal shear injury&lt;br&gt;• Radiation&lt;br&gt;• Calcification&lt;br&gt;• Cavernous Malformation</td>
<td>• Developmental Venous Anomaly&lt;br&gt;• Capillary Telangiectasia&lt;br&gt;• Cavernous Malformation w/DVA&lt;br&gt;• Arterial or Venous Thrombosis</td>
<td>• Hemorrhage in trauma, aneurysm, tumor, infarct.&lt;br&gt;• Mineralization&lt;br&gt;• Pneumocephalus from recent procedure</td>
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<td><strong>Rare</strong></td>
<td>• Fat Embolism&lt;br&gt;• Sickle Cell Anemia&lt;br&gt;• Hemorrhagic Encephalitis&lt;br&gt;• Cerebral Malaria</td>
<td>• Vasculitis&lt;br&gt;• Neurocystercerosis&lt;br&gt;• CADASIL</td>
<td>• AV Malformation&lt;br&gt;• Sturge-Weber&lt;br&gt;• Dural AV Fistula&lt;br&gt;• Hereditary Hemorrhagic Telangiectasia&lt;br&gt;• CNS Angiitis</td>
<td>• Superficial Siderosis</td>
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**eEdE-106**

**A Pictorial Review of Intrathecal Pump Assessment and Complications: A Radiologist's Guide**

M Seymour¹, M Mullican¹, H Scott¹, E Stehel¹

¹University of Texas Southwestern Medical Center, Dallas, TX
Purpose
Rising numbers of imaging requests for evaluation of intrathecal pumps within our radiology department has encouraged collaboration between our neuroradiologists, general radiologists, and referents. This collaboration has been the impetus for multidisciplinary education regarding the best way to assess these pumps by imaging. The purpose of this educational exhibit is to share our experiences and current management of potential pump malfunction in an image rich format. We will show numerous examples of intrathecal pump complications.

Materials and Methods
Retrospective review was performed of patients who have undergone imaging assessment of intrathecal pumps at University of Texas Southwestern Medical Center. Select cases best depicting normal appearance, specific complications, and pitfalls were selected for inclusion in this educational exhibit.

Results
Our routine imaging assessment of a malfunctioning intrathecal pump begins with radiographs. Radiographs can depict numerous abnormalities of the pump system, including nonrotation of the pump motor, flipped or "twiddled" pumps, kinked catheters, catheter disconnections, and catheter discontinuity. Radiographic assessment often can be challenging due to prior spinal fusions, concurrent spinal stimulators, and difficult to visualize Ascenda catheters. If radiographic assessment is unrevealing, we proceed to fluoroscopically guided injection of the pump via the catheter access port immediately followed by CT. Fluoroscopy demonstrates flow of contrast through the tubing, identifying focal areas of obstruction or catheter discontinuity. Following the intrathecal contrast injection, CT is helpful to detect subtle contrast leaks, potential epidural placement of the catheter, radiographically occult catheter kinking, and filling defects which can suggest granuloma formation. MR imaging (MRI) also is included occasionally in the work up, such as when patients develop changes in their neurologic status or have an atypical presentation which could overlap with pump malfunction. MR imaging can show granulomas and other potential disk or cord abnormalities.

Conclusions
Increasing numbers of imaging studies to evaluate intrathecal pumps has required educating both our radiologists and referents about the appropriate workup for potential pump malfunctions. Through our experience, we have gathered numerous cases of intrathecal pump-related complications that we believe are beneficial for the neuroradiologist to review.

KEYWORDS: Intraspinal, Pain

A Radiologic Tour of the Brainstem with Pathology Correlation

B Connolly, T Roberts, D Green, A Tarabishy, J Hogg
West Virginia University, Morgantown, WV

Purpose
This electronic educational exhibit provides a review of the radiology of the brainstem including the relevant anatomy, appropriate clinical context, and pertinent imaging findings. The approach is based on anatomical localization using high quality computed tomographic and magnetic
resonance images. Each radiographic image of the basic anatomy will be accompanied by the corresponding gross pathologic imaging findings for correlation. This exhibit is targeted to both practicing radiologists and those in-training for board exams and re-certification.

Materials and Methods
This electronic educational exhibit provides a review of the radiology of the brainstem including the relevant anatomy, appropriate clinical context, and pertinent imaging findings. The approach is based on anatomical localization using high quality computed tomographic and magnetic resonance images. Each radiographic image of the basic anatomy, including white matter tracts, will be accompanied by the corresponding gross pathologic imaging findings. Pertinent clinical cases will conclude the exhibit for reinforcement and will include the pathologic correlate. A few examples of specific pathologic cases include: brainstem infarction, neoplastic disease, white matter disease, and sequelae of metabolic derangement.

Results
The audience of this poster will gain or refresh information about the anatomy of the brainstem with using high quality imaging with gross and microscopic pathologic correlation. Clinically relevant case material from a tertiary referral center to highlight more common brainstem pathology will reinforce learning for clinical practice and board certifying examinations.

Conclusions
The audience of this poster will gain or refresh information about the anatomy of the brainstem with using high quality imaging with gross and microscopic pathologic correlation. Clinically relevant case material from a tertiary referral center to highlight more common brainstem pathology will reinforce learning for clinical practice and board certifying examinations. An emphasis on the anatomy and clinical context will assist the radiologist in arriving at an appropriate differential diagnosis.

KEYWORDS: Anatomy, Brainstem

eEdE-121

6:30AM - 9:00PM

Added Value of Coronal and Sagittal Reformations on Routine Non-contrast CT of the Head - Initial Experience from an Academic Center

W Moore¹, M Fiesta¹, D Chason², R Suss², A Whittemore², M Pinho²
¹University of Texas-Southwestern, Dallas, TX, ²University of Texas-Southwestern Medical Center, Dallas, TX

Purpose
To illustrate the added value of coronal and sagittal reformations over axial imaging alone on noncontrast CT of the head with specific case examples in a pictorial review.

Materials and Methods
Beginning Fall 2012, we began reformatting all noncontrast CT head examinations in the coronal and sagittal planes, and sending them to PACS for review in addition to the industry standard routine axial images. Over this time period, it has been our experience that these additional reformatted images have at times added valuable information for image interpretation. We have accumulated cases and classified them into three main scenarios: (1) increase in absolute sensitivity for lesion detection, (2) increase in diagnostic confidence and characterization of axial
findings, (3) decrease in false positive findings including artifact identification (i.e., increased specificity).

Results
Historically, noncontrast CT imaging of the head has relied essentially on interpretation of sequential axial images. With the advent of volumetric helical acquisitions, raw imaging data can be reconstructed in multiple planes with no additional scanning time, cost, or radiation exposure. Multiplanar interpretation has become incorporated into clinical practice on CT for most body regions, with the notable exception of the head at most institutions, despite some available published data demonstrating added value in some clinical scenarios such as trauma (1, 2). We have recently modified our routine protocol to include those reformats, and our initial experience is favorable, especially for identification of normal and abnormal structures near the vertex, extra-axial spaces, brain/bone interface at the skull base and midline structures. In locations such as these, subtle abnormalities on axial images are often more obvious on an orthogonal plane, which may be invaluable to increase sensitivity and add diagnostic confidence, especially for less experienced readers in the academic training setting. Reduction of false positives is another important advantage, and we have encountered several situations in which reformats have improved the prospective identification of image artifacts and other pitfalls, avoiding additional imaging or follow up and potentially decreasing health care costs and patient radiation exposure.

Conclusions
Multiplanar reformats for noncontrast head CT studies can be instrumental at improving diagnostic confidence and accuracy with no added cost or radiation burden. We plan to demonstrate our preliminary experience with a pictorial presentation, focusing on potential benefits to patients. Further cost-effectiveness research is being implemented at our institution to compare the potential clinical and management benefits versus possible costs of increased interpretation times and data storage requirements.

KEYWORDS: CT, Postprocessing
Small subdural hematoma confirmed on coronal images: a. Axial CT in brain window. b. Coronal CT in brain window. Subtle peripheral hyperdensity (arrow) seen only on one axial slice raises question for extra-axial hemorrhage. Coronal reformat clearly demonstrate the shape an extent of a subdural hematoma, increasing diagnostic confidence.

(Filename: TCT_eEdE-121_Moore-PinhoASNRI mage.jpg)

eEdE-118

6:30AM - 9:00PM

Anomalies and Variations of Intracranial Circulation Demonstrated on MR Angiogram

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Purpose
The aim of this educational exhibit is to: 1. To present various anomalies and variations of the intracranial circulation demonstrated on MR angiogram. 2. To discuss these anomalies and their clinical significance.

Materials and Methods
We reviewed all the MR angiograms of the intracranial circulation performed at our institution
within the last five years and assessed the various anatomical variants present in these angiograms.

Results
Magnetic Resonance (MR) angiogram is a frequently used imaging technique in most of the centers for evaluation of the intracranial circulation. Three-dimensional time-of-flight (TOF) sequence is the preferred and most commonly used MRI technique. This study covers the circle of Willis as well as the distal vessels, allowing the identification of most of the vascular abnormalities and anatomical variants. Normal variations of the cerebral circulation are not uncommon. Knowledge and understanding of these variations such as aplasia/hypoplasia, agenesis, duplication, fenestration and persistent fetal arteries plays an important role in endovascular or surgical management of patients with stroke and subarachnoid hemorrhage. The significance of various anomalies differs with respect to its clinical presentation, for example, the fenestration and persistent fetal arteries are commonly associated with increased risk of aneurysm formation.

Conclusions
It is important to identify and report various normal anatomical variants and anomalies while evaluating the cerebral circulation using MR angiogram. Knowledge of the anatomical variations is important since it can influence surgical and interventional procedures.

KEYWORDS: Anatomical Variation, Fenestration, Variants

eEdE-100

Case-Based Review: Differential Diagnosis for Commonly Encountered Lesions of the Pons.

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Purpose
The pons is the largest portion of the brainstem responsible for both relaying information and controlling a number of essential functions. It is also a common location for a variety of pathologic entities to present, from ischemia and inflammation to neoplasm and vascular malformations. While there is considerable overlap in the imaging characteristics of these entities, certain findings and clinical information may be employed to narrowing the differential and often make a specific diagnosis. The purpose of this exhibit is to offer the radiologist an approach to these lesions, and help guide the diagnostic work up and management of these patients.

Materials and Methods
A menagerie of cases were collected over a one-year time frame at the University of Maryland Medical System. In addition to cases encountered during typical day-to-day proceedings, a radiology search engine was utilized to identify additional rare and unusual entities. Approximately two dozen example cases were collected, which includes both classic and atypical presentations of disease.

Results
Following a brief illustrated discussion of the anatomy and of the function of the pons, we
review the identification and differential diagnosis for commonly encountered pontine lesions. Pathologic entities presented in a case-based format include acute and chronic ischemia, hemorrhagic lesions, infectious and inflammatory entities, demyelinating disease, toxic-metabolic derangements, neurodegenerative disorders, anatomical variants, vascular malformations and neoplasms. The imaging features for each entity are reviewed, with an emphasis on specific distinguishing features that may be used to differentiate among these entities. When possible, advanced imaging techniques including MR spectroscopy (MRS) and diffusion tensor imaging (DTI) are employed. For lesions without specific imaging features, the clinical history and laboratory data required for patient management are reviewed.

Conclusions
A wide variety of lesions, both aggressive and benign, may be encountered in the pons with a number of possible clinical presentations. This brief review should increase familiarity with and diagnostic confidence for these entities for any practicing radiologist.

KEYWORDS: Adult Brain, Arteriovenous Malformation, Central Pontine Myelinolysis

eEdE-123

CAT Lesions: When Pathology Involves the Caverno-Apical Triangle

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Purpose
1. To examine the anatomical contours that define the caverno-apical triangle (CAT). 2. To demonstrate the most important and unusual pathologies that may involve the caverno-apical triangle and the implications for the surgeon and oncologist.

Materials and Methods
Through high-resolution CT and MR images and with PET and pathologic correlation, we present a detailed anatomical study of the contours that define the caverno-apical triangle and the key and unusual pathologies that may be found here.

Results
The caverno-apical triangle is a small triangular-shaped area at the junction of the anterior and middle cranial fossae where the anterolateral aspect of the cavernous sinus meets the orbital apex and superior orbital fissure. This area can harbor pathology which is subtle on imaging but because of the intimate anatomical relations can result in significant morbidity and be difficult to access surgically for biopsy.

Conclusions
The caverno-apical triangle has been described poorly in the literature and because of its small size may be readily overlooked on imaging. The clinically important anatomical relations mean that pathology in this area may result in high morbidity and surgical access is difficult for diagnosis. This area should be carefully evaluated on CECT or MRI particularly when patients have symptoms of CN3, 4 or 6 neuropathy, orbital pain or altered visual acuity.

KEYWORDS: Cavernous Sinus, Cranial Nerve Pathology, Orbits
Clinical Utility of Susceptibility Weighted Imaging

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Purpose
Susceptibility-weighted imaging (SWI) utilizes flow/velocity compensated long echo, RF spoiled, gradient recalled echo pulse to obtain MR images. It has been used traditionally in evaluation of large-vessel flow quantification or for use in inversion recovery sequences. Recently, there has been marked interest in the information provided by SWI at tissue interface especially about local tissue susceptibility changes that can arise from presence of ferromagnetic agents such as iron and other substances that change the local field. We aim to review basic concepts of SWI with a case-based discussion highlighting the origins of low signal on SWI and the significance of high-pass filtered phase images in distinguishing hemorrhage from other causes of low signal on SWI. By the conclusion of this presentation, the radiologist should have a better understanding of various clinical presentations of granulocytic sarcoma and relevant imaging and pathologic findings.

Materials and Methods
We present a case-based review highlighting basic concepts of various SWI (T2*WI versus SWI, magnitude and high-pass filtered phase images, minimum intensity projection SWI, QSM) and various causes of low signal on SWI (diamagnetic versus paramagnetic causes) using MR images, flow-chart and/or cartoons. The exhibit will include clinical image examples of SWI including trauma, neoplasm, vasculopathy, neurodegenerative diseases, inflammatory and infectious diseases. Emphasis will be on key points that help differentiate low signal high-pass filtered phase images and how certain patterns can help differentiate between diamagnetic versus paramagnetic substances. We also will discuss common pitfalls of SWI including orientation within main magnetic field, chemical shift artifacts, etc.

Results
We will give an image-rich overview of physical principles of SWI and how these principals can be used to aid in image interpretation. Following this, there will be case-clinical image examples of SWI including trauma, vasculopathy, and neurodegenerative diseases. Emphasis will be on key points that help narrow the differential diagnosis. Case examples also will highlight utility of SWI in neonatal imaging (hydrocephalus, hypoxic encephalopathy, CVAs, etc.), role of SWI in dymelinating diseases (MS, NMO), neoplasms (primary CNS and metastases (hemorrhagic versus nonhemorrhagic), lymphoma, hemangiopericytoma and malignant fibrous histiocytoma), infection (tuberculosis, pyogenic abscess, neurocysticercosis, nocardia, aspergilloma, cryptococcosis, etc.), and inflammatory conditions (neurobehcet's, sarcoidosis, lupus, CLIPPERS, etc).

Conclusions
Susceptibility-weighted imaging is a key diagnostic MR imaging tool which combines phase and magnitude information to detect magnetic susceptibility differences between adjacent tissues. Because of its ability to detect paramagnetic and diamagnetic substances (e.g., iron deposits,
calcifications, blood degradation products, etc.) with high sensitivity, it provides clinically useful information in the evaluation of various disorders including traumatic brain injury, neonatal brain, vasculopathy, neurodegenerative disorders, neoplasms, etc. By the conclusion of this presentation, the viewer should be familiar with principals behind SWI, characteristic SWI patterns of the aforementioned clinical entities and beware of the common pitfalls of SWI.

KEYWORDS: Neuro-Behçet, Neurosarcoidosis, Susceptibility-Weighted Imaging

eEdE-111

Cranial Nerve Anatomy as Illustrated by Schwannomas

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Purpose
A firm understanding of cranial nerve anatomy and function is necessary for the interpretation of examinations that include the skull base or head and neck. Particularly, in the evaluation of patients with cranial neuropathies, it is imperative for the radiologist to assess for pathology along the entire course of the cranial nerve, from nucleus to end organ. Cranial nerve schwannomas are benign nerve sheath tumors that can be seen along the intracranial and extracranial course of cranial nerves III-XII. The aim of this pictorial essay is to refresh the expert and educate the novice imager about cranial nerve anatomy and function using schwannomas to illustrate key points.

Materials and Methods
Patients undergoing MR imaging (MRI) or CT imaging for the workup of cranial neuropathies will be included in this pictorial essay. Normal anatomy of the cranial nerves will be depicted on MRI images, from nucleus to end organ, and CT images will be used to demonstrate the normal and abnormal appearance of the skull base foramina. Multiple cranial nerve schwannomas will be presented to emphasize this anatomy along the course of each nerve.

Results
With an emphasis on MRI, techniques and relevant physics for imaging the cranial nerves will be reviewed. For each individual cranial nerve, a discussion of function will be included. Next, imaging anatomy will be demonstrated including nuclei and major branches. Clinically relevant anatomical relationships along the course of each cranial nerve with adjacent structures will be stressed. Schwannomas will serve to facilitate understanding of these anatomical and functional concepts. Finally, various clinical presentations of cranial nerve dysfunction also will be discussed. A systematic approach for the assessment of the cranial nerves will be presented.

Conclusions
For every radiologist whose practice includes neuroimaging, intimate knowledge of cranial nerve anatomy, function, and presentations of dysfunction is a must. A CT and MRI review of cranial nerve anatomy presented here aims to illustrate this intricate anatomy using cranial nerve schwannomas for emphasis.

KEYWORDS: Cranial Nerve Pathology, Cranial Nerves
Crossroads for Head and Neck Cancer: Critical Imaging Findings that Alter Management of Squamous Cell Carcinoma of the Head and Neck

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Purpose
The aim of this exhibit is to familiarize radiologists with the staging principles for squamous cell carcinoma (SCC) of the head and neck at multiple primary sites, with a focus on key cross-sectional imaging findings that directly impact prognosis and patient management. After exploring this exhibit, participants will become more comfortable interpreting cross-sectional studies due to a better understanding of staging principles and how these affect treatment options.

Materials and Methods
We will revisit the newest edition of the American Joint Committee on Cancer (AJCC) Cancer Staging Manual, and provide a pictorial review of head and neck SCC staging, including lesions of the lip and oral cavity, oropharynx, nasopharynx, larynx, hypopharynx and nasal cavity/paranasal sinuses. The review will discuss key imaging findings that help determine tumor stage and how this information influences clinical decision making, including a summary.
discussion of updated treatment options for each stage of disease. An interactive quiz will be available at the end of the exhibit, allowing participants to test their knowledge by searching for key imaging findings on unknown cases, with explanations of how the findings affect clinical management and prognosis.

Results
In an era that increasingly emphasizes the added value of radiology, it is crucial for radiologists to possess an understanding of how imaging findings influence clinical management. Due to the complex anatomy of the head and neck, staging of head and neck SCC can be a daunting task. However, by adhering to guidelines set forth by the AJCC, becoming familiar with key imaging findings that influence cancer stage and building a solid search pattern, radiologists often can play a decisive role at the crossroads of integrating clinical and imaging findings to determine prognosis and best strategies for patient care.

Conclusions
Radiology training is undergoing changes as the specialty evolves into a more patient-centered practice and radiologists participate more directly on treatment decisions. To be seen as important members of a multidisciplinary head and neck cancer group, radiologists need to be familiar with key staging and treatment principles adding greater value to patient care.

KEYWORDS: Cancer, Head And Neck, Staging

56 y/o female smoker with 4 month onset hoarseness and 30 lbs Contrast enhanced CT of demonstrates a supraglottic inf with extralaryngeal extension (T4 IVa). Stage IVa disease is moderately advanced and patient eligible for partial laryngeal laryngectomy is an option but functional organ preservation concurrent chemoradiation is chemotherapy option of laryngectomy for local fi
Purpose
To study the embryology, bony and ligamentous anatomy and topographic relationship of craniovertebral junction on imaging. To understand imaging features of various craniovertebral junction abnormalities on CT and MRI.

Materials and Methods
Computed tomography was performed on Philips 40-slice multidetector scanner (Brilliance). Helical acquisition was used with multidetector computed tomography, and thin slices of 0.5 to 1 mm from clivus to lower end of C2 vertebral were acquired. MR imaging was performed using Siemens 1.5 T MR system (Magnetom Symphony) with a phased array spinal coil. The examination was conducted in a nonemergent (nonacute) setting. Sedation (oral or intravenous) if required was given. Axial T1, T2 and gradient echo. Coronal T2, STIR. Sagittal T1, T2, gradient echo and STIR. Postcontrast, dynamic flexion/extension studies and 3D TOF angiography were done wherever required/possible.

Results
Study included 30 males and 18 females. Patients between 18 to 40 years of age constituted the largest group. Congenital abnormalities were seen in 39 (81%) cases and were found to be more common than acquired abnormalities which were seen in nine (19%) cases. Among the acquired abnormalities cases of trauma were seen in four (9%), infective etiology (tuberculosis) in two (4%), tumors in two (4%) and inflammatory in one (2%). Out of 39 patients of congenital cases, atlanto-axial dislocation was the most common bony abnormality in 74.3% followed by basilar invagination in 64.1%, occipitalization of atlas in 35.9%, dens dislocation in 23%. Other bony abnormalities seen were platybasia (25.7%), os odontoideum (15.4%), segmentation anomalies (17.9%), rachischsis and condylus tertius in 5.2% each, split atlas, foramen magnum stenosis, dens aplasia and os terminale in 2.5% each. Out of 39 patients of congenital abnormalities increase in predental soft tissue was the most common soft tissue abnormality seen in 56.4% cases, followed by ligament thickening seen in 23.77% cases, syrinx in 17.8% and cerebellar herniation in 10.25% of cases. CT could detect 100% of the congenital bony abnormalities. However, MRI could detect 86.27% atlantoaxial dislocation, 88% of basilar invagination, 78.5% atlantooccipital assimilation, 88.8% of dens subluxation, 90% platybasia, 66.6% os odontoideum. 28% cases with syrinx were detected on CT, whereas MRI detected all the cases with syrinx. In the four cases of trauma involving CVJ, CT detected all of atlas and axis fractures. MRI detected 75% of fracture and 100% of the cord and ligamentous injuries while CT detected 50% of cord and none of ligamentous injuries. 2 cases of CVJ tuberculosis seen, which revealed bony destructive lesions, atlanto-axial dislocation, dens subluxation, prevertebral abscess, epidural extension and cord changes. Two cases of CVJ tumors seen, one was meningioma and other was giant cell tumor of clivus.
Conclusions
An understanding of embryology and knowledge of the wide spectrum of pathology and its clinical presentation combined with imaging findings allows the radiologist to play a key role in the presurgical evaluation and treatment planning for the neurosurgeon. Though CT has a role in demonstrating bony abnormalities, MR imaging provides multiplanar images, and is proved to be superior soft tissue characterization, comprehensive anatomical definition and topographical relationships of the craniovertebral junction which is useful for surgical planning and prognostication. This ability makes MR imaging the primary imaging modality in the evaluation of the CVJ.

KEYWORDS: Atlantoaxial, Atlas, Basilar Invagination

CRANIOVERTEBRAL JUNCTION ANOMALIES

Fig A: Congenital abnormalities: odontoid aplasia(A), basilar invagination (B) and Os- odontoideum(C)

Fig B: Acquired abnormalities: fracture (A), tuberculosis (B) ankylosing spondylitis (C) and Juvenile rheumatoid arthritis(D)

(Filename: TCT_eEdE-132a_Slide1.jpg)
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Purpose
The purpose of this exhibit is to review various congenital and developmental anomalies of the occiput, atlas, and axis (craniovertebral junction) in an interactive format.

Materials and Methods
We retrospectively reviewed teaching files from two institutions for congenital and developmental anomalies of the craniovertebral junction (CVJ). Representative cases were used for this exhibit.

Results
The occiput, atlas and axis comprise the craniovertebral junction (CVJ). Imaging plays a key role in identification of CVJ anomalies. Anatomy of CVJ with relevant embryology is discussed with normal imaging features. Anomalies of the CVJ can result in underlying cervicomedullary compression and, therefore, are important to recognize. These anomalies can be categorized based on the anatomical location (occiput, atlas and axis). Occiput anomalies included are basioccipital and occiput hypoplasia (and resultant basilar invagination), incorporation of the proatlas to the basiocciput, and various atlantooccipital assimilations. Atlas anomalies include split atlas and posterior arch anomalies (Keller aplasia, arch hypoplasia/aplasias, rachischesis) and persistent epicondylar process. Axis anomalies include os odontoideum, odontoid hypoplasia, and C2 spondylolysis. Figure shows nonfusion at the anterior and posterior arches of atlas consistent with split atlas.

Conclusions
It is important to be aware of the imaging appearance of the various CVJ anomalies due to their significant clinical implications. The knowledge of normal imaging anatomy and parameters is crucial for the recognition of these anomalies. We present an interactive tutorial on CVJ anomalies. After reviewing this exhibit, the viewer should develop a practical approach for these lesions.

KEYWORDS: Cranio-Cervical Junction
Detecting the Dots- MRI in Spinal Dural ArterioVenous Fistulas with Angiographic Correlation.

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Purpose
Spinal dural arteriovenous fistula (SDAVF) is an uncommon but treatable cause of myelopathy with nonspecific clinical presentation. If left undiagnosed and untreated, it can result in significant morbidity. It is important for the neuroradiologist to be familiar with the appearance of SDAVF and suspect the diagnosis on the initial MR imaging (MRI). The purpose of this exhibit is to describe the MRI findings of SDAVFs with angiographic correlation.

Materials and Methods
We describe the normal blood supply of the spinal cord and types of SDAVFs. We describe the
findings on MRI of the spine and correlation with spinal angiogram, which is considered the gold standard for the diagnosis of SDAVF.

Results
MR imaging of the spine is the first line of investigation in patients presenting with symptoms referable to the spinal cord. T2-weighted images show hyperintensity in the central cord due to venous hypertension resulting in edema/ischemia. This may be at the level of the fistula or remote from it. It is important to examine the entire cord and look for flow voids on the surface of the cord, which represent the dilated perimedullary veins. Postcontrast T1-weighted images may show enhancement within the cord showing T2 prolongation, due to venous ischemia. Enhancing serpigenous vessels can be seen on the surface of the cord. Selective spinal angiogram should be performed in suspected cases to confirm the diagnosis, localize the fistula, demonstrate the feeding artery and the venous drainage. PC-FIESTA MR imaging has been described to be useful in elderly patients in whom spinal angiography is difficult due to tortuosity of vessels or shunting is limited due to venous hypertension.

Conclusions
Spinal dural arteriovenous fistula is a treatable cause of myelopathy and a neuroradiologist may be the first clinician to suspect it. MR imaging findings of T2 prolongation within the cord along with presence of flow voids and/or presence of serpigenous vascular enhancement on the surface of the cord should prompt spinal angiography. Selective spinal angiogram may localize the fistula remote from the site of cord signal abnormality and demonstrate the feeding artery and venous drainage.

KEYWORDS: Dural Arteriovenous Fistula, MR Imaging/MR Angiography, Spinal Angiography

Diffusion MRI-Tractography of the Temporal Stem: A Pictorial Review of Fiber Tract Anatomy

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Purpose
Most references agree that the uncinate fasciculus, inferior occipitofrontal fasciculus and Meyer’s loop of the optic radiation pass through the stem of the temporal lobe or temporal stem. However, the anatomical definition of the temporal stem has shown some inconsistency in the literature. Some authors include also the anterior commissure, ansa peduncularis and extreme capsule in the definition (1). A previous study has presented a progressive dissection guided by three-dimensional MR renderings and cross-sectional images (2). High angular resolution diffusion imaging (HARDI) is an MR imaging (MRI) technique that permits in vivo white matter tract visualization and overcomes some of the drawbacks of diffusion tensor imaging (DTI) such as crossing, diverging or highly curved fibers (3). This technique permits better visualization of tracts in brain regions with many convergent fiber tracts such as in the temporal stem. To our knowledge, HARDI has never been used to study the anatomy of the temporal stem. Here, we
propose to use this technique to demonstrate the relationship of the temporal stem with its main tracts.

Materials and Methods
A literature review will be performed in order to accurately discuss the anatomy and function of the temporal stem. MR images: Images were acquired with a Siemens 1.5 T MRI scanner. High-resolution axial T1-weighted images were acquired with gadolinium enhancement. Single shot echo planar (EPI) sequence was used (TR:11700ms; TE:98ms; b-value:1000s/mm2; Number of diffusion directions:64; in-plane resolution: 2x2mm2; slice thickness: 2mm). Diffusion image processing and tractography: Susceptibility and motion artifacts were corrected on all images (4) and Rician noise correction was used for denoising DW images. Streamline tractography was used on the field of fiber orientation distribution function (5) using MRtrix. 120000 streamlines were reconstructed. The FiberNavigator software (6) was used to define regions of interests based on anatomical sites of interest for isolating the fiber tracts.

Results
This educational exhibit will present a literature review of the anatomy and function of the tract passing through the temporal stem. The review will focus not only on the functional importance of the temporal stem, but also on the importance of this structure in spread of tumors, infection, and seizures. A brief introduction on the HARDI technique will be presented with state of the art HARDI images of the temporal stem. Finally, emphasis on surgical recognition of this structure will be made to avoid important repercussions for the patient such as hemianopia or quadrantanopia.

Conclusions
At the end of this presentation, the viewer should be familiar with the anatomy and function of the temporal stem and its importance in tumor, infection and epilepsy propagation pathway.

KEYWORDS: DTI Tractography, Fiber Tracking
standard for evaluation of spinal vascular anatomy and pathology; however the cost and relative risk has advanced the need for the development of noninvasive techniques. Spinal MRA, conventional and dual energy spinal CTA for assessment of the spinal vasculature are described and illustrated using normal and pathologic examples. Assessment of the spinal vasculature, particularly the artery of Ademkiewicz, in the setting of aortic aneurysm and spinal dural arteriovenous fistula are demonstrated.

Conclusions
Noninvasive and invasive spinal imaging are adjunctive in the evaluation of patients with suspected spinal vascular lesions. Accurate interpretation of cross-sectional spinal vascular anatomy requires an understanding of anatomy, pathology and flow characteristics optimally demonstrated by catheter angiography. Knowledge of correlative vascular anatomy can improve diagnostic yield on invasive and noninvasive imaging techniques.

KEYWORDS: Angiography, Spinal Vascular Disorders

**Evaluation of Oral Cavity Carcinomas: A Case-Based, Computer-Interactive Tutorial**

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Purpose
Educational Objectives: 1. Review normal anatomy of the oral cavity. 2. Learn the American Joint Committee on Cancer (AJCC) criteria for staging of oral cancer carcinoma (OCCA). 3. Gain an understanding of how to assess extent of lesions in the various oral cavity subsites.

Materials and Methods
Following a brief review of pertinent normal oral cavity anatomy, we present multiple cases of OCCa in each of the top five subsites on CT/MR. We employ a computer-interactive checklist approach for systematic evaluation of tumors in the various subsites and lead the reader through a step-by-step analysis of each tumor.

Results
The AJCC tumor node metastasis (TNM) criteria for oral cavity carcinoma is useful for staging and prognosis, typically dictating treatment options. Tumor node metastasis staging, however, may be incomplete in terms of describing individual tumor extent for the variety of subsites. The top five "oral cavity" carcinoma subsites, in decreasing order of frequency, are: 1) lower lip; 2) oral tongue; 3) floor of mouth; 4) gingiva/retromolar trigone; and 5) hard palate. Although the lip and oral cavity are separated in terms of T4 lesions, these subsites otherwise share common AJCC staging criteria. The patterns of spread for tumors in these various locations, however, differ considerably, making radiological evaluation of OCCa tumors a challenge for both the radiology trainee and the experienced radiologist, given the complex anatomy and various patterns of spread. Accurate assessment of tumor extent is extremely important for appropriate tumor staging as this information impacts patient prognosis and optimal treatment options. We suggest a simplified "checklist approach" for systematic analysis of OCCa. Such an approach could be used by the radiologist to help ensure thorough imaging analysis while, at the same time, directly providing pertinent information for appropriate clinical tumor staging.
Conclusions
A simplified computer-interactive checklist is presented to assist the radiologist in systematically analyzing the extent of various subsites of OCCa. This permits the reviewer to optimize his/her imaging reports by inclusion of both pertinent positive and negative findings, thus providing accurate information for appropriate clinical staging.

KEYWORDS: Carcinoma, Head And Neck, Oral Cavity

(Filename: TCT_eEdE-88_Slide6.jpg)

EEdE-96

Go with the Flow: Employing Arteries and Veins in the Face and Neck to Predict Lesion Origin

A Dubey¹, S Lavianlivi¹, S Pulitzer¹, D Reede², L Gentry³, R Holliday⁴, W Smoker⁵
Purpose
After viewing this module the reviewer will be able to: 1. Identify major vascular structures in the face and neck. 2. Correlate vascular anatomy to surgical landmarks in the face and neck. 3. Identify typical patterns of vascular displacement associated with commonly encountered lesions of the face and neck.

Materials and Methods
Normal anatomy of the major arteries and veins in the face and neck is reviewed, emphasizing the relationship of vessels to submandibular gland, parotid duct, major nerves and muscles. Representative cases are presented to demonstrate typical patterns of vascular displacements produced by common neoplastic and nonneoplastic processes. Ancillary imaging findings that aid in interpretation are discussed.

Results
Vascular anatomy is useful in the detection of pathology involving the parotid duct, submandibular gland, and localization of the thoracic duct. Branchial cleft and thymic cysts also can be recognized by their relationship to the carotid sheath. Additionally, lesions arising from the vagus nerve, carotid body, thyroid gland, and sympathetic chain all cause typical patterns of displacement of the carotid sheath or its contents.

Conclusions
Correct identification of major vascular structures is essential prior to surgical intervention/biopsy. An image-based algorithm is provided to assist in the development of an appropriate differential diagnosis for a lesion based on patterns of vascular displacement and/or location with reference to a vessel.

KEYWORDS: Anatomy, Head And Neck, Neck Masses
Imaging Findings of Cystic Lesions of the Head and Neck

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Purpose
To describe CT and/or MR imaging (MRI) appearance of common head and neck cystic lesions to aid in correct diagnosis and facilitate appropriate management.

Materials and Methods
The authors will review retrospectively all cases of cystic lesions of the head and neck imaged at University of Missouri Hospital and Clinics between 07/01/2010 and 10/01/2013.

Results
Cysts and cystic-appearing lesions of the head and neck have a broad imaging spectrum. They can be developmental or acquired. Majority of the cystic lesions in infants and newborn are developmental such as thyroglossal duct cyst, vascular malformations, thornwaldt's cyst and cystic hygromas. In children and adults, majority of cystic lesions are inflammatory or neoplastic in nature and include lesions such as cystic metastatic nodes, ranula and abscess. Some of the cystic lesions can mimic other lesions on imaging. This poster will convey the spectrum of imaging findings related to cystic masses of the head and neck using a variety of examples and multiple modalities. Each case will include characteristic imaging findings, relevant differentials
diagnoses, discussion of the optimal imaging strategy and pathologic correlation when available. Reference will be made to the appropriate nomenclature used in the classification of each lesion.

Conclusions
Cystic masses of the head and neck constitute a wide array of developmental and acquired lesions. Patient's age, history and physical exam as well as lesion location are important in formulating a reasonable differential diagnosis.

KEYWORDS: Cystic Neck Mass, Cysts

eEdE-130
Imaging of Referred Otalgia - What You Should Look For

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Purpose
This exhibit will provide guidance for the imaging work up of patients with ear pain and no identifiable abnormality within the ear (referred otalgia). We will demonstrate the wide spectrum of abnormalities that can present with referred otalgia and discuss the anatomical basis for referred ear pain.

Materials and Methods
The sensory innervation of the ear is quite complex with contributions arising from cranial nerves 5, 7, 9, and 10 as well as spinal nerves 2 and 3. Pathologic lesions that involve branches of these nerves distant to the ear can potentially present with symptoms of ear pain. The symptoms of ear pain can lead to erroneous work-up of the cause of pain. We will systematically review the detailed anatomy of these major cranial nerves in order to provide an understanding of the problem of referred otalgia. We will provide numerous examples of head and neck pathologies that present with referred otalgia and discuss the cranial nerve branches that are the basis of referred ear pain.

Results
Patients with ear pain may be seen initially by either an otolaryngologist or a primary care physician. Otolaryngologist may order additional diagnostic studies if the ear exam is negative. The radiologist needs to be aware of referred causes of ear pain in order to rule out sinister lesions that may be remote from the ear. Contrast-enhanced CT or MR scans that include the neck, nasopharynx, aortic arch, and upper spinal canal usually will detect the most common lesions causing referred otalgia. A primary care physician may not be as familiar with referred otalgia and order examinations dedicated to the ear. It is important to communicate to these physicians that a temporal bone CT may not be sufficient for work up of the patient.

Conclusions
Referred otalgia is a common problem encountered in head and neck imaging. Numerous etiologies must be considered during the work up in order to avoid diagnostic error. This exhibit reviews the common etiologies of referred otalgia and the neuroanatomical basis of referred ear pain.
Purpose
Sellar and parasellar region is a critical area with several vital structures including pituitary, parts of the optic pathway, cavernous sinus and its contents, carotid arteries, meninges, etc. Several important pathologies occur in this location and can provide an ultimate test to the skills of anyone dealing with imaging of brain as well as head and neck. Recognition of normal variants, identification of life threatening conditions such as aneurysms, pituitary apoplexy and cavernous sinus thrombosis, etc. without delay, identification of the extent and relationship of a tumor to the several vital structures and accurate diagnosis of various pathologies are fundamental steps in the correct management of sellar and parasellar lesions. This exhibit will serve to update the knowledge of imaging features of various sellar and parasellar lesions.

Materials and Methods
The exhibit will provide a definition of sellar and parasellar regions. A detailed imaging anatomy of the sellar and parasellar regions will be discussed with color plates, computed tomography (CT) and MR imaging (MRI) to facilitate the understanding of various pathologies occurring in this area and also the extension of pathologies from nearby anatomical areas. A brief review of embryology will be provided to understand the developmental lesions affecting pituitary and
tumors such as craniopharyngioma. Various imaging techniques will be highlighted under appropriate pathologies. Relevant clinical cases will be used to discuss the imaging features of various pathologies occurring in this location. An imaging algorithm will be provided at the end of the presentation to facilitate the imaging analysis of sellar and parasellar lesions.

Results
Sellar lesions consist mainly of the pituitary gland. Pathologies affecting the pituitary gland including developmental lesions, variants, incidental lesions and tumors will be discussed. Further, extension of a tumor to the suprasellar cistern, relationship of a pituitary tumor to the optic chiasm and invasion of the cavernous sinus as well as the skull base will be discussed. Anatomical variants at the skull base and sella and their influence on surgical treatment will be emphasized. Also, influence of MR signal characters of pituitary tumors on transphenoidal resection will be discussed. Further, relevant clinical features, laboratory investigations and posttreatment changes will be discussed. Imaging pitfalls will be highlighted particularly in the detection of pituitary tumors less than 3 mm and the available technologies will be explored. Parasellar lesions will be categorized as lesions of cavernous sinus and suprasellar region. Pathologies from the cavernous sinus including vascular lesions such as carotid artery aneurysm, carotid cavernous fistula and sinus thrombosis will be discussed. Tumors from the cranial nerves traversing cavernous sinus and the lesions originating from the dural wall of cavernous sinus will be discussed. Also developmental lesions near the parasellar region will be discussed. Finally, suprasellar lesions including developmental anomalies, infection, tumors and vascular lesions will be discussed. Posttreatment imaging features will be discussed in appropriate conditions. The importance of identifying posterior pituitary bright signals will be emphasized in relationship to suprasellar tumors. Finally, skull base lesions invading sellar and parasellar regions either directly or through perineural invasion will be discussed.

Conclusions
A review of the exhibit will help to understand the sellar and parasellar anatomy, identify various pathologies occurring in this location, guide the appropriate imaging technique and recognize the posttreatment changes.

KEYWORDS: Parasellar, Pituitary Gland, Suprasellar Mass

Imaging of Tongue Lesions - "A Tasty Pictorial Review"

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Purpose
To highlight the imaging features of various intrinsic tongue-based lesions and extrinsic pathologies causing tongue changes.
Materials and Methods
We intend to describe the computed tomography (CT) and MR imaging (MRI) features of multiple pathologies involving the tongue with clinical correlation.

Results
The tongue forms a major component of the oral cavity and a part of the oropharynx. In this pictorial we intend to emphasize on various pathologies involving the tongue. The lesions can be intrinsic and comprising of congenital, vascular malformations and neoplasms. Extrinsic pathologies involving brainstem and skull base also can manifest with secondary changes in the tongue and comprises of skull base tumors, brain stem lesions and other pathologies along the course of hypoglossal nerve. The pictorial will highlight the imaging features of lingual thyroid, lingual dermoid, lipoma, venolymphatic malformations, tongue hemangioma, ranula, skull base pathologies like hypoglossal nerve schwannoma, squamous cell carcinoma of the tongue, lymphomas of tongue base, skull base tumors and brain stem lesions.

Conclusions
Imaging and identification of intrinsic tongue pathologies plays a vital role in their surgical management. The tongue also can serve as a clue in diagnosing brainstem and skull base pathologies.

KEYWORDS: Congenital Anomalies, Masses, Tongue
Inherited and tumor syndromes of head and neck: Neuroimaging review

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Purpose
To identify the key radiologic findings, discuss the clinical features and review the surveillance guidelines of the most common phakomatoses, multiple endocrine neoplasias and other tumor syndromes with neurological manifestations.

Materials and Methods
A review of our PACS database and personal teaching files performed by the authors. Representative cases of various imaging findings of phakomatoses, MEN syndromes and other head and neck manifestations of tumor syndromes are presented with the help of computed tomography (CT) and MR imaging (MRI). Emphasis is on syndromes that need long term surveillance.

Results
Many inherited syndromes and tumor syndromes like neurofibromatosis (types 1 and 2), tuberous sclerosis, Sturge-Weber syndrome, von Hippel-Lindau disease, cardiofaciocutaneous syndrome, PHACE syndrome, multiple endocrine neoplasias, (MEN 1 and 2 syndromes), basal cell naevus syndrome, Cowden syndrome, Carney syndrome, Li-Fraumeni syndrome and Turcot's syndrome have neurological lesions and associated malignancies, both neurological and/or non-neurological. Recognizing the characteristic lesions, differentiating between syndromes with similar manifestations is essential for accurate diagnoses and appropriate patient management. Genetic abnormalities that cause many of these syndromes are well characterized allowing us to understand the genotype-phenotype correlation. We review the various clinical and imaging characteristics of some of the more common syndromes. Imaging of the head, neck and spine and nonneurological sites in these disorders plays an important role in diagnosis, determining the extent of involvement and guiding surgical interventions when necessary. As some of these syndromes are associated with increased malignant potential (cranial, spinal or non-neurological), surveillance programs have been developed for early detection.

Conclusions
We aim to provide a comprehensive review of the most common inherited and tumor syndromes with head and neck manifestations based on radiologic and clinical characteristics. We describe prognosis and provide guidance on the appropriate use of surveillance imaging in affected individuals.

KEYWORDS: Neurofibromatosis, PHACES, Phakomatoses
Materials and Methods
blank

Results

Conclusions
Many systemic diseases have calvarial manifestations arising from a few specific common underlying pathophysiologic mechanisms such as bone softening, extramedullary hematopoiesis, medication-induced osteoblast proliferation, and sharply marginated lytic lesions created by clusters of neoplastic hematopoietic cells.

KEYWORDS: Calvarial
Learning Neuroradiology: A Web-Based Learning Tool for Medical Students

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Purpose
Neuroradiology plays an integral role in the diagnosis of neurologic conditions. It is important for medical students to have an understanding of the different types of imaging studies that are used to assist in the diagnosis of diseases affecting the brain and spine as well as the indications and contraindications of imaging tests. We have converted a lecture-based neuroradiology curriculum for 3rd and 4th year medical students into a self-paced website that enables students to learn about Neuroradiology. This interactive web-based learning module provides the student an opportunity to review neuroimaging techniques, learn neuroanatomy and navigate through a series of cases that review core concepts in the neurosciences.
Materials and Methods
Using a Google platform we were able to create a site that is easily authored by course instructors. The instructional website can be accessed by students from any location and any web-based viewing device. The site has several primary sections including a homepage, a section on imaging techniques, a section on neuroanatomy and a section with cases. The URL for the site is www.learningneuroradiology.com.

Results
At the end of the learning module, students should be able to recognize the differences between CT and MR imaging (MRI) scans of the brain and spine, understand the most common indications and contraindications for brain and spine imaging and understand the indications for contrast in neuroimaging. Students also should be able to identify important anatomical structures of the brain and spine and recognize patterns of disease including intracranial hemorrhage, stroke, tumor, infection and multiple sclerosis.

Conclusions
Medical students now require alternative tools for learning beyond a traditional lecture-based curriculum. This self-paced learning module is an effective tool that teaches students Neuroradiology and can be integrated into any Radiology, Neurology or Neurosurgery elective.

KEYWORDS: Educational, Medical Education

eEdE-116

Limbic Encephalitis: What is new in Paraneoplastic Syndromes, Autoimmune Diseases and Infections?

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Purpose
1) To classify limbic encephalitis according to etiology and pathophysiology. 2) To describe MRI findings of the different subtypes of limbic encephalitis. 3) To review the differential diagnosis with other causes of temporal lobe involvement (tumor, trauma...)

Materials and Methods
In this poster we review the MR imaging (MRI) findings of limbic encephalitis and illustrate other possible causes of temporal lobe involvement.

Results
Limbic encephalitis is an uncommon entity with a subacute clinical presentation characterized by impaired short-term memory, confusion, seizures and psychiatric disorders. The most common causes are infectious and autoimmune diseases. In infectious limbic encephalitis, the herpes simplex virus type I (HSV-1) is the most commonly implicated agent. In limbic encephalitis with autoimmune origin, antibodies against neural antigens are created in the central nervous system. This encephalitis can be classified in turn as paraneoplastic and nonparaneoplastic. Antibodies in paraneoplastic encephalitis are developed predominantly against intracellular antigens (anti-Hu, anti-Ma2, anti CV2/CRMP-5), but not exclusively. Tumors most commonly associated with temporal lobe involvement are those of lung, breast and testicular origin, non-Hodgkin lymphoma, teratoma, and thymoma. In the case of autoimmune encephalitis of nonparaneoplastic
source, the antibodies are mainly produced against the cell membrane antigens, including some involved in paraneoplastic encephalitis such as NMDA receptors, AMPA receptors, GABAB receptors, anti-GAD and the classic voltage-gated potassium channels (VGKC), which are currently under investigation and known as the VGKC-complex antigens (LGI1, CASPR2 and contactin-2).

Conclusions
Advances in clinical knowledge, pathophysiology and immunology of limbic encephalitis have allowed a better characterization of the disease with a higher chance of treatment. To be familiar with imaging findings is of great importance in the timely diagnosis, appropriate treatment and patient's clinical course.

KEYWORDS: Autoimmune, Limbic Encephalitis, Paraneoplastic

**Median Raphe of the Pharynx - Complete or Not**

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Purpose
Describe the median raphe of the pharynx and discuss whether its complete or not to evaluate its importance to limit spread of infection or cancer.

Materials and Methods
Clinical database was evaluated retrospectively to illustrate normal, variant and pathologic anatomy in patients with infections and cancers. Correlation with described fascial planes was done to look for variations to the normal anatomy.

Results
Median raphe is a septum attaching the pharynx to the cervical spine. The anatomy of the raphe has not been described well. This exhibit aims to define the raphe and its extent as well its clinical significance. During discussions of the fascial planes, the raphe often is overlooked. The present exhibit aims to define it as an important structure that limits the spread of pathology from one side of the neck to the other. The relevant conditions include kissing carotid arteries, retropharyngeal infections, nasopharyngeal and oropharyngeal cancers.

Conclusions
Median raphe of the pharynx is an important structure that tethers the pharynx to the spine and is deficient beyond the pharyngoesophageal junction. It limits spread of pathology from one side of the neck to the other in the upper neck.

KEYWORDS: Anatomy

**Middle Ear Masses: A pictorial Review.**
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Purpose
The literature describes multiple disorders that affect the middle ear; however, often the descriptions are vague and differential diagnoses are poorly formulated. The purpose of this exhibit is to review the differential diagnosis of mass lesions that affect the middle ear and present a systematic approach to these entities using their principal location and specific imaging features on CT and MR imaging (MRI).

Materials and Methods
This exhibit discusses the appearance of tumors and other lesions that affect the middle ear using CT and MRI. We researched the literature and then selected appropriate examples from our teaching files to develop an organized and rational approach to the differential diagnosis of middle ear masses.

Results
One can narrow the differential based on the specific subsite or structures involved. Common characteristic locations include: Prussak's space and adjacent to the tympanic membrane (acquired cholesteatomas); along the tegmen tympani (cephaloceles); along the cochlear promontory (paraganglioma); and along the canal for the tympanic segment of the facial nerve (schwannoma). Some masses, including choristomas, hemangiomas, congenital cholesteatomas, adenomatous tumors, sarcomas, metastases, myeloma, and infections occur anywhere in the middle ear; however most of these are rare. In addition, vascular variants like aberrant ICA and dehiscent jugular bulb can be mistaken for intratympanic masses clinically. The presence or absence of bone erosion and the type of erosion can further subdivide these lesions into those that cause no or smooth bone erosion such as small glomus tympanicum tumors, hemangiomas, schwannomas, small cholesteatomas, and choristomas. Masses which result in more aggressive bone erosion include those described above when large, as well as jugulotympanic paragangliomas, sarcomas, carcinomas, metastases, myeloma and infections. When the tegmen tympani is violated, one also must include encephaloceles and meningoceles, which tend to spare other bony structures. Cholesteatoma of the mural type is the only lesion which may result in bone erosion without a mass. Although the diagnosis of middle ear masses is primarily based on CT, MRI allows for assessment of intracranial extension, lesion enhancement, and ADC of lesions which, when decreased, may suggest cholesteatoma, abscess, or malignancy. Hyperintensity on unenhanced T1-weighted imaging is virtually pathognomonic for cholesterol granuloma, while lesion enhancement should suggest neoplasm or granulation tissue. Digital subtraction angiography (DSA) should only be used if the mass is suspected to be hypervascular based on its MRI appearance and/or if pre-operative embolization is being considered.

Conclusions
Although middle ear masses can exhibit varying and nonspecific imaging manifestations, they usually can be characterized based on location and specific radiologic characteristics. In many cases CT and MRI can establish the diagnosis or help narrow the differential, oftentimes obviating the need for exploratory middle ear surgery.

KEYWORDS: Cholesteatoma, Middle Ear, Temporal Bone

eEdE-109
Mirror, Mirror, on the Wall, Which Is the Greatest Salivary Gland of All?

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Purpose
The parotid gland is the most noble of the salivary glands. In this exhibit, the embryology, anatomy, and imaging landmarks of the parotid gland will be reviewed, followed by a discussion of the key imaging findings of the different parotid masses, illustrated with cases from our institution.

Materials and Methods
A search of our PACS will be undertaken to identify the cases of parotid masses. The cases that best illustrate the typical imaging findings on computed tomography (CT) and MR imaging (MRI) of each type of parotid lesion will be retained and used as examples in this exhibit.

Results
The parotid gland has several unique features, being the only secretory gland to have both an important motor nerve running through it, and lymph nodes within its parenchyma. These properties, as well as the important landmarks of the gland, must be thoroughly understood, as certain disease processes can be recognized based on how they affect these structures, which, in turn, will alter any potential surgical management. For this reason, imaging plays a crucial role in the evaluation of parotid gland masses. The CT and MRI findings of the different parotid gland masses will be discussed and examples of each will be given.

Conclusions
Of all the salivary glands, the parotid has the most unique anatomy and relation to several important structures in the head and neck. These features must be recognized and taken into consideration when imaging parotid lesions, in order to better determine the type of lesion, and to guide surgical management.

KEYWORDS: Anatomy, Masses, Parotid Gland
T1 and T2 hyperintense lesion that completely suppresses on fat-saturated sequences, extending from the parotid space to the parapharyngeal space through the stylo-mandibular tunnel, in keeping with a lipoma.
imaging (DWI) has revolutionized our ability to detect acute to early subacute infarctions. Many ischemic insults are tiny in size but result in significant symptomatology as they affect a complex area of the brain, e.g., the brainstem. These tiny infarctions often are missed because of suboptimal imaging (e.g., too thick slice thickness) or their decreased conspicuity on the various sequences including DWI. Comprehensive knowledge of the structural and functional anatomy of the brain can predict the location of the ischemic insult based on patient's presentation and clinical findings facilitating: #1 appropriate protocolling of MRI examinations, #2 identification of those tiny infarctions that may be otherwise easily overlooked.

Materials and Methods
A series of tiny to small stroke cases will be presented in a quiz format. Each case will start with the initial stroke symptoms and clinical findings prompting the radiologist to predict the expected site of pathology. Subsequently, the MRI correlates will be displayed and the key anatomy will be discussed using diagrams and/or animations.

Results
Comprehensive review of the structural anatomy will be performed focusing on the clinical presentation of tiny/small ischemic insults to specific, often complex areas of the brain such as: basal ganglia nuclei, different tracts in the internal capsule, thalamic nuclei, brainstem cranial nerve nuclei and specific white matter tracts, cerebellum, as well as cerebral and cerebellar peduncles. The vascular supply also will be discussed briefly.

Conclusions
Radiologists play an important role in the multidisciplinary evaluation and triaging of patients with acute stroke. Tiny infarctions may be difficult to detect requiring a comprehensive knowledge of the structural and functional anatomy of the brain. After completing this exhibit, the radiologist will more confidently correlate presenting symptoms to anatomical regions of concern and will be able to tailor the study to optimize detection of more subtle infarctions.

KEYWORDS: Brainstem, Stroke, Thalamic

eEdE-101


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Purpose
Upper airway includes nasopharyngeal to larynx. Disease entities causing acute upper airway obstruction usually are serious and life-threatening, and require immediate diagnosis and intervention. Imaging often plays an important role for accurate identification of the pathology causing upper airway obstruction. The aim of this exhibit is to describe different type of diseases causing acute upper airway obstruction, imaging techniques for evaluation and discuss the treatment, common pitfalls and clinical course of those diseases.

Materials and Methods
All cases are gathered from Baystate Health System between 2008-13. The disease entities
described are divided into different categories. They are evaluated by multimodal imaging, highlighting relevant embryologic anatomy and associated anomalies. The goal is not only to review each lesion, but to highlight potential diagnostic pitfalls, optimal imaging techniques/sequences, and current best-practice guidelines in order to streamline care.

Results
The exhibit will begin with signs of acute upper airway obstruction. Different causes of obstruction are illustrated, combining the patients's clinical history and imaging findings. Common diseases causing upper airway obstruction are described, including trauma, infectious or inflammatory diseases, foreign body, .... In some cases, radiologic-pathologic correlation are provided. Benefits and pitfalls of different imaging techniques are discussed. The treatment option and clinical course of the diseases are briefly mentioned.

Conclusions
Acute airway obstruction is a serious condition which needs urgent intervention. Clinical history often provides very useful information. Radiographic imaging are extremely important tools for detecting the underlying etiology. At the end of this exhibit, the reader will be able to accurately identify signs of acute upper airway obstruction, find most suitable imaging technique for evaluation, and help make proper diagnoses, so that timely treatment can be initiated.

KEYWORDS: Emergencies, Head And Neck
Sensorineural Hearing Loss: A Review of Cross Sectional Imaging Findings

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Purpose
To demonstrate the spectrum of radiographic findings of the various structural causes of sensorineural hearing loss.

Materials and Methods
Several cases have been collected that illustrate the multimodal imaging manifestations of both the common and rare diseases of the inner ear, internal auditory meatus, cerebellopontine angle and the vestibulocochlear nerve, all of which often represent pathology that primarily presents with sensorineural hearing loss (SNHL). In order to be able to identify the myriad of abnormalities, many of which can have a very subtle appearance, the neuroradiologist must be familiar with the intricate details of the normal anatomy and anatomical variants of the inner ear. After reviewing these cases and the available literature, we describe the relevant imaging findings, anatomical details and pathophysiological processes that underlie these pathologies.

Results
Hearing loss represents a major public health problem. It is the third most common chronic condition in older Americans after hypertension and arthritis. Sensorineural hearing loss is a common reason for referral for cross-sectional imaging. The most common causes of SNHL include noise exposure, ototoxicity and presbycusis which are most often due to dysfunction of the hair cells of the organ of Corti and cannot be appreciated on imaging. Neuroimaging frequently is required to exclude congenital malformation, central or peripheral nervous system neoplasm, vascular malformations and trauma amongst other etiologies. This exhibit is intended to give a comprehensive review of these pathologies. Of the potential causes of SNHL which are identifiable on imaging, vestibular schwannomas are the most common. As this is a common presentation, we have explored in some detail both the typical and unusual features of vestibular schwannomas. However, many uncommon causes of sensorineural hearing loss have typical, although subtle, features on neuroimaging that neuroradiologists should be familiar with in order to not miss other potential diagnoses. Some of the cases included demonstrate cerebellopontine angle meningioma, pilocytic astrocytoma, glioma, Wegner's granulomatosis, metastases, arachnoid cyst, hemangioma and epidermoid cyst. Cases which focus on the inner ear include temporal bone fracture, large endolymphatic sac anomaly, large vestibular aqueduct syndrome, endolymphatic sac tumor, endolymphatic sac, aneurysmal bone cyst, otosclerosis, and Ramsay-Hunt syndrome. Although the management of the pathologies is varied, many of these patients progress to consideration of cochlear implants. Therefore, the neuroradiologist must have an awareness of "what the clinician needs to know" including the pertinent features that deem a candidate suitable for cochlear implants.

Conclusions
As neuroradiologists we should be familiar with the many possible causes of SNHL in order to correctly characterize pathology of the cochlear and retrocochlear auditory pathway.

KEYWORDS: Inner Ear, Sensorineural Hearing Loss, Vestibulocochlear Nerve

6:30AM - 9:00PM
Skull Base: Review of anatomy, imaging technique, and illustration of common benign and malignant tumors at the skull base.

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Purpose
To provide an overview of the skull base anatomy including the bones, apertures and contents. Discuss the skull base imaging technique at our institution and illustrate imaging features of some common benign and malignant skull base tumors.

Materials and Methods
After obtaining IRB approval, our database will be searched for pathologies of interest utilizing the RadQuery software at our institution.

Results
The exhibit will discuss and illustrate the normal skull base anatomy followed by a discussion of the skull base imaging technique and illustration of some common benign and malignant skull base tumors: Benign tumors (paragangliomas (glomus jugulare), nerve sheath tumors, meningiomas, chordomas) and malignant tumors (metastases, lymphoma/leukemia, myeloma, chondrosarcoma and osteosarcoma).

Conclusions
After reading the exhibit, the radiologist will have a better understanding of the skull base anatomy, imaging technique and will become familiar with the imaging features of some common benign and malignant skull base tumors.

KEYWORDS: Skull Base Neoplasms
Systematic Approach to Hyperdense Intracranial Masses

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Purpose

Hyperdense intracranial lesions are a common finding on noncontrast CT with hemorrhage being the most common cause. However, a number of additional processes can present as hyperdense lesion on CT scan which can be benign or malignant. Distinguishing between the two can be challenging and is critical for patient care as miss of a malignant lesion can prove to be fatal. Although there is overlap in imaging findings, radiologists can play a critical role in identifying key imaging feature which can be helpful in distinguishing these lesions and arriving at the diagnosis promptly. We aim to present a case based pictorial essay of hyperdense intracranial masses highlighting key points that can help to narrow the differential diagnosis.
Materials and Methods
Case-based demonstration of common and uncommon causes of hyperdense intracranial lesions. Case examples include: malignant fibrous histiocytoma, hemangiopericytoma, hematoma, lymphoma, metastasis, abscess, meningioma, gliomas, desmoids, esthesioneuroblastoma, etc. Discussion of their different clinical findings, imaging feature, treatment and prognosis of the presented entities will be discussed. A flowchart of salient features for quick reference will help summarize these key points.

Results
This exhibit focuses on the imaging findings of hyperdense intracranial masses with radiology-pathology correlation that can assist in narrowing the differential diagnosis. A stepwise approach will be used for each entity to narrow the differential diagnosis by identifying if the disease as solitary or multifocal; symmetric or asymmetric; intracranial location; presence osseous changes and involves the soft tissues. Key findings on magnetic resonance imaging (MRI) sequences (DWI, SWI, DTI, etc.) can further help delineate origin of the lesion.

Conclusions
Hyperdense intracranial lesions are a common finding on noncontrast CT and their presence should be explained as these may be from a benign or malignant process. The differential diagnosis can be narrowed utilizing age, clinical features, and imaging characteristics of the hyperdense lesion (e.g., MRI findings, enhancement pattern, necrosis, cystic degeneration, etc.). By the conclusion of the presentation, the viewer should be able to aid in the work up, guide any potential biopsy and recommend appropriate imaging follow up.

KEYWORDS: AVM, Esthesioneuroblastoma, Neoplasm
That's a Nothing: Common Brain MR Artifacts and Pitfalls Encountered by Radiologists in Training

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Purpose
To the untrained eye, artifacts, normal variants, and physiologic developmental changes encountered on brain MR can be mistaken for disease. The purpose of this exhibit is to depict some of the more common of these pathologic mimickers.

Materials and Methods
Selected images from brain MR exams depicting various artifacts, variants, and normal phenomena are reviewed and exhibited. Didactic explanations will be provided with correlative CT images when appropriate.

Results
Many types of signal alterations on brain MR examinations are nonpathologic. While elementary to the seasoned radiologist, they may be a source of distress to the radiologist in training. It is imperative that these disease imitators be recognized as such. In this exhibit, signal changes reflecting the following entities will be presented: cerebrospinal fluid (CSF) flow voids, vascular pulsation artifact, perivascular spaces, parenchymal and meningeal mineralization, immature myelin/terminal myelination zones, arachnoid granulations, asymmetric petrous apex pneumatization, diffusion-weighted imaging (DWI) skull base artifacts, and corticospinal tract/optic radiation hyperintensity.

Conclusions
Signal alterations reflecting nonpathologic processes such as artifacts and variant anatomy are commonly encountered on brain MR. It is important for radiologists in training to recognize the common appearance of these various signal changes to avoid misdiagnoses.

KEYWORDS: Artifacts, Normal Variant
The Embryologic Cervical Aortic Arch

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Purpose
Since its original description in 1914, the cervical aortic arch has been variably defined throughout the literature. The most common usage of the term is as a general descriptor of an abnormally high position of the aortic arch extending into the lower neck, potentially presenting clinically as a pulsatile mass. However, this definition encompasses a wide variety of underlying aortic arch configurations, ranging from pseudocoarctation and circumflex aortic arches to what we define as the embryologically true cervical aortic arch. The purpose of this study was to review the cervical aortic arches described in the literature, identify the number of cases representing true cervical aortic arches, and reclassify the remaining arch types.
Materials and Methods
A PubMed search of the literature was conducted using the search term "cervical aortic arch", limiting the text search field to Title/Abstract and English. This yielded 54 search results. Nine of the articles were excluded due to inadequate description or imaging, such that the final number of articles for review was 45. Three articles presented two separate cases, with a final sample size of 48 cases. The images depicting the individual cases were reviewed by one diagnostic neuroradiologist, one interventional neuroradiologist, and one anatomist/medical illustrator. Based on aortic arch embryology and the spectrum of aortic arches presented in the reviewed cases, the following classification scheme was identified: Type 1: True embryologic cervical aortic arch (with separate origins of the internal and external carotid arteries from the arch), Type 2: Right aortic arch with aberrant left subclavian artery, Type 3: Left circumflex aortic arch, and Type 4: Right circumflex aortic arch. Each case then was classified collectively by the group with one or a combination of these aortic arch types. A Type 0 arch represented aortic arches that had normal branching patterns.

Results
Of the 48 cases reviewed, 19/48 (39.6%) of cases were Type 0 (reflecting coarctation or pseudocoarctation), 7/48 (14.6%) of cases were Type 1 (Figure 1A), 4/48 (8.3%) of cases were Type 2, 4/48 (8.3%) of cases were Type 3, and 12/48 (25%) of cases were Type 4 aortic arches (Figure 1B). One additional case exhibited features of both a Type 1 and Type 3 aortic arch. Another single case exhibited features of both a Type 1 and Type 4 aortic arch.

Conclusions
Our findings demonstrate the various types of aortic arches that have become included under the umbrella term "cervical aortic arch," which is applied widely to any type of aortic arch that extends into the neck. However, we believe that a more precise and developmentally correct description of aortic arches is warranted, including recognition of "true" cervical aortic arches where the third arch persists in an embryologically high position in the neck with separate origins of the internal and external carotid arteries. Other types of aortic arches are best described based on their underlying ascending, branching and descending configuration, as well as the degree of cervical extension. True cervical aortic arches are always positioned cephalad because of their embryologic third arch origin. Other types of arches with regression of the third arch that demonstrate extension into the neck likely reflect a varying spectrum of migrational anomaly secondarily in the developing embryo. Normal arches (39.6%) and right circumflex arches (25%) were misidentified most commonly as cervical arches.

KEYWORDS: Anatomy, Aortic Coarctation
The Lost Art of Interpreting Skull Abnormalities: Appearance on CT and MRI Imaging

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Purpose
At one time, skull plain films played an important part in diagnosing intracranial abnormalities and systemic disease. As CT scanning and MR imaging (MRI) have become more prevalent in cranial imaging, skull plain film images have become relatively rare. Frequently, radiologists are
more familiar with the findings of the intracranial contents than the skull. The purpose of this exhibit is to examine the lesions that can occur in the cranium and demonstrate their appearance on CT and MRI. An approach to the differential diagnosis of these lesions will help the radiologist comfortably evaluate these lesions.

Materials and Methods
The electronic exhibit will review pertinent anatomy and review various skull abnormalities in that context. Computed tomography (CT) and MRI images of various cranial lesions with discussion will delineate these findings and aid the radiologist in diagnosing these lesions.

Results
The cases presented will include congenital/developmental changes, metabolic and hematologic changes, and benign and malignant lesions and other various abnormalities, such as Paget's. Their characteristics will be contrasted with other similar lesions to help develop a differential of these lesions. Their involvement in the inner or outer tables or the diploic space, and their densities also will help to narrow the differential of a particular lesion.

Conclusions
Many radiologists are not comfortable with the diagnosis of skull abnormalities. This exhibit is designed to examine the spectrum of changes in the cranium and to aid the radiologist in developing a differential diagnosis of any finding in the skull.

KEYWORDS: Differential Diagnosis, Skull

eEdE-114

The Piccadilly Circus of the Head and Neck: Cross Sectional Imaging and Angiography of the Pterygopalatine Fossa

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Purpose
The pterygopalatine fossa (PPF) is the convergence of numerous structures of the oral and nasal cavities, nasopharynx, orbits, masticator space, cavernous sinus, and the middle cranial fossa. The PPF may permit spread of tumor and infection to and from the skull base and head and neck. Knowledge of its anatomy and involvement in various disease processes is imperative for neuroradiologists. This educational exhibit reviews the anatomy of the PPF and its connections, as well as various pathologies involving this region.

Materials and Methods
Anatomy of the PPF, including its connections and boundaries, are reviewed using multiple imaging modalities. Numerous pathologic processes involving the PPF are presented. Further demonstration is made of routes of spread of disease through the PPF with attention to specific implications for surgical and radiation therapy planning.

Results
The boundaries of the PPF, as well as its contents and communications, are readily evaluated by computed tomography (CT) and MR imaging (MRI). Illustrative examples provided include perineural and local spread of malignancy, osseous tumors, lymphoma, juvenile nasopharyngeal
angiofibroma, meningeal pathologies, and infection. To tailor evaluation for these processes, utility of specific MRI sequences is discussed. Angiography also is considered as appropriate, specifically with respect to the role of endovascular therapies.

Conclusions
Knowledge of the complex anatomy of the PPF is essential for neuroradiologists. Important anatomical relationships with the orbit, nasal and oral cavities, nasopharynx, masticator space, and middle cranial fossa can be evaluated with cross-sectional imaging and angiography. Such relationships are crucial for identifying easily missed processes and spread of disease. Knowledge of these structures and processes allows neuroradiologists to better inform therapeutic management.

KEYWORDS: Anatomy, Angiography, MR Imaging

eEdE-119

6:30AM - 9:00PM

The truth will set you free: what you need to know about the autonomic ganglia in the head and neck

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Purpose
The autonomic nervous system is formed by two functional divisions, sympathetic (thoracolumbar) and parasympathetic (cranio-cervical and sacral). The purpose of this exhibit is to review the cranio-cervical autonomic system, detailing the anatomy and locations of its corresponding ganglia and nerve supply, using cross-sectional imaging examples, as well as discussing their function and presenting examples of their most frequent pathology.

Materials and Methods
A complete literature review of the autonomic nervous system anatomy and function will be reviewed and discussed in the exhibit. After obtaining IRB approval, our database will be searched for pathologies of interest at our institution.

Results
The autonomic nervous system is concerned with processes normally beyond voluntary control and consciousness. The effects of its two divisions, sympathetic and parasympathetic on the organs, are antagonistic. The stimulation of the sympathetic division results in outburst of activity (fight and flight), while stimulation of the parasympathetic division results in effects concerned with conservative and restorative processes. In this exposition we will review the cranio-cervical autonomic nervous system, detailing the anatomy and locations of its corresponding ganglia and nerve supply (otic, pterygopalatine, ciliary, submandibular, etc.), using cross-sectional imaging examples, as well as discussing their function and presenting examples of their most frequent pathology, such as perineural spread of tumor and carotid dissection causing Horner's syndrome.

Conclusions
After reading the exhibit, the reader will have a better understanding of the anatomy, distribution, function and imaging findings of the cranio-cervical autonomic system, with examples of its most frequent pathology.
SCG - Superior cervical ganglion, MCG - Middle cervical ganglion
CTG - cervicothoracic or stellate ganglion
ICA - Common Carotid artery, IJV - Internal jugular vein, SY.Ch - Sympathetic chain

Triangles in Neuroradiology

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6:30AM - 9:00PM
Purpose
Geometric shapes can be very helpful in identifying both anatomy and pathology. A review of
the notable triangles within the field of neurology and neuroradiology will be presented, as well
as a brief biography of the historical figures responsible. The importance of these structures and
relevant anatomy in relation to pathology will be presented.

Materials and Methods
Several triangles in neuroradiology are discussed with illustrative images. Some triangles refer to
triangles constructed by actual contents, such as the myoclonic triangle or the superior sagittal
sinus. Other useful triangles are inferred by the relationship of adjacent structures, such as the
retrotracheal triangle, sylvian triangle, and Wackenheim's triangle of silence.

Results
The myoclonic triangle, also known eponymously as the triangle of Gillian and Molleret, is a
feedback circuit involving the deep cerebellar nuclei and brainstem. The rubro-olivary tract,
inferior olivary nucleus, Purkinje cells, and dentate nucleus are involved in this circuit, which
modulates motor function in the spinal cord. The dense triangle and empty triangle signs can be
used to identify venous sinus thrombosis on unenhanced and contrast-enhanced CTs,
respectively. The sylvian triangle is an inferred structure visible on lateral projections during
cerebral angiography. Bounded by middle cerebral artery branches, this landmark can indicate
presence and location of supratentorial masses. Wackenheim's triangle of silence is an additional
angiographic marker of intracranial mass effect inferred by the venous drainage of the posterior
fossa. Surgical triangles relied upon for operations involving the cavernous sinus or adjacent
structures can be discerned in neuroradiology. In head and neck imaging, the retrotracheal
triangle, also known as the Raider triangle, can be used to identify subtle plain film evidence of
vascular, esophageal, mediastinal, and neck soft tissue pathologies.

Conclusions
The use of triangles, both perceived and inferred, can aid in understanding and identification of
subtle pathologies in neuroradiology, as well as aiding understanding of fundamental
neuroanatomy.

KEYWORDS: Anatomy, Educational

eEdE-126

Unusual patterns of arachnoid granulations: A pictorial review:

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General Hospital, McGill University Health Centre, Montreal, Quebec, 3Montreal General
Hospital, McGill University Health Centre, Montreal, QC

Purpose
The purpose of this educational exhibit is to review unusual patterns of arachnoid granulations.

Materials and Methods
We shall present a variety of unusual cases of Arachnoid Granulations mimicking pathologic
conditions on computed tomography (CT) and magnetic resonance imaging (MRI).
Results
Arachnoid granulations are commonly seen on CT scan and brain MRI. In a minority of cases, these arachnoid granulations may present unusual imaging patterns. Imaging findings may include large erosions in the inner table or even complete defects in the calvarium, suggesting a pathological lytic process in the skull. They may also penetrate into the dural sinuses mimicking the pattern of dural sinus thrombosis.

Conclusions
A radiologist should be familiar with unusual patterns of arachnoid granulations in order for them to be differentiated from pathologic entities.

KEYWORDS: Arachnoid Granulation, Dural Sinus, Skull

What Stems from the Brainstem?

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Purpose
Pathologies affecting the brainstem are diverse and occasionally can be challenging to differentiate on imaging because of their nonspecific appearance. The purpose of this exhibit is to categorize brainstem lesions, and to describe their epidemiology, presentation, key imaging findings, and differential diagnoses.

Materials and Methods
Brainstem lesions can be classified as focal or diffuse, with further subdivisions based on etiology. A search of our PACS will be undertaken to identify patients with brainstem lesions. The cases that best illustrate the typical imaging findings of lesions in each category will be retained and used as examples in this exhibit.

Results
Brainstem lesions can be classified as focal or diffuse. Focal lesions generally are well defined and confined to a single brainstem segment, whereas diffuse lesions are larger, with ill-defined borders, occupying more than half of a brainstem segment, or extending across more than one segment. Focal and diffuse brainstem lesions can be further subdivided into tumor, ischemic, infectious, demyelinating, degenerative, metabolic, traumatic, and vascular. Some of these entities can present both as focal and as diffuse lesions. Examples of each category will be illustrated with cases from our institutions, and their characteristics and imaging findings will be highlighted.

Conclusions
Because brainstem pathologies can be so diverse, it is useful to divide them into categories to facilitate conceptualization. Placing brainstem lesions into categories, presenting different examples in each category, and reviewing their characteristics will enable better differentiation and identification of such lesions on imaging.
What’s Eating You?: Destructive Lesions of the Skull Base

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Purpose
• A systematic approach for imaging and diagnosing invasive osseous skull base lesions. • How to evaluate the neural foramina and correctly identify involvement of nerves and vessel. • Key concepts regarding CT and MR evaluation destructive skull base lesions. • Common and uncommon patterns of disease presentation of invasive skull base lesions.
Materials and Methods
Cases selected from the teaching file of three major medical centers will be presented in a quiz format to demonstrate destructive skull base lesions. Pertinent anatomy is presented using illustrations, animations and corresponding cross-sectional images.

Results
After a comprehensive review of the key anatomical points cases are shown to demonstrate patterns of disease presentation. Key anatomical structures that need to be evaluated in specific areas are emphasized. Pathology presented: Cholesterol granuloma, Chordoma, Giant cell tumor, Metastasis, Invasive pituitary adenoma, Interosseous meningioma, Mastoiditis with osseous break through, Paraganglioma, Wegner's granulomatosis, Schwannoma, Malignant otitis externa and Fibrous dysplasia.

Conclusions
Many different types of pathologic processes involve the skull base ranging from primary neoplasms, secondary invasion from head and neck neoplasms, intracranial neoplasms and infectious or inflammatory processes. What is unique to the skull base is that diseases can spread from the head and neck to the brain/intracranial compartment and vice versa. An in-depth understanding of the anatomy and anatomical structures within the neural foramina can help localize the disease process and lead to the proper diagnosis and treatment. An understanding of the common pathways of disease spread through neural foramina and into the soft tissues of the head and neck is required to localize the primary site of disease as well as detect and predict spread to adjacent areas. This multi-media educational exhibit will present a concise and rational approach to evaluating and diagnosing lesions involving the skull base and neural foramina.

KEYWORDS: Neural Foramen

When Zebras Look Like Horses: Atypical Teratoid-Rhabdoid Tumor (AT-RT) and its Mimics

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Purpose
Atypical Teratoid-Rhabdoid Tumor (AT-RT) is a malignancy of early childhood with a rapid and devastating course. Because AT-RT was described only relatively recently (1), and has imaging and histological characteristics that overlap with less aggressive neoplasms, AT-RT presents a diagnostic challenge. Further, Hilden et al (2) have demonstrated improved survival time with new intensive therapies, making early and accurate diagnosis critical. The aim of this educational exhibit is to describe AT-RT both generally and in contradistinction to its potential mimics in the posterior fossa and supratentorially, so that early diagnosis can lead immediate intervention and increased survival.

Materials and Methods
All cases have been gathered at Baystate Hospital between 2005-2013, with histological correlates provided. An extensive literature search will be performed to describe AT-RT,
medulloblastoma (MB) and supratentorial primitive neuroectodermal tumor (S-PNET) in terms of the classical six questions of journalism: who, what, when, where, how (it presents), and why we care (treatment).

Results

Who (pathology). The sine qua non of AT-RT is a population of rhabdoid tumor cells that demonstrates brisk mitotic activity. In over 70% of lesions, sheets of primitive neuroectodermal cells are present which may obscure the rhabdoid component, leading to a misdiagnosis of S-PNET or MB (3). Immunohistochemical markers now reliably differentiate the entities. Grossly, there is a variable degree of hemorrhage, necrosis, and calcification. When (epidemiology). AT-RT typically presents earlier than MB, with a mean age of approximately 2 years, but is roughly coeval with S-PNET. While the overall incidence has increased artifically due to refinement in immunohistochemical analysis, AT-RT remains rare, composing only 7% of CNS tumors in children less than two years of age (4). No gender or racial predominance has been reported.

What (it looks like). There is overlap in the imaging characteristic of AT-RT and its mimics. The lesions tend to be hyperdense on CT, mixed on both T2- and T1-weighted images, and demonstrate heterogeneous but strong enhancement. Characteristics which may help differentiate AT-RT are a cystic component and foci of T1-shortening (4). All lesions may demonstrate restricted diffusion. Where. AT-RT may arise in the posterior fossa (50%), supratentorially (40%) or in both compartments. Localization in the cerebellopontine angle is suggestive of AT-RT. How (presentation). Presentation is nonspecific and may stem either from increased intracranial pressure or local distortion of brain parenchyma. Why we care (natural history and treatment). Whereas PNET-MB may be treated with subtotal resection and traditional chemotherapy, these measures have been ineffective with AT-RT. Recently, both total resection and myeloablative chemotherapy with autologous stem cell rescue have been shown to improve survivability (5).

Conclusions

AT-RT is an aggressive malignancy of the central nervous system in very young children. Because new therapies are being developed, familiarity with this rare entity is critical. Further, the radiologist may yet play a critical role in differentiating AT-RT from its more commonplace mimics, guiding the interdisciplinary team to confirmatory immunohistochemistry and a better outcome for the child.

KEYWORDS: ATRT, Pediatric Neoplasms
“Going for the jugular”: A computer-interactive, case-based review of jugular foramen “lesions.”

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Purpose
1) Recognize the computed tomography (CT) and MR imaging (MRI) characteristics of jugular foramen lesions, including common and uncommon benign and aggressive pathology. 2) Understand the anatomy of the jugular foramen and the surrounding posterior skull base.

Materials and Methods
To facilitate review and discussion of jugular foramen lesions and anatomy, we present CT and MR imaging from representative cases in a computer-interactive quiz format. Unknown cases are followed by the diagnosis with discussion of each individual entity and key imaging characteristics. These cases also are used to demonstrate relevant anatomy.

Results
We present a selection of cases collected from our institutions of patients with jugular foramen lesions, both benign and malignant. Included are jugular paragangliomas, vagal paragangliomas that extend superiorly, schwannoma, meningioma, cholesterol granuloma, metastatic disease, jugular megabulb, high riding jugular bulb, jugular dehiscence, chordoma, Paget disease, and fibrous dysplasia. We emphasize key imaging characteristics of these entities and the complex anatomy of the jugular foramen and posterior skull base using annotated images followed by answers in an interactive quiz format. Figure shows a large enhancing paraganglioma in the right jugular foramen.

Conclusions
This educational exhibit demonstrates the varied common and uncommon, benign and malignant lesions arising from within or around the jugular foramen. Included is a discussion of their multimodality imaging characteristics and a discussion of the essential regional anatomy. We provide an interactive learning experience after which the reviewer will feel more confident when encountering a lesion in the jugular foramen.

KEYWORDS: Jugular Foramen, Metastases, Paraganglioma
Purpose
The utility of oblique sagittal computed tomography (CT) images in the depiction of the long axes of the malleus and incus, the long axis of the cochlea, the superior semicircular canal and the facial nerve canal is well documented (1). The purpose of this exhibit is to demonstrate the utility of nonoblique sagittal CT imaging in the evaluation of pathologic processes involving the temporal bone.

Materials and Methods
Two board-certified neuroradiologists retrospectively reviewed consecutive patients who had undergone high resolution CT of the temporal bone across five academic-affiliated institutions over a nine-month period. Scans were obtained on Aquilion (Toshiba), Sensation 16 (Siemens Healthcare), and Sensation 64 (Siemens Healthcare) scanners. The studies were performed at 0.5 – 1 mm section thickness and 0.3 – 1 mm spacing at 120 kV and 125–400 mAs. Sagittal reconstructions were created at the CT console with 1 mm thickness at 1 mm intervals and with zero angulation in the mediolateral plane. In cases of patient head rotation, sagittal images were reconstructed parallel to the long axis of the bony EAC. Temporal bone pathologies were categorized according to the anatomical subsites of external ear, mastoid/temporal cranial junction/petrous apex, middle ear, inner ear and vestibular aqueduct, and osseous foramina for the facial and vestibulocochlear nerves.

Results
We present infectious, inflammatory, traumatic, neoplastic, and vascular pathologies of the temporal bone with particular attention to the external auditory canal. Representative cases, also drawn from institutional teaching files, include malignant otitis externa, labyrinthitis ossificans, tegmen tympani dehiscence, paraganglioma, jugular diverticulum, and dilated vestibular aqueduct. Sagittal images are useful in evaluating oblique fractures or evaluating fractures which run parallel to the axial or coronal plane. Sagittal images also provide an excellent en-face evaluation of Prussak’s space and tympanic ring where attic cholesteatoma erosions can produce a dilated Prussak’s space six times as large in height and twice as large in width compared to normal individuals (2). Finally, sagittal images better evaluate the inferior wall of the tympanic facial nerve canal compared to axial and coronal images and may alert surgeons to facial nerve dehiscence (3).

Conclusions
The addition of nonoblique sagittal reformatted images to conventional axial and coronal views...
of the temporal bone improves the assessment of temporal bone pathology and optimizes pre-operative planning, especially in processes involving the bony external auditory canal.

KEYWORDS: Temporal Bone

Figure 1: CT Temporal bone without contrast in a 80-year-old female with left hearing loss. (A) Axial image of the left temporal bone demonstrates fusiform erosion and remodeling of the left EAC compatible with remote primary canal cholesteatoma. (B) Sagittal image at the same level best demonstrates the extent of bony thinning at the junction of the anterior and inferior walls of the EAC.

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A Bit of a Twist on Head and Neck Imaging: When PET/CT has made a significant impact on changing the course of action relative to the patient care decision making process.

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Purpose
The neuroradiologist with Head and Neck expertise should be familiar with the added benefits of PET/CT. We intend to illustrate the added value of PET/CT in Head and Neck imaging through presentation of cases where PET/CT had significant impact on patient care.

Materials and Methods
A retrospective review of PET/CT Head and Neck cases was performed from 2010-2013. Cases with interesting unexpected findings were identified and chart reviews were performed.

Results
The following cases will be presented in our exhibit: -Nasal carcinoma with septal involvement only seen on PET, not appreciated at CT, but positive on pathology. - Head and Neck cancer with unexpected distant metastasis during staging (liver, lung, pancreas, bone). - Unexpected nodal disease. - Post-therapy laryngeal carcinoma recurrence. - Detection of unknown primaries in cases presenting with cervical nodal disease. - Synchronous primary tumors. - Recurrences. - Metastasis during surveillance.

Conclusions
Even with dedicated Head and Neck radiologists, experienced oncologic surgeons, and high quality cross-sectional CT and MR imaging, PET/CT adds value to patient care. The addition of the metabolic information from PET is an important tool for caring for the patient with head and neck cancer. In this educational exhibit, we have shown how PET/CT can change stage, prevent unnecessary treatment, and reveal lesions that might not have been adequately treated.

KEYWORDS: Head And Neck, PET/CT

eEdE-164

AJCC Classification of Head and Neck Cancer: A Radiologist’s Perspective

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Purpose
Through this interactive model, the audience is made aware of the American Joint Committee on Cancer (AJCC) staging of various types of head and neck cancer using an algorithmic approach. We shall use a case-based approach focused on computed tomography (CT) and MR imaging (MRI) of different head and neck cancers involving the nasopharynx, oropharynx, oral cavity and larynx (amongst others). We shall emphasize normal anatomy as well as nodal staging to improve the participant's interpretation of these conditions.
Materials and Methods
A PACS search will be undertaken to identify selected cases. The representative images will be combined with multiple choice questions focusing on tumor location, tumor size and extent, invasion of surrounding structures, presence of nodal metastases and the presence of distal metastases, as to arrive at the correct TNM staging. Emphasis will be placed on the prognosis and management plan of each case.

Results
AJCC staging system is the most widely used staging system for cancers affecting the head and neck. Staging is considered an important means of communication between the referring physician and the interpreting radiologist. It helps with patient management and prognosis. The radiologist should be familiar with the staging system of head and neck cancer.

Conclusions
Accurate staging of head and neck cancer is an important element in the formulation of a management plan as well as determining the prognosis of various tumors. The radiologist's input is essential in staging and therefore knowledge of TNM staging is critical.

KEYWORDS: Cancer, Head And Neck, Staging
Findings:
Large right sided transglottic tumor, centered in the true vocal cord, and extending laterally into the paraglottic space.
It is extending to the supra- and infra-glottic regions and is invading the cricoid and thyroid cartilages.
No evidence of metastatic lymphadenopathy.

Stage T4AN0M0

(Filename: TCT_eEdE-164_Slide1.JPG)

eEdE-165

Approach to Sinonasal Pathology

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Purpose
The purpose of this electronic educational exhibit is to teach an organized approach to sinonasal imaging, using multiple didactic and interactive cases to illustrate key and practical concepts. This approach aids in the clinical triage of radiologic pathology, and stresses clinically important findings while avoiding common pitfalls. Particular attention is given to whether a process appears aggressive or indolent, and whether further imaging with MRI is warranted.

Materials and Methods
The exhibit is divided into CT, MRI, Nasal and Special Cases sections. The CT section emphasizes the importance of osseous erosion as a sign of aggressive disease. The participant will also characterize lesions by density. The major obstructive inflammatory patterns of sinus disease are reviewed, and the relevant anatomy illustrated. The MRI section emphasizes the superior sensitivity of MRI in fully evaluating the extent of aggressive disease, including soft tissue and bone marrow infiltration, and in distinguishing cystic components of masses from trapped secretions or mucosal hypertrophy. The Nasal section contains interactive cases that illustrate the relevant clinical anatomy and pathology.

Results
The participant will identify erosion as related to neoplastic and infectious processes and contrast their appearance with cases of bone remodeling and expansion, sinus atelectasis and pressure demineralization, which reflect more indolent processes. The participant will learn to distinguish the above from other osseous pathology, including fibrous dysplasia and Paget's. The participant will distinguish mucosal or polypoid lesions from masses, and recognize the hyperattenuating CT appearance of mycetoma, inspissated mucus, and blood products. The participant will differentiate mass-like enhancement from mucosal enhancement on MRI, and will learn to distinguish the restricted diffusion associated with a hypercellular mass from that of a viscous collection. The participant will also recognize MR signal loss in the sinuses related to fungal disease. The nasal section focuses on nasal septal pathology, and stresses the concept that any solid mass in the nasal region is potentially aggressive. The Special Cases section reviews the classic locations associated with the more common "anatomically distinctive" sinonasal tumors such as juvenile angiofibroma, and their typical appearance and distinguishing features, as well as clinically relevant pathophysiology. The exhibit concludes with a collection of multiple choice questions to test the participant's newly acquired knowledge.

Conclusions
An organized diagnostic approach to the sinonasal region is presented using multiple interactive cases to review and emphasize clinically relevant findings, help avoid common pitfalls, and aid in identifying distinguishing features of aggressive and indolent pathology.

KEYWORDS: Anatomy, Educational, Sinonasal Disease

eEdE-148

6:30AM - 9:00PM

Arterial Anomalies of the Middle Ear: A Pictorial Review with Clinical-Embryologic and Imaging Correlation

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Purpose
Arterial anomalies of the temporal bone are rare, but critical variations of anatomy which are important to detect on imaging studies. Failure to detect these abnormalities pre-operatively can lead to significant complications during middle ear surgery. A thorough understanding of the anatomy of the different types of persistent stapedial artery (PSA) in addition to the classical aberrant internal carotid artery is important for detecting these abnormalities.

Materials and Methods
The embryologic development of the aberrant internal carotid artery and persistent stapedial artery will be reviewed with a focus on anatomy. CT images from cases of aberrant internal carotid artery (ICA) and the various types of persistent stapedial artery will be displayed along with histopathologic and clinical correlates. The types of anomalies displayed will include PSA arising from the caroticotympanic artery, PSA arising from the inferior tympanic artery with an aberrant ICA, PSA arising from the inferior tympanic artery without an aberrant ICA, and PSA arising from a fenestrated internal carotid artery. In this variant, the internal carotid artery is present but small and there is a large vessel representing the inferior tympanic artery. These vessels join again to form a normally sized transverse petrous carotid artery.

Results
Anomalous arteries of the middle ear may be detected incidentally, or may present with symptoms or a retrotympanic red mass. Regardless, recognition of these vascular structures is vital to pre-operative patient care since misdiagnosis can lead to disastrous clinical consequences. While the CT appearance of aberrant internal carotid artery is characteristic, various types of PSA exist each with their own unique CT findings. Classically, PSA has been described as occurring with or without an aberrant ICA. A more detailed assessment of the embryology and anatomy of the four different types of PSA will enhance our understanding of these anomalies.

Conclusions
This review of the arterial anomalies of the middle ear will improve awareness of, and therefore detection of, these rare anomalies.

KEYWORDS: Middle Ear, Temporal Bone, Variants

eEdE-159

Can’t Take My Eyes Off the Post-op Eye: Comprehensive Imaging Assessment of the Post-operative Orbit in Adults and Children.

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¹University of Pennsylvania, Philadelphia, PA

Purpose
• To present a simplified, yet comprehensive and systematic review of the imaging spectrum of the post-operative orbit in adults and children. • To familiarize the radiologist with a broad range of oculoplastic and orbital surgeries and different types of orbital implants and prostheses. • To highlight the imaging features of potential surgical complications.
Materials and Methods
1) Orbital surgeries: a) Orbital wall reconstruction, orbital augmentation and decompression. b) Orbital enucleation, evisceration and exenteration with globe prostheses. 2) Lacrimal apparatus surgery such as dacryocystorhinostomy and nasolacrimal duct stents. 3) Strabismus surgery. 4) Glaucoma surgery. 5) Retinopexy and scleral buckles. 6) Lens surgery and implants. 7) Eyelid surgery such as blepharoplasty and eyelid weights.

Results
Imaging plays a pivotal role in the postoperative management of patients with orbital disease, facilitating early diagnosis of postoperative complications as well as long term follow-up assessment. The development of novel surgical approaches and techniques in oculoplastic and orbital surgery, as well as advances in the development of biocompatible materials offer a wide range of alternatives to traditional methods and implants for orbital surgeries.

Conclusions
Imaging assessment of the postoperative orbit remains challenging even for an experienced neuroradiologist. Oculoplastic and orbital surgeries are common and familiarity of radiologists with imaging findings of the wide ranging spectrum of postoperative changes are crucial as a part of multidisciplinary team.

KEYWORDS: Orbits, Postoperative Findings

Cervical Lymph Node Metastasis, a Systematic Review of CT, US, MRI and FDG-PET with pathological correlation.

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Purpose
Accurate identification of cervical lymph node metastasis is critical for head and neck staging, and has a significant impact on prognosis and treatment. Lymph node size, morphologic features, and metabolism evaluation can be used to distinguish physiologic and malignant lymph nodes. A systematic approach for evaluation of the lymph nodes is imperative for accurate diagnosis and management. This exhibit will provide an image-based review of the literature for the evaluation of cervical lymph nodes with pathologic correlation.

Materials and Methods
Review the most recent literature of cervical lymph node metastasis with guidelines for evaluation with computed tomography (CT), ultrasound (US), MR imaging (MRI) and FDG-positron emission tomography (PET). Review typical patterns of lymph node spread. Predict the unknown primary location of malignancy based on the anatomical location of cervical nodal metastasis. Illustrate imaging features associated with malignancy of cervical lymph nodes. Focusing on the specific features such as hyperenhancement, round shape, hypo-echoic appearance, central cystic component and extra-nodal extension. Review size criteria and SUV-max threshold for determining malignancy of cervical lymph nodes. Evaluate various methods used including short axis and long axis measurement with the specificity and sensitivity of each. Explain the role of imaging in pre-op planning for lymph node dissection. Rationale for use of
RECIST 1.1 criteria for evaluating response to therapy of malignancy with regard to cervical lymph nodes.

Results
Will illustrate imaging features that determine the clinical decision making and treatment of cervical lymph node metastasis, based on CT, ultrasound, MRI, and/or PET-CT imaging findings. We will give the evidence based radiology recommendations for evaluation of cervical lymph node metastasis. Additionally, we will demonstrate the pathologic findings that correspond to specific imaging features.

Conclusions
This exhibit reviews what radiologist needs to know about cervical lymph nodes for the evaluation of malignancy, based on the latest guidelines and literature. Understanding the diagnosis, prognostic factors and management of cervical lymph node metastasis and the pathologic correlation has important implications for facilitating patient care.

KEYWORDS: Head And Neck, Lymph Node Metastasis, Lymph Nodes
(A) Necrotic 2 cm left level IIA lymph node in patient with history of lung cancer, originally thought to represent metastasis from lung adenocarcinoma.

(B) Pathology of the lymph node demonstrated squamous cell carcinoma, associated with a 3 mm non-visualized tonsillar carcinoma. Necrotic cervical lymph node strongly associated with head and neck primary carcinoma, as in Figure A.
Purpose
1- To review basic background about connective tissue disorders of head and neck. 2- To review typical and atypical imaging findings of connective tissue disorders at different regions of head and neck.

Materials and Methods
1- Updated classification, clinical and laboratory findings of connective tissue disorders. 2- Imaging appearance of Sjögren's syndrome of head and neck. 3- Imaging findings of rheumatoid arthritis at head and neck. 4- Imaging of relapsing polychondritis of head and neck. 5- Imaging findings of antiphospholipid antibody syndrome of head and neck. 6- Imaging findings of systemic lupus erythematosus at head and neck. 7- Imaging appearance of progressive systemic sclerosis of head and neck. 8- Imaging appearance of mixed connective tissue disease of head and neck. 9- Imaging of Polymyositis/Dermatomyositis in head and neck. 10- Imaging of adult stills disease in head and neck. 11- Imaging findings helps to differentiate connective tissue disorders from other malignancy and inflammatory lesions of head and neck. 12- Role of advanced MR imaging such as diffusion MR imaging in assessment of connective tissue disorders.

Results
Imaging shows bilateral salivary and lacrimal gland enlargement in patients of Sjogren's disease. Also, imaging shows changes in temporomandibular joints and subglottic stenosis in patients with rheumatoid arthritis. External ear calcification and subglottic stenosis are reported in patients with relapsing polychondritis. Vascular thrombosis is seen in patients with antiphospholipid antibody syndrome. Opportunistic infection is seen in patients with systemic lupus erythematosus. Areas of osteolysis in the mandible and maseter muscle changes in patients with progressive systemic sclerosis. Calcification is seen in patients with trigmenial neuropathy with mixed connective tissue disorder and cervical lymphadenopathy is seen in patients with adult stills disease.

Conclusions
We concluded that imaging in conjunction with clinical assessment are important for diagnosis of different head and neck lesions in patients with connective tissue disorders. Also, imaging can be used to differentiate connective tissue disorders of head and neck from simulating lesions.

KEYWORDS: Head And Neck


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Purpose
The aim of this educational exhibit is three-fold: 1) Familiarize the reader with the normal vascular anatomy of the nasal cavity, with attention to the areas of shared vascular supply and potential anastomotic connections. 2) Provide a framework for deciding which vascular territories are involved in epistaxis, which may facilitate diagnosis and management. 3)
Introduce a broad range of diagnoses that can be associated with morbid epistaxis, with emphasis on their classic radiologic findings across various imaging modalities.

Materials and Methods
Patients presenting with morbid epistaxis were identified over the past five years, and cases were categorized based on the type of etiology: benign neoplasm, malignant neoplasm, congenital vascular malformation, acquired vascular malformation, infectious, and inflammatory/granulomatous disease. Key images illustrating each individual disease process were selected across various imaging modalities (CT, CTA, MRI, MRA, and conventional angiography), and subsequently compared to each other with a focus on clinically relevant anatomy. Case images also were compared to "normal" angiography and CT examples, in order to emphasize the overlapping vascular territories and critical anatomical landmarks. All cases are accompanied by a brief discussion that highlights the most important clinical and radiologic features for each disease. The material is presented in a Powerpoint slideshow format, as a pictorial overview of this topic.

Results
Epistaxis is a commonly encountered albeit nonspecific clinical presentation, which can on occasion indicate the presence of a serious underlying pathology. In particular, high volume and recurrent epistaxis are more likely to be caused by any number of worrisome medical conditions, including: benign and malignant neoplasms, accidental and iatrogenic trauma, granulomatous disease, vascular malformations (both acquired and hereditary), and various infections. These conditions can be associated with high morbidity or mortality, so effective and appropriate treatment relies upon timely diagnosis. In our exhibit, we demonstrate at least 11 individual cases of morbid epistaxis, each with distinct pathologic etiologies. By emphasizing and understanding the underlying vascular anatomy, we can facilitate prospective identification of each individual lesion's arterial supply, improve pretreatment planning, and possibly expedite embolization or clipping of the critical vessel.

Conclusions
The eruption of blood from the nasal cavity is usually a self-limited condition bearing little to no significant clinical consequence. Most cases are associated with irritation or injury to a rich vascular plexus within the anterior nasal septum, and easily treated with tamponade. However, epistaxis originating from the posterior vascular territories or secondary to the presence of an underlying lesion, and it is therefore wise to maintain a broad differential in such patients. The vascular supply to these lesions often is multifold, and awareness of collateral pathways can help plan treatment and anticipate outcomes. Familiarity with the imaging and clinical features for a wide range of nasal cavity lesions is therefore a useful skill set for any radiologist.

KEYWORDS: Anatomy, Hemorrhage, Nasal

eEdE-157

Evaluation of Sinonasal Glomangiopericytoma (Hemangiopericytoma): A Distinct Entity.

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Purpose
Hemangiopericytomas are rare soft tissue vascular tumors arising from capillaries and pericytes that most commonly occur in the pelvis, retroperitoneum and lower extremities. Under 20% occur in the head and neck region and have been reported in the orbit, sinonasal cavity, oral cavity, jaw, salivary glands, and the extramucosal spaces. This work evaluates the clinical presentation and imaging findings that are important in directing further work up and management of these rare but important tumors.

Materials and Methods
The medical records, cross-sectional images and pathology reports were reviewed in eight patients with hemangiopericytomas of the sinonasal cavity. The clinical presentation, and CT and MR imaging manifestations were reviewed retrospectively including tumor density on unenhanced CT, associated bone changes, MR signal characteristics, enhancement patterns, and the presence of neovascularity.

Results
Hemangiopericytomas are rare vascular tumors arising from pericytes. Pericytes are modified smooth muscle cells that surround the walls of capillaries and assist in the regulation of blood flow. Given their slow growth and vascular nature, patients often present with long-standing nasal congestion, sinus headaches and intermittent epistaxis. They usually present in middle aged adults and more often arise in the nasal cavity than the paranasal sinuses. On unenhanced CT imaging sinonasal hemangiopericytomas are often large iso- to hyperdense masses. While bony destruction can occur particularly with larger masses, smooth bony remodeling and expansion is the predominant osseous finding. On MRI, they are iso to hypointense on T2-weighted imaging, and have avid enhancement that may be homogenous or heterogenous. Careful evaluation for prominent flow voids signifying their vascular nature is recommended, and identification of this vascularity is important in suggesting the diagnosis and directing further preoperative work which may include preoperative embolization prior to surgical excision which is the mainstay of therapy. Although hemangiopericytomas are low-grade malignant tumors, the degree of malignancy can vary and their behavior can be unpredictable. They behave less aggressively in the head and neck than the abdomen and extremities. These tumors often are radioinsensitive, and surgical resection is the preferred treatment. While local recurrences and metastases do occur, they do so at a lower rate when arising within the head and neck.

Conclusions
While hemangiopericytomas are rare vascular tumors occurring in the head and neck, familiarity with their appearance on imaging is important as the imaging findings including the presence of flow voids may suggest the diagnosis preoperatively and direct the appropriate work up prior to biopsy and surgical resection.

KEYWORDS: Hemangiopericytoma, Sinonasal Disease

**eEdE-137**

**Functional head and neck imaging in the 21st century**

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Purpose
1. To describe the functional imaging techniques applicable in head and neck imaging. 2. To discuss the clinical relevance, limitations and challenges of functional imaging in head and neck evaluation.

Materials and Methods
Diffusion-weighted imaging: • Technology, • Clinical applications, • Pitfalls and challenges. CT and MR Perfusion: • Technology, • Clinical applications, • Pitfalls and challenges. PET-CT: • Technology, • Clinical applications, • Pitfalls and challenges. PET-MR: • Technology, • Clinical applications, • Pitfalls and challenges. Dual Energy CT: • Technology, • Clinical applications, • Pitfalls and challenges. Diffusion imaging shows promise in differentiation of benign and malignant pathologies, identification of metastatic lymph nodes, differentiation of recurrent malignancy and posttherapeutic changes, and prediction and monitoring of response to chemoradiation. MR and CT perfusion measure physiological parameters that can help in prediction and monitoring of response, and stratify patients into complete and poor responders. Prediction of response to chemoradiation during early therapy can be crucial since this would be the first step towards developing modified treatment strategies (e.g., escalated radiation doses) in potentially unresponsive patients. PET-CT is the standard of care for assessment of the unknown primary and evaluation of tumor recurrence. Recent introduction of PET-MR has paved the way for merging the excellent contrast resolution of MR with the metabolic signature of PET to achieve better imaging assessment. The recent introduction of dual energy CT has opened the possibility of better tissue characterization on CT through material density analysis and this may help in differentiation of benign and malignant tissues.

Results
Treatment of patients with head and neck cancers remains challenging despite advances in delivery of chemoradiation, likely due to primary tumor radioresistance, tumor hypoxia and understaging of disease. Pitfalls of conventional imaging include identifying small volume tumor in morphologically normal appearing tissue and identifying recurrent tumor in the posttreatment neck, where distortion of normal anatomical boundaries confounds interpretation, resulting in both false positive and false negative interpretations. Accurate assessment of the neck after treatment is important to detect residual neoplastic disease and/or recognize early recurrence since these negatively affect patient outcomes. Functional imaging, defined as characterization of biologic processes at the cellular or molecular level, has the potential to detect malignant disease at an earlier stage than conventional imaging alone. Preliminary studies suggest that functional imaging may play an important role in prediction and monitoring response to therapy, allowing individualization of treatment strategies rather than a 'one-for-all' approach. Advanced imaging modalities including CT perfusion, MR perfusion, diffusion-weighted MRI, PET-CT, PET-MR and dual energy CT will be introduced with discussion of its specific role in the pre and posttreatment neck.

Conclusions
Adequate and accurate knowledge of the anatomical and functional status of head and neck cancer is essential to understanding the prognosis, making the right treatment options and a more accurate assessment of the posttreatment lesion. However, it should be remembered that the information derived from biologic imaging modalities cannot be interpreted in isolation, and the
anatomical and functional information need to be synthesized together for a comprehensive assessment of head and neck cancer.

KEYWORDS: DCE MR Imaging, Diffusion MR Imaging, Head And Neck

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eEdE-143

Hypopharynx: “Don’t call me LARYnx”
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Purpose
To clarify the anatomy and function of the hypopharynx as a separate and distinct entity from the larynx.

Materials and Methods
We will illustrate the anatomy of the hypopharynx through graphic, radiological and gross anatomical images, as well as review those pathologic entities that occur in this region.

Results
The hypopharynx lies in intimate proximity to the larynx yet is an anatomically and functionally distinct structure. It is the inferior continuation of the pharyngeal space, located between the oropharynx and the cervical esophagus, and provides a conduit for food. The larynx, located anterior to the hypopharynx though sharing several structures, is the conduit for air. Both are enclosed within the laryngeal skeleton, and may be confused easily, particularly when the hypopharynx is collapsed. We will review detailed anatomy of the hypopharyngeal subsites, as well as pathologic entities that may affect the hypopharynx including squamous cell carcinoma, with particular emphasis on those features important in accurate localization and staging.

Conclusions
Given difficulties in radiologic depiction, the hypopharynx may be confused with its close neighbor, the larynx. Review of their distinct anatomical and functional features will aid the radiologist in accurate localization of disease processes.

KEYWORDS: Anatomy, Head And Neck

Imaging and neuroophthalmology: some clues to avoid mistakes

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Purpose
Imaging plays a mandatory part in multiple neuro-ophthalmological pathologies. Both clinician and radiologists may be aware of errors leading to misdiagnosed or missed lesions and should figure out ways to avoid them.

Materials and Methods
Selection of chosen cases among a four-year study of neuro-ophtalmological cases with a wrongly analyzed MR imaging (MRI), either because of poor clinical data or radiological mistakes. This presentation will propose several typical examples of both usual clinical and radiological mistakes leading to moderate or severe misdiagnosis.

Results
Most common mistakes are due to both clinical and radiological side. Clinician: Lack of clinical information provided to the radiologist, miserable handwriting, use of complicated abbreviations often not or misunderstood by the radiologist. Radiologist: Poor knowledge of ophthalmological pathology and/or visual and oculomotor pathways, leading to inadequate imaging (wrong
sequence or lack of useful sequence) or to poor reading of the images. Misreading of specific aspects of the pathology. Wrong interpretation of nonspecific lesion. Previous imaging not taken into account.

Conclusions
Clinician should always provide a detailed prescription and be critical when the patient comes back with his imaging (it fits the clinical data??). Radiologist should always consider clinical data while establishing the MRI protocol or reading the images. They should keep in mind that some lesions may be small, even if clinical examination shows major impairment. They should not hesitate to perform further examination or repeat the MRI in case of atypical or nonspecific images. They should remain critical, even if the diagnosis seems established. They should improve their knowledge of the pathology they have to study. Communication between clinician and radiologist before the MRI is the best weapon against misdiagnosis.

KEYWORDS: Oculomotor, Ophthalmoplegia, Optic Nerve

**eEdE-135**

**Imaging of internal derangement of Temporomandibular joint**

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Purpose
1- To illustrate basic background about biomechanics of temporomandibular joint (TMJ). 2- To review clinical classification of internal derangement (ID) of TMJ. 3- To review disk, bony and soft tissue changes in ID of TMJ with MR imaging (MRI). 4- To discuss role of other imaging modalities in diagnosis of ID of TMJ.

Materials and Methods
1- Normal anatomy and biomechanics of TMJ. 2- Different pulse sequences of MR imaging of TMJ. 3- Clinical staging of ID of TMJ. 4- Changes in position and shape of disk in ID of TMJ. 5- Retrodiskal abnormalities such as effusion and LPM muscles. 6- Bony changes of condyle and eminence. 7- Role of MRI in selection of patient management. 8- Role of advanced MR imaging such as 3 T, MR arthrogram and dynamic contrast MR in ID of TMJ. 9- Other lesions simulating ID of TMJ as arthritis, trauma and tumors. 10- Role of panorama, ultrasound and CBCT in ID of TMJ.

Results
MR imaging is essential for detection changes in position and shape of disk in ID of TMJ, retrodiskal abnormalities such as effusion and changes in lateral pterygoid muscles and may has a role in detection of bony changes. MR imaging helps in selection of patient management. Computed tomography (CT) scan can be used for detection of bony changes. Ultrasound may be used in children and for interventional guidance.

Conclusions
We concluded that MR imaging is important for diagnosis of changes in disk position and shape, retrodiskal soft tissue and bony changes at MR imaging in patients with ID of TMJ. Computed tomography scan has a role in detection of bony changes of mandibular condyle.
Purpose
The purpose of this study is to profile radiological imaging characteristics of various intraorbital implants and prostheses that are found incidentally on neuroimaging studies. While orbital implants and prostheses have been around for decades, radiographic appearances of them have not been thoroughly described in the literature. Gale et al were among the first ones to address this topic (1985) when they described post-operative CT imaging findings in patients who underwent orbital implant placements with a description of post-operative changes and implant complications(1). Subsequent studies have primarily focused on some specific ocular implants and their safety when MR is performed(2,3), along with the MR artifacts produced by them(4). While these studies have assisted in our understanding of this topic, a comprehensive study describing the radiographic imaging characteristics of various intraorbital implants and prostheses is necessary to provide radiologists with a basis for a reference during image interpretation.

Materials and Methods
Selection of subjects' images was performed using keyword search in radiology reports stored in PACS for "intraocular", "ocular", "intraorbital", 'orbital", "eye", and "implants" or "prostheses". This was followed by identification these implants and prostheses using operative and/or follow up clinical notes. Analysis of these implants and prostheses imaging characteristics were then performed on a PACS station. Images of intraorbital implants not found initially through PACS keyword search were obtained separately through collaboration with the Bascom Palmer Eye Institute.

Results
We analyzed radiographic images for corneal implants (Kpro/Boston keratoprosthesis, contact lenses, corneal rings), intraocular lenses, glaucoma implants (Baerveldt, Ahmed, Molteno), scleral banding implants, replaced vitreous fluid (oil), orbital prostheses, and cosmetic prostheses. The majority of these implants are seen on CT scan, while they generate a variety of artifacts on MRI due to their ferromagnetism properties. This is in keeping with prior finding by Aksoy et al in 1999, who addressed CT and MR imaging of contact and ocular lenses and reported that these objects were better seen on CT than MR(5). Orbital prostheses, glaucoma implants, and lens implants are the most commonly seen in our patient group.

Conclusions
In this study we have created an imaging profile for a variety of intraorbital implants and prostheses that are frequently encountered during image interpretation.

KEYWORDS: Implant, Intraocular Foreign Bodies, Orbits
Imaging of Non-neoplastic Complications Following Surgical Flap Reconstruction and Radiation for Head and Neck Malignancies.

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Purpose
The purpose of this exhibit is to illustrate the imaging appearance of the post-treatment neck following flap reconstructive surgeries and radiation treatment with an emphasis on accurately diagnosing various non-neoplastic complications which may arise.

Materials and Methods
We searched our institutional imaging database and selected several cases demonstrating the altered anatomy and various complications following head and neck surgical flap reconstructive surgeries and radiation therapy.

Results
Resection of head and neck cancers often requires reconstructive surgeries utilizing local/pedicle/free flaps for anatomical and functional restoration. Radiation treatment is an integral component of management. Accurate imaging evaluation of these patients requires a thorough understanding of "normal" postoperative appearances. It is imperative to be able to identify non-neoplastic complications including surgical flap infection/breakdown, pharyngocutaneous fistula, wound seroma, hematoma and abscess formation, vascular complications including thoracic duct injury and chylous fistulae. Radiation alone is associated with numerous complications including mucositis, mucosal necrosis, osteoradionecrosis, accelerated atherosclerosis, vascular injury and pseudoaneurysm formation which may require prompt recognition to prevent devastating outcomes.

Conclusions
Interpretation of neck imaging following surgical and radiation treatment for head and neck malignancies often presents as a daunting task for radiologists. In this exhibit, we present a series of cases from our institution highlighting cross-sectional imaging features of non-neoplastic complications following surgical flap reconstructive surgeries and radiation therapy.

KEYWORDS: Neck Lesions, Posttreatment Neck, Radiation Effects
Imaging of the Brachial Plexus

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Purpose
Purpose: 1. To review the normal MR anatomy of the brachial plexus. 2. To review common pathologies of the brachial plexus. 3. To discuss advantages and disadvantages of different MR
protocols when imaging for brachial plexus. 4. To discuss latest imaging techniques of brachial plexus.

Materials and Methods

We retrospectively reviewed the MR brachial plexus studies performed at our institution over the last five years and will discuss the common pathologies involving the brachial plexus. The presentation will focus on: Normal MR anatomy of the brachial plexus, MR imaging techniques, Common causes for brachial plexus plexopathy, Thoracic outlet syndrome.

Results

Review normal MR anatomy of the brachial plexus including the different parts (roots, trunks, divisions, cords and branches), anatomical landmarks and spaces (interscalene triangle, costoclavicular and retropectoralis minor spaces). MR imaging techniques: Discussion of advantages and disadvantages of various MR protocols and latest imaging techniques. • Bilateral versus unilateral imaging, • High resolution imaging, • Contrast use, • High resolution 3T 3D T2 STIR imaging, • Diffusion tensor imaging (DTI) and Tractography. Common causes for brachial plexus plexopathy: Appearances of these entities on MR imaging and discussion of diagnostic pearls: • Nerve sheath tumors, • Metastases, • Direct extension of non-neurogenic primary tumor, • Lymphoma, • Traumatic injuries, • Radiation-induced brachial plexopathy, • Compressive lesions, • Brachial neuritis, • Immune mediated neuropathies. Thoracic outlet syndrome - neurogenic versus vascular (arterial or venous), MR techniques including MRA/MRV and use of Ablavar.

Conclusions

Major teaching points of the exhibit are: 1. Understand MR anatomy of the brachial plexus. 2. Review the imaging characteristics of common brachial plexopathies. 3. Discuss advantages and disadvantages of various imaging protocols and latest imaging techniques.

KEYWORDS: Brachial Plexopathy, Brachial Plexus

Imaging Review of Common Patterns of Perineural Spread of Tumor in the Head and Neck and Anatomical Review

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Purpose

1. To review the terminology, pathophysiology, and clinical significance of perineural spread of head and neck tumors. 2. To review the relevant anatomy with cross-sectional imaging correlates for perineural spread of head and neck tumors. 3. To understand the imaging findings of perineural spread of head and neck tumors.

Materials and Methods

A literature review on perineural spread of tumor was performed. A modern understanding of terminology, pathophysiology, and clinical relevance including the effect on treatment paradigms will be presented. Appropriate cross-sectional images demonstrating the relevant anatomy as
well as excellent examples of the typical imaging findings seen in perineural spread of head and neck tumors were collected at the Veterans Affairs Boston Healthcare System, removed of patient identifying information, and will be presented here for educational purposes.

Results

The terminology for perineural spread of tumor will be discussed including the concept of neurotropism. Pathophysiology including upregulation of neural cell adhesion molecules (NCAMs) and the histologic cancer subtypes inclined toward perineural spread will be reviewed. We will discuss the clinical significance, particularly with regard to symptoms induced, prognostic indication, increased morbidity and mortality, and treatment paradigms. Relevant anatomy will be reviewed, including skull base anatomy via CT correlates including the pathways leading to and from the pterygopalatine fossa, the course of the three branches of the trigeminal nerve, the course of the facial nerve, and the interconnections between the trigeminal and facial nerves. Computed tomography (CT), MRI, and PET-CT images will be reviewed demonstrating the salient imaging findings for perineural spread of head and neck tumors, particularly expansion of the relevant skull base fissures and foramina, fat pad effacement, nerve thickening and enhancement, restricted diffusion, and signal changes and enhancement of downstream muscles affected by motor nerve involvement.

Conclusions

Perineural spread of tumor commonly is seen in patients with head and neck malignancies, most commonly squamous cell carcinoma, minor salivary gland cancers, and lymphoma. Because the skull base foramina serve as a potential conduit from cutaneous and mucosal cancers to the brain, knowledge of this anatomy as well as the common findings associated with perineural spread of tumor are critical in correct staging and clinical management.

KEYWORDS: Cranial Nerve Pathology, Neoplasm, Perineural

Imaging Review of External Auditory Canal Lesions

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Purpose

Review the spectrum of lesions involving the external auditory canal.

Materials and Methods

Various lesions of the external auditory canal were categorized and representative images were selected for this exhibit.

Results

External auditory canal (EAC) is curvilinear tubular structure with both cartilaginous and bony parts. There are a wide variety of lesions that can involve the EAC. In current practice, the modality of choice for external auditory canal imaging has been CT of the temporal bone. Here, we review the relevant EAC anatomy and imaging characteristics for the spectrum of abnormalities associated with EAC including: anatomical variants, congenital lesions, malignant/benign neoplasms, vascular lesions, infection and trauma. List of lesions: Anatomical Variant: Foramen tympanicum, cerumen. Congenital: Congenital cholesteatoma, isolated EAC

Conclusions
CT of temporal bone is the modality of choice for imaging of the external auditory canal lesions and provides the necessary clinically significant information.

KEYWORDS: Atresia, Cholesteatoma, Squamous Cell Carcinoma
Purpose
Temporal bone imaging can be challenging for most radiologists, and the evaluation can become even more perplexing when the patients have had previous surgical interventions. In today's world of multidisciplinary medicine it is imperative for the neuroradiologist to be able to provide clinically relevant information to the otolaryngologists after they have chosen to surgically intervene. In order to accomplish this, the neuroradiologists should have a firm grasp on the basic and complex postoperative imaging findings of the temporal bone. The purpose of this presentation is to discuss the imaging spectrum of the postoperative temporal bone and common complications, utilizing clinical images and diagrams, that neuroradiologists must know.

Materials and Methods
The otolaryngology surgical case logs at a tertiary care facility were searched retrospectively from 2009-2013 for temporal bone interventions. The PACS system then was searched for postoperative imaging of these patients, and cases were selected for presentation of both the common and uncommon procedures as well as their complications.

Results
The mainstay of surgical intervention of the temporal bone is the mastoidectomy, which can be further subdivided into canal wall up, canal wall down, modified radical, and radical. It is performed most commonly for cholesteatoma, with the invasiveness of the lesion determining the extent of the procedure performed. A stapedectomy removes an affixed stapes and replaces it with a microprosthesis. It is performed most commonly for otosclerosis. Tympanoplasty and ossiculoplasty commonly are performed in conjunction after a history of chronic middle ear infection. Ossicular reconstructions options include autografts (patient's own bone or cartilage), homografts, or allografts (synthetic prostheses). The two main forms of allografts, total and partial ossicular replacement prostheses (TORP and PORP, respectively), have been gaining in popularity due to their sterility and availability. Each of these procedures has their own specific complications, which can be diagnosed radiographically.

Conclusions
With the increasing roles of imaging in temporal bone surgery, it has become increasingly important for the radiologist to be familiar with the postoperative temporal bone. Common interventions include all forms of the mastoidectomy, ossiculoplasty, and stapedectomy, which must be identified on temporal bone CT, as well as their respective complications.

KEYWORDS: Middle Ear, Postoperative Findings, Temporal Bone
Major salivary gland tumors: the good, the bad, and the ugly.

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Purpose
Major salivary gland neoplasms provide a diagnostic challenge given their nonspecific clinical presentation. As such, imaging plays a major role in assessing possible malignant potential, extent, and staging of these tumors. Through our educational exhibit, we aim to provide an overview of common salivary gland malignancies and their imaging features. Furthermore, we will discuss staging of salivary gland tumors and the role of cross-sectional imaging.

Materials and Methods
The medical records, cross-sectional images and pathology reports were reviewed of 89 salivary gland tumors at our tertiary care academic institution. The clinical presentation, and CT and MR imaging manifestations were reviewed retrospectively to elucidate key imaging findings of the different malignant histologic pathologies.

Results
Tumors of the major salivary glands comprise a diversity of benign and malignant entities. Clinical history, including symptoms and tumor growth, infrequently correlates with histology. Therefore, cross-sectional imaging plays an important role in suggesting malignancy, and ultimately guiding treatment of these masses. Important radiologic findings that are essential for the radiologist to report include distinctness of the tumor margin, T2 signal intensity, presence of adenopathy, extraparenchymal extension, perineural spread, and distant metastases. We provide an image-rich overview of the pathology and CT and MRI features of various salivary gland
tumors. Cases presented in our exhibit include pleomorphic adenoma, Warthin's tumor, adenoid cystic carcinoma, acinic cell carcinoma, mucoepidermoid carcinoma, squamous cell carcinoma, lymphoma and metastatic lesions.

Conclusions
Salivary gland tumors have a nonspecific clinical presentation and cross-sectional imaging plays an important role in suggesting malignant potential and staging of these lesions. Familiarity of the imaging characteristics of the good, the bad, and the ugly salivary gland tumors is invaluable for preoperative planning and counseling.

KEYWORDS: Neoplasm, Parotid Gland, Salivary Gland

eEdE-156

More than Skin Deep: Neuroimaging of Dermatological Diseases

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Purpose
The goal of this exhibit is to review the appearance of skin lesions on neuroimaging studies.

Materials and Methods
The following topics will be reviewed: * Anatomy; * Neurocutaneous syndromes; -NF 1; -NF2; -Tuberous sclerosis; -PHACES syndrome; -Neurocutaneous melanosis; -Sturge-Weber; -Basal cell nevus syndrome; -Incontinentia pigmenti; * Skin; tumors; -Skin appendage lesions (inclusion cyst, pilomatrixoma, cystadenoma); -Primary malignancies; (melanoma, squamous cell carcinoma, basal cell carcinoma); -Metastases; * Trauma; -Lacerations; -Hematomas; -Foreign bodies; -Third-spacing; * Infectious and inflammatory processes; -Cellulitis; -Abscess; -Herpes-Zoster; -Scleroderma; -Parry Romberg disease; * Posttreatment; -Mohs surgery; -Reconstructive skin flaps and grafts; -Cosmetic facial fillers and implants.

Results
Radiological imaging, including CT and MRI, play an important role in evaluating patients with primary skin tumor of the head and neck region. Although visible on clinical exam, neuroimaging is used to determine the degree of local invasion and distant metastases, which affects patients management and prognosis. Neuroimaging also is essential for evaluating conditions associated with skin lesions in the neurocutaneous syndromes. Alternatively, skin lesions may be encountered incidentally on neuroimaging performed for other reasons. Recognizing these lesions and their significance is helpful.

Conclusions
There are a wide variety of skin diseases that can be encountered on routine neuroimaging. Therefore, it is important to be familiar with the corresponding radiological features and associated findings.

KEYWORDS: Head And Neck

eEdE-139
Multimodality Staging and Restaging of Laryngeal Carcinoma with MRI, CT and PET/CT

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Purpose
The purpose of the exhibit is: 1) Review the basic anatomy of the larynx as it relates to laryngeal carcinoma; 2) Discuss the initial staging of laryngeal carcinoma with a focus on the contributions of multimodality imaging with PET/CT, CT and MRI; 3) Illustrate the importance of multimodality imaging, particularly PET/CT, in the surveillance for and restaging of disease recurrence; 4) Discuss the limitations that can be seen with conventional imaging and PET/CT and how to avoid potential pitfalls.

Materials and Methods
After a short review of the basic anatomy of the larynx, a case series of patients will be presented demonstrating the value of multimodality imaging for initial staging of laryngeal carcinoma. While the focus will be on conventional imaging with MRI and CT, a detailed review of PET/CT also will be included. For restaging of laryngeal carcinoma, the focus will be primarily on the added value of PET/CT for disease surveillance and restaging of recurrent disease with MRI, CT, and PET/CT (Figure 1). This series also will include cases which demonstrate the potential limitations of imaging and how both false negative and false positive studies can be obtained and potentially avoided.

Results
Multimodality imaging for the initial staging of laryngeal carcinoma can be a powerful tool for detecting subtle, clinically important disease both locally, regionally, and distant for the primary tumor. Knowledge and a thorough understanding of the basic anatomy of the larynx is critical to being able to clearly define the primary tumor in terms that are clinically useful to the referring surgeon. Given the potentially high rate of local recurrence, disease surveillance is a critical part of imaging laryngeal carcinoma as well. Being able to synthesize information from multiple modalities will significantly increase the ability of the imager to detect and define disease recurrence. Finally, as with all imaging studies, the potential pitfalls of imaging need to be understood and mimickers of disease need to be avoided.

Conclusions
Multimodality imaging with MRI, CT, and PET/CT can provide significant added value to the evaluation of laryngeal carcinoma. Careful understanding of the limitations of these modality is needed though to avoid unnecessary interventions.

KEYWORDS: Carcinoma, Larynx, Multimodality Imaging
Pathologic temporal bone calcification/ossification: A pictorial review.

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Purpose
The purpose of the educational exhibit is to review the pathological processes characterized by abnormal calcification/ossification on temporal bone CT examination.

Materials and Methods
The education exhibit will be a pictorial review of pathology characterized by abnormal calcification/ossification on CT of the temporal bones. We will focus on key imaging findings that will allow differentiation of the different pathologic processes. Disease processes that will be covered include: • Tympanosclerosis (see attached image), • Labyrinthine ossificans, • Facial nerve hemangioma, • Endolymphatic sac tumor, • Otosclerosis, • Chronic Otomastoiditis, • Paget's disease, • Fibrous Dysplasia, • Osteopetrosis.

Results
Certain pathologic processes result in abnormal calcification/ossification on routine temporal bone CT. Analyzing the presence, location, and morphology of the abnormal calcification/ossification in these cases will help the radiologist clinch the correct diagnosis. Dystrophic ossification is identified in the middle ear with tympanosclerosis or the inner ear with labyrinthine ossificans. The presence of stipple calcifications on temporal bone CT help the radiologist diagnose both facial nerve hemangiomas and endolymphatic sac tumors. Irregular lucency of the otic capsule at the level of the fissula ante fenestram allows diagnosis of fenestral
otosclerosis/otospongiosis. More generalized pathologic ossification of the temporal bone can be seen in fibrous dysplasia, Paget's disease, and osteopetrosis.

Conclusions
Certain disease processes result in abnormal calcification on temporal bone CT. Analyzing the presence and morphology of the abnormal calcification will guide the radiologist to the correct diagnosis.

KEYWORDS: Temporal Bone

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eEdE-151

Post-surgical neck – what is recurrence and what is expected postsurgical change?

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Purpose
1. To discuss with illustrations the various postoperative procedures for head and neck cancer and their imaging appearance. 2. To highlight the postchemo and radiotherapy changes on CT, MR and PET scan. 3. To illustrate the various post-treatment complications.

Materials and Methods
We retrospectively studied 214 patients from our oncology data which formed the basis for this exhibit. All patients had undergone surgical procedures for their head and neck cancer. One hundred sixty-three patients also had received RT while 51 patients had received RT and CT combination.
Results
We have categorized this exhibit into: 1) Neck dissections (ND): a) radical ND, b) modified ND, c) selective ND, d) extended ND. 2) Reconstructive surgery: appearances of various types of myocutaneous flaps, infection and recurrence. 3) Radio and chemotherapy changes. 4) Treatment related complications: vascular: thrombosis, pseudoaneurysm, vessel wall injury; osseous: infection, necrosis; chylous fistula; postsurgical neuroma; skin metastasis; and flap infection.

Conclusions
1. Knowledge of postsurgical procedures is essential for evaluation of post-treated neck follow up and surveillance. 2. Distinguishing early recurrence verses expected postsurgical changes are important to avoid unnecessary surgical biopsies

KEYWORDS: PET/CT, Radiation

eEdE-169a

6:30AM - 3:00PM

Radial-VIBE with GRASP: A Novel Technique in Evaluation of the Head and Neck

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Purpose
Radial-VIBE with GRASP is a novel contrast-enhanced T1-weighted gradient-echo sequence providing excellent fat-suppressed motion robust sequences. In addition, its unique K-space sampling and data acquisition parameters allows for assessing structural permeability characteristics. The purpose of our study is to evaluate the role of Radial-VIBE in assessing head and neck anatomy and relevant pathology.

Materials and Methods
Utilizing illustrative images, we will demonstrate the different applications of Radial-VIBE with GRASP in evaluation of the neck, orbits, base of the skull, and pituitary gland.

Results
Discussion will include: - Overview of the new technique and its advantages in comparison with conventional sequences. - Demonstration of unique permeability patterns utilizing Radial VIBE with GRASP of normal structures of the neck as well as assessment of pathology such as metastatic lymph node and certain primary carcinomas. - Assessing its role in evaluation of skull base lesions. - Assessing its role in evaluation of normal anatomical structures of the orbit and associated pathology. - Demonstration of normal permeability characteristics of anterior, posterior pituitary gland and the infundibulum, and assessing its role in evaluating pathology including macroadenoma, microadenoma and cysts.

Conclusions
Radial-VIBE with GRASP provides unique insight into evaluation of head and neck anatomy and pathology. It is a potentially superior technique rather than the conventional fat-suppressed T1-weighted sequences.

KEYWORDS: Head And Neck, Permeability MR Imaging
Rare and Aggressive Thyroid Carcinoma: You May Not Have Seen Them, But They May Have Seen You!

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Purpose
Due to their widespread prevalence (greater than 50% in autopsy series), incidental thyroid nodules commonly are identified on cross-sectional imaging. Citing low malignancy risk, relatively indolent growth rate, apparent increasing incidence, and costs involved in their work up, recent literature has compellingly argued that imaging-based risk stratification should be employed to determine which thyroid nodules require further imaging characterization or fine needle aspiration (FNA) in the current costconscious medical practice climate. Rare but aggressive forms of thyroid carcinoma, such as medullary thyroid carcinoma, anaplastic thyroid carcinoma, the tall cell variant of papillary thyroid carcinoma, and Hurthle cell thyroid carcinoma, are associated with poor prognosis, account for the majority of thyroid carcinoma-related deaths, and therefore always require further evaluation, including FNA and evaluation for distant metastases. Although rarely seen clinically, awareness of concerning thyroid carcinoma imaging characteristics is necessary to identify aggressive rare forms that require further assessment. After pathologic diagnosis, imaging-directed tumor staging is necessary to guide treatment planning and monitor treatment response. Appropriate imaging surveillance following initial treatment is essential to identify local/regional recurrence and presence of distant metastases.

Materials and Methods
Using pathology and radiology information systems at our institution, 30 total patients between January 2001 and November 2013 were identified with both rare forms of thyroid carcinoma and relevant imaging: nine with medullary thyroid carcinoma, four with poorly differentiated thyroid carcinoma, seven with Hurthle cell thyroid carcinoma, and ten with anaplastic thyroid carcinoma. Relevant literature review also was performed.

Results
Discussion includes: 1. Summary of concerning primary tumor imaging features requiring further evaluation/FNA. 2. Brief review of each tumor type, including demographics and clinical
characteristics. 3. Determination of appropriate imaging strategy and modalities to initially stage each tumor. 4. Review of consensus imaging surveillance guidelines for these tumors.

Conclusions
Rare but aggressive forms of thyroid carcinoma carry a poor prognosis compared with differentiated thyroid carcinoma. Awareness of concerning imaging characteristics is critical to appropriately risk-stratify incidental thyroid nodules based on imaging findings. In addition, discrete strategy for initial tumor staging and imaging surveillance is necessary, as each of these forms has a high risk of local recurrence and distant metastases.

KEYWORDS: Carcinoma, Staging, Thyroid

**eEdE-163**

*Read 'Em and Weep: Imaging of Lacrimal Pathology*

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**Purpose**
The lacrimal drainage system, including the lacrimal gland and duct, are host to a range of pathologies. Congenital, acquired and neoplastic conditions may affect the lacrimal system and its related components. The purpose of this presentation is to review the anatomy and pathologies of the lacrimal system, focusing on both common and rare conditions.

**Materials and Methods**
Content will be presented using a quiz format, beginning with a focused review of anatomy followed by case presentations highlighting the spectrum of pathologies affecting the lacrimal gland and drainage system.

**Results**
Specific developmental, inflammatory and neoplastic conditions are reviewed, with focus on highlighting characteristics that lead to the diagnosis. Specific entities to be reviewed include: - Congenital dacrocystocele, -Dacrocystitis, -Systemic disease, including sarcoidosis, -Sjogren's syndrome, -Pseudotumor, -Tumors, -Benign mixed tumor, -Squamous cell carcinoma, -Adenoid cystic carcinoma, -Lymphoma, -Metastasis.

**Conclusions**
Recognition of the range of lacrimal pathologies helps to generate a focused differential diagnosis when confronted with abnormalities of the lacrimal gland or duct. An understanding lacrimal system anatomy can help in predicting routes of spread and complications of lacrimal disease.

KEYWORDS: Lacrimal Apparatus

**eEdE-155**

*Seeing is Believing: Laryngeal Carcinoma Imaging and Laryngoscopy Correlation*
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Purpose
Laryngoscopy long has been recognized as the gold standard for characterizing the extent of mucosal disease and vocal cord mobility in the setting of laryngeal neoplasia. Advances in imaging technology have improved diagnostic accuracy for tumor staging, particularly when interpreters are armed with knowledge both of normal and variant anatomy, as well as typical patterns of spread for a given pathologic entity. The radiologist should be familiar with findings at laryngoscopy and how those findings might guide patient management and subsequent imaging. The purpose of this exhibit is to review normal anatomy at laryngoscopy with an emphasis on case-based radiology-laryngoscopy correlation.

Materials and Methods
We will illustrate normal anatomy at laryngoscopy. Further, using the tumor node metastasis (TNM) system devised by the American Joint Committee on Cancer (1) as a guide, we will show imaging examples of laryngeal carcinoma with digital laryngoscopic correlation. Specific attention will be given to radiology-laryngoscopy correlation pertinent to a classification scheme for laryngeal endoscopic cordectomies (2, 3).

Results
Clinically evident tumor involving the surface of the vocal cords, cord fixation and early transglottic extension can be difficult for the radiologist to recognize on cross-sectional imaging. The traditional emphasis in head and neck imaging has been on finding the imaging correlate for a clinically apparent abnormality as well as identifying submucosal and deep extension of disease that is clinically silent to the laryngoscopist. As expected, lesion location, even in the setting of low-grade disease, can significantly alter treatment approach. Ongoing advances in laryngoscopic technology, such as narrow band imaging (4) and the ability to digitally record the examination hold further promise in improving diagnostic accuracy. The availability of laryngoscopic imaging can be helpful in directing the radiologist’s approach to a given case, further enhancing the spirit of cross-specialty collaboration and patient care.

Conclusions
Correlation with advanced techniques in digital laryngoscopy will enable the radiologist to more effectively approach the imaging evaluation of laryngeal neoplasms.

KEYWORDS: Larynx, Squamous Cell Carcinoma, Staging

**Sizing up the Extraocular Muscles: Small or Big?**

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Purpose
To review the various pathological conditions that cause the extraocular muscles to either increase or decrease in size.

Materials and Methods
1. Review the anatomy and innervations of the extraocular muscles. 2. Describe the general categories of relevant disease processes - inflammatory, infectious, congenital, acquired, metabolic, trauma, and neoplastic. 3. Provide cases of entities that cause diminished size of extraocular muscles including: Denervation atrophy, mitochondrial myopathy, chronic progressive external ophthalmoplegia, Duane's syndrome, and congenital hypoplasia. 4. Provide cases of entities that cause enlargement of extraocular muscles including: Thyroid associated orbitopathy, orbital pseudotumor, sarcoidosis, trauma, cellulitis, and malignancy.

Results
Pathology that causes the extraocular muscles to either increase or decrease in size can affect individual or multiple extraocular muscles. It is important to recognize the broad categories that these lesions fall into, in order to have a systematic way to approach and analyze these abnormalities. There are certain imaging features unique to some conditions that can help narrow the differential diagnosis.

Conclusions
Enlargement of extraocular muscles is a common phenomenon; however, entities that cause the extraocular muscles to decrease in size are uncommon and often can be difficult to appreciate on cross-sectional images. This exhibit will familiarize the reader with both conditions as well as emphasize the imaging characteristics that can aid in the diagnosis of these lesions.

KEYWORDS: Extraocular Muscle Dysfunction, Orbits

Temporal Zone from A to Z

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Purpose
To the inexperienced, temporal bone anatomy and pathology can be complex. This exhibit will serve as a review of the basic temporal bone anatomy and broad breadth of pathology one encounters on computed tomography (CT) and MR imaging (MRI).

Materials and Methods
This electronic exhibit will begin with a review of basic temporal bone anatomy on CT in the axial and coronal planes. The remainder of the exhibit is divided into the eight categories and will review multiple anatomical variations and pathologic processes.

Results
CONTENT OUTLINE: Anatomy: Basic Temporal Bone anatomy on CT and MRI. Anatomical variants: Aberrant CN7; Petrous Apex/ Effusion; Bilateral Vestigal Appendages; High riding Jugular Vein; Dehiscent Jugular Bulb; Aberrant ICA. Post-traumatic Processes: Cochlear/Vestibular Hemorrhage; Malleoincudal separation; Ossicle Dislocation; Temporal bone fractures. Congenital Processes: Microtia; 1st Branchial Cleft Cyst; Cochlear/Vestibular
Dysplasia; Congenital Cholesteatoma; Cochlear Nerve Hypoplasia/aplasia; Goldenhar and CHARGE syndromes; Absent Cochlear Nerve; Isolated Cochlea; EAC Atresia; CN VII ptosis; Common cavity; Large Endolymphatic Sac Anomaly. Inflammatory/Infectious processes: Otitis Media/Middle Ear Effusion; Cholesterol granuloma; Labyrinthitis; Otomastoiditis; Bezold's Abscess; Mastoiditis with Sinus Thrombosis/Sigmoid Plate Erosion; Bells Palsy; Otitis Externa/Malignant Otitis Externa; Petrous Apicitis/Gradengo's Syndrome. Tumor/Tumo- like Processes: Middle ear and EAC Squamous Cell Carcinoma; CN VII Cystic Schwannoma; Glomus Tympanicum; Facial Nerve/Labyrinthine Schwannoma; IAC Lipoma; CN VII and Petrous Apex Hemangioma; 7th CN Perineural Spread; Endolymphatic Sac tumor. Bony Pathology: Fibrous dysplasia; Petrous Apex Meningocele /Encephalocele; Temporal Bone Encephalocele; Sphenoid Encephalocele/Meningocele; IAC Osteoma; EAC Exostosis. Pathology related to Hearing Loss/Tinnitus: Retrofenestral Otospongiosis; Fenestral otospongiosis/Otosclerosis; Posterior Semicircular Canal Dehiscence; Acquired Cholesteatoma with Lateral Semi-circular Canal Dehiscence; Large Cholesteatoma; Otoradionecrosis; Petrous Apex Cholesteatoma; EAC cholesteatoma; Labyrinthitis Ossificans. Postoperative Processes/Prosthesis: Postoperative Temporal Bone/ Mastoidectomies; Tympanostomy; Complete Ossiculectomy with Prosthesis Placement; Postop Labyrinthitis; Stapes Prosthesis Herniation/Dislocation; Sound Bridge Prosthesis; Cochlear Gusher.

Conclusions
At the completion of this exhibit the radiologist should feel more comfortable with the breadth of pathology one may encounter on a temporal bone study.

KEYWORDS: Temporal Bone

Figure #1: Absent CN VIII with isolated cochlea.
The Devil’s in the Details: Small field of view MRI in imaging of laryngeal and hypopharyngeal cancers

S Gupta¹, J Goh¹, S Loke¹, A Karandikar¹, T Tan², W Smoker³
Purpose
To highlight the utility of small field of view (SFOV) MR imaging (MRI) in the evaluation, staging and management of laryngeal and hypopharyngeal cancers.

Materials and Methods
A retrospective review of patients with laryngeal and hypopharyngeal cancer imaged in our department with MRI between 2008 and 2013 was performed. Imaging findings pertinent to local staging were identified; these include cartilage involvement, extralaryngeal spread and paraglottic spread.

Results
Several studies have established the superiority of MRI in soft tissue contrast and evaluation of laryngeal cartilage over CT scan. With improved software and coil technology it is now possible to obtain superior anatomic depiction and disease delineation using surface coils and SFOV imaging, in comparison to traditional large field of view (LFOV) images. Enhanced imaging information further helps in the staging and management of the disease. This exhibit aims to show how SFOV MRI: 1. Provides improved anatomical depiction of soft tissues and cartilage compared to CT and LFOV MRI; 2. Better demonstrates locoregional invasion by neoplasms; 3. Affects tumor staging and management planning.

Conclusions
Small field of view MR is superior to CT and LFOV MRI in detailed evaluation of loco-regional invasion by laryngeal and hypopharyngeal neoplasms, thereby affecting the staging and management.

KEYWORDS: Head And Neck, Larynx, MR Imaging

eEdE-146

Ultrasound Parotid imaging reporting and data system (PIRADS)

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Purpose
1-To review normal anatomy of parotid gland. 2-To review ultrasound appearance of benign lesions and malignant tumors of parotid gland. 3-To illustrate ultrasound parotid imaging reporting and data system (PIRADS) and its impact on patient management.

Materials and Methods
1-Normal anatomy of parotid gland with ultrasound. 2-Ultrasound appearance of benign parotid tumors. 3-Ultrasound appearance of malignant parotid tumors. 4-Ultrasound of sjogrene disease and other connective tissue disorders. 5-Ultrasound of developmental lesions of parotid gland. 6-Spectrum of bilateral and multiple parotid gland lesions. 7-Ultrasound parotid imaging reporting and data system (PIRADS). 8-Impact on PIRADS in patient management and treatment planning. 9-Summary of future prospect.
Results
Ultrasound commonly is used as an initial imaging modality for assessment of parotid tumors. Ultrasound parotid imaging reporting and data system (PIRADS) is a new proposal system for classifying parotid masses on the basis of sonographic findings. PIRADS aims to reduce variability in lesion interpretation by standardizing report content and structure; improving communication with clinicians; and facilitating decision making.

Conclusions
We concluded that ultrasound parotid imaging reporting and data system (PIRADS) is a new noninvasive that can be used to differentiate benign from malignant lesions. This reporting system has impact on patient management and treatment planning.

KEYWORDS: Cancer, Parotid Gland

eEdE-169

What did I miss? A Case Based Correlation of Videofluoroscopic Swallow Examinations with Cross-sectional Imaging Studies.

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Purpose
Videofluoroscopy is a great tool for the initial evaluation of patients with dysphagia. Over the years, radiologist's role has shifted as to, in general, only provide fluoroscopic guidance rather than in depth interpretation of videofluoroscopic swallow studies. Speech pathologists are trained primarily to evaluate the functional process of swallowing but might overlook structural abnormalities. Therefore, it is important for every radiologist to be familiar with the videofluoroscopic appearance of normal anatomy and the various disease processes affecting the oral cavity and pharynx in order to provide interpretative assistance and suggest additional studies that may be needed for diagnosis.

Materials and Methods
Clips or still images of videofluoroscopic swallow studies will be presented in a case-based quiz format prompting the radiologist to: #1 identify the area of abnormality; #2 suggest a specific diagnosis. Subsequently important anatomy and pathology will be reviewed and corresponding cross-sectional images (CT, MRI and/or PET/CT) will be displayed.

Results
Knowledge of the normal appearance of the oral cavity and pharynx on videofluoroscopy is essential when evaluating a patient for dysphagia. We will review anatomical landmarks and various disease processes that can present during videofluoroscopic swallow evaluation. Emphasis will be placed on the detection of the abnormality through correlations to different cross-sectional imaging studies (CT, MRI and/or PET/CT). Cases to be discussed include: - functional disorders, - congenital/genetic abnormalities, - neurological disorders, - neoplasms of the head and neck, - post-treatment effects (radiation therapy versus surgery) and complications.
Conclusions
Although videofluoroscopic swallow studies are primarily interpreted by the speech pathologist, the radiologist also may assume a legal responsibility for detection of any pathology. Therefore it is crucial for the overseeing radiologist to be familiar with the normal and abnormal appearance of the oral cavity and pharynx on fluoroscopy. After reviewing the important concepts demonstrated in this exhibit, the radiologist will be able to more confidently detect abnormalities on videofluoroscopy or simply confirm a normal study.

KEYWORDS: Fluoroscopy, Head And Neck, Oropharynx

eEdE-140


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¹University of Iowa Hospitals and Clinics, Iowa City, IA, ²University of Wisconsin Hospitals, Madison, WI, ³SUNY Downstate Medical Center, Brooklyn, NY

Purpose
The educational objectives of this exhibit include: 1. Describe the imaging appearance of the most common cystic neck masses. 2. Learn less common cystic lesions that also must be considered in the differential diagnosis. 3. Learn the typical locations of these various cystic neck lesions.

Materials and Methods
Reviewers are challenged with both common and uncommon cystic neck lesions utilizing a case-based, computer-interactive, tutorial approach. Each case includes representative images that illustrate key diagnostic findings for the disease entity. A brief discussion highlighting salient clinical and imaging features follows each case.

Results
Cystic neck masses can be a diagnostic challenge for the radiologist. It is important to consider both common and uncommon entities when faced with these lesions. One needs to consider congenital, neoplastic, and miscellaneous lesions. Congenital lesions include thyroglossal duct, branchial cleft (II-IV), cervical bronchogenic, and thymic cysts, as well as venolymphatic malformations. Neoplastic lesions include nodal metastases, dermoid and epidermoid cysts, and cystic schwannomas. Miscellaneous lesions include abscesses and saccular cysts.

Conclusions
After reviewing this interactive, case-based, educational exhibit, the reviewer will be able to identify common and uncommon cystic lesions of the neck. Cystic neck masses offer a diagnostic challenge to the radiologist. Careful inspection for characteristic distinguishing features often will lead to the correct diagnosis or significantly narrow the differential.

KEYWORDS: Cystic Neck Mass, Cysts
Where are You Going?: Geographic Approach for the Evaluation of Perineural Tumor Spread in the Head and Neck

V Kunam¹, p cherukuri¹, D Reede², J Nath², R Holliday³, W Smoker⁴
**Purpose**

After viewing this module the user will know the: 1. Normal gross and imaging anatomy of nerves commonly involved in perineural tumor spread (PNTS) with emphasis on their relation to various spaces/locations in the head and neck. 2. Imaging findings of PNTS and common pathways of spread encountered with lesions in specific locations. 3. Clinical findings and significance of PNTS.

**Materials and Methods**

Cross-sectional images and illustrations are used to demonstrate the anatomy of pertinent nerves most commonly involved by PNTS (greater auricular, CN V and CN VII), and their relationship to various spaces of the head and neck. Common connections between these nerves are reviewed, followed by a discussion of pathophysiology, clinical findings, therapeutic and prognostic implications of PNTS. Direct and indirect imaging findings of PNTS are presented. Cases are used to demonstrate common pathways of PNTS associated with tumors in specific locations. Lesion locations and common patterns of nerve involvement (including retrograde spread) include: Nasopharyngeal tumors (V2 and V3), masticator space (V3), parotid space (VII, auriculotemporal branch and greater auricular nerve), supraorbital lesions (V1), maxillary sinus and buccal space lesions (V2) and hard palate (palatine nerve to the pterygopalatine ganglion, vidian nerve and V2).

**Results**

Perineural tumor spread is extension of tumor along the neural sheath of cranial nerves that commonly occurs in a retrograde fashion towards the cranium but also can spread antegrade towards the periphery. It is important for radiologists to recognize subtle findings of PNTS because it has a significant impact on management prognosis. It is associated with an increased incidence of local recurrence and decreased survival. Direct signs of PNTS are enlargement and/or enhancement of the nerve. Loss of fat in the neural foramen and foraminal enlargement are indirect signs. Squamous cell carcinoma (SCCa) is the most common malignancy in the head and neck; therefore, most cases of PNTS are due to SCCa. Adenoid cystic carcinoma has the strongest association with PNTS; however, it is much less common. Lymphoma, rhabdomyosarcoma and melanoma also can demonstrate this pattern of disease spread.

**Conclusions**

Since forty percent of patients with PNTS are asymptomatic, therefore cross-sectional images of patients with head and neck malignancies should be carefully evaluated for this pattern of disease spread. Familiarity with the normal anatomy and imaging (CT/MR) appearance of pertinent nerves, imaging findings of PNTS and common pathways of disease spread based on tumor location, improves diagnostic accuracy. An imaging check list, based on tumor location, is provided to aid in detection of PNTS.

**KEYWORDS:** 1.5 T, 1H MRS, 3 T, 3-Dimensional Reconstruction, 32-Channel Head Coil, 320 Detector Row, 3D Angiography, 3D Computed Tomography, 3D DSA, 3D Imaging, 3D Visualization, 3T, 4D CT, 4D CT Angiography, 4D CTA, 4D DSA, 4D Flow MR, 4D MRA, 4D-CT, 7 T, Abnormalities, Abscess, Abusive Head Trauma, Accuracy, ACGME, Acoustic Schwannoma, Actinomycosis, Actue Stroke, Acute Basilar Artery, Acute Cerebellar Stroke,
Aneurysms of the Vertebrobasilar Junction, Anterior and Posterior Inferior Cerebellar Arteries: Diagnostic Considerations and Endovascular Treatment Methods

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¹Henry Ford Health System, Detroit, MI

Purpose
The purpose of this exhibit is to provide a pictorial review of aneurysms involving the vertebrobasilar (VB) junction, anterior inferior cerebellar artery (AICA) and posterior inferior cerebellar artery (PICA). For each entity, we will discuss relevant imaging findings and endovascular treatment options, including methods, technical considerations, and potential complications.
Materials and Methods
Using our case files, we will show clinical examples of various types of aneurysms involving the VB junction, AICA, and PICA. Cases will include berry aneurysms arising at vessel origins; distal aneurysms of the AICA and PICA, dissecting aneurysms of the intracranial vertebral artery, fenestration aneurysms, and fusiform basilar aneurysms. For each entity, we will discuss:
- Important diagnostic and therapeutic considerations, including anatomical (e.g., limited surgical access, adjacent cranial nerves, shared blood supply), as well as those related to the aneurysms themselves (e.g., size, geometry, location).
- Various treatment methods, including endovascular coils (with and without stent and balloon assistance), vessel reconstruction, parent vessel occlusion, and liquid embolization.

Results
Aneurysms involving the vertebrobasilar system are rare, representing only 8-12% of all intracranial aneurysms. In particular, aneurysms affecting the VB junction, AICA and PICA are especially uncommon lesions, ranging from approximately 0.5-3% of all intracranial aneurysms. When occurring, aneurysms in each of these locations can present a number of challenges to successful treatment, both from a surgical and endovascular approach. In addition to aneurysm characteristics, a number of anatomic factors can also influence the treatment decision, including limited surgical access secondary to the petrous bone, close proximity to the perforating arteries and cranial nerves of the brainstem, as well as potential loss of normal AICA and PICA supply. An additional factor to consider when evaluating these aneurysms is the high degree of vascular anatomic variation, which can lead to unusual presentations of aneurysms such as dissecting and fenestration aneurysms, as well as the presence of collateral pathways, which have implications on treatment planning and selection.

Conclusions
Aneurysms affecting the vertebrobasilar junction, AICA and PICA are uncommon lesions, fraught with a number of treatment challenges, both surgically and endovascularly. After viewing this exhibit, the individual will better understand the methods available for treating aneurysms in these locations, as well as important factors to consider before, during, and after treatment.

KEYWORDS: Aneurysm, Aneurysm Treatment
Review of Vascular Access Closure Devices

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Purpose

Neuroangiography and many other angiographic procedures require access to the common femoral artery. Proper arteriotomy closure at the conclusion of the procedure is vital with a major complication of continued hemorrhage. Historically, manual pressure has been used to close arteriotomy sites. This requires approximately 30 minutes of operator and procedure room time as well as cessation of anticoagulation. Approximately four hours of postprocedure immobility is required by the patient to ensure proper arteriotomy closure. In addition, complications can be highly dependent on operator experience, patient body habitus, and anatomy. More recently, several femoral artery closure devices have become available to save physician, procedure room, and recovery time. This exhibit aims to explain the appropriateness of closure device usage, description of the existing devices, instructions for usage, and potential complications.
Materials and Methods
We will review the contraindications of arterial closure devices and describe the benefits. We then will discuss the various classes and mechanisms of the available devices and their usage.

Results
Internal active arterial closure devices cannot be used in vessels with atherosclerotic disease or other irregularity such as dissection. Therefore angiography of the access site must be performed to rule out these conditions. There are multiple mechanisms of action for arterial closure devices. Most devices employ an anchor within the artery to be able to apply pressure between the arteriotomy and skin surface. The Cardiva Catalyst (Boomearang) device is the simplest device with a temporary anchor which is removed after hemostasis is achieved. No foreign body is left behind. Most other devices leave a foreign material to aid in closure which also creates the risk of distal embolization if there is device malfunction. Angioseal (St. Jude Medical) devices use an absorbable anchor and collagen plug external to the vessel for closure. Because of the foreign body, there is a slightly increased theoretical risk of infection. Mynx (AccessClosure) devices utilize a temporary balloon anchor with polyethylene sealant to close the tissues outside the artery. Because no permanent anchor is left in place, the risk of embolization should be lower. Exoseal (Cordis) devices also utilize a similar synthetic material to close the surrounding tissues. Other devices utilize mechanical closure rather than biologic or chemical materials. Starclose (Abbott) uses a nitinol clip to close the arteriotomy, but have been associated with persistent oozing in many cases. Perclose (Abbott) devices utilize a suture closure system. Many of these devices have been shown to reduce complication rated and accelerate time to patient ambulation. However there are small but significant risks such as infection and lower extremity ischemia that do not occur with simple manual compression. These risks can be decreased when the devices are used in the appropriate manner and in the appropriate circumstances. This exhibit will help in understanding these devices and their usage.

Conclusions
Multiple arterial closure devices are available on the market. When indicated, these can be a valuable tool to save time for both physicians and patients. The devices must be used carefully as incorrect operation or application in a contraindicated situation can result in hemorrhage or limb ischemia.

KEYWORDS: Arteriography, Closure Device

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Education Exhibits (eEdE) - Pediatrics
eEdE-189

"Uncommon Phakomatoses" Clinical and Imaging Spectrum-What The Radiologist Needs to Know ?

L Amaral¹, P Hanagandi², F Goncalves³
Purpose
To familiarize the radiologist about uncommon phakomatoses syndromes.

Materials and Methods
Computed tomography (CT) and MR imaging (MRI) findings with relevant clinical correlation and review of neuroradiology literature will be discussed.

Results
Phakomatoses comprises a diverse group of multisystemic lesions presenting in different age groups. The spectrum of neurofibromatosis (NF1 & NF2) and tuberous sclerosis (TS) are diagnosed easily in routine imaging practice. When encountered with uncommon phakomatoses syndromes, the clue to diagnosis depends on clinical examination which is often overlooked. This educational exhibit emphasizes the importance of examining skin lesions which hold the key to diagnosis in many of these conditions. A variety of mucocutaneous lesions with imaging correlation will be the highlight of this educational exhibit. Diseases like Incontinentia pigmenti, Neurocutaneous Melanosis, Hypomelanosis of Ito, PHACES, Meningioangiomatoses, Osler Weber Rendu and Sturge Weber syndrome will be discussed with review of neuroradiology literature. Very often a small nonspecific naevus, mucocutaneous telangiectasia, facial brith mark, unusual cutaneous lesions like "lines of Blaschko" may be vital in clinching the diagnosis.

Conclusions
It is of prime importance to examine the skin and accessible mucocutaneous regions as they hold the key to diagnosis of uncommon phakomatoses.

KEYWORDS: Neurocutaneous Melanosis, PHACES, Phakomatoses
eEdE-191

3T Fetal MRI

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Fetal MR imaging (MRI) is important both for the further evaluation of anomalies detected by ultrasound as well as for screening fetuses at risk for brain abnormalities due to family history. In the post-natal period, imaging at 3 T has become preferable due to improved signal to noise ratio compared to 1.5 T. Although these benefits also hold for fetal imaging, 3 T fetal imaging has not yet become routine. Factors contributing to this include safety concerns related to 3 T imaging and management of artifacts worsened at higher field strength. We present our experience with 3 T fetal MRI safety and artifacts, as well as protocol optimization.

Materials and Methods
1) Although no specific FDA safety criteria for fetal imaging exist, there are FDA guidelines for determining MRI risks. Factors addressed are main static magnetic field, specific absorption rate, gradient fields rate of change, and sound pressure level. Risk in each of these four areas is assessed through literature review. 2) Common artifacts encountered on 3 T fetal MRI include signal drop off due to receive coil placement and/or dielectric effects, but artifacts due to fetal motion often dominate. Signal dropouts can be due to inappropriate positioning of the receive coil array, an artifact which can be fixed easily by repositioning them. Artifacts also may be caused by the dielectric effects from the inhomogeneous transmit field observed in body imaging at 3 T. The level of inhomogeneity depends on abdominal size, with larger abdominal sizes at later gestational ages (GA) tending to introduce more signal dropouts compared to smaller abdominal size at earlier GA. To mitigate motion artifact, the fetal acquisitions done on our 3 T system use a total of 30 ch coil elements, allowing robust imaging using in-plane (GRAPPA) acceleration factor (AF) of R = 2, resulting in 40-50% reduction in the amount of time needed to acquire a single slice. For example, in a typical HASTE acquisition (voxel size 1 x 1 x 2 mm^3), acquisition time for one slice is ~900 ms for the nonaccelerated case, and ~500ms with acceleration. Although in-plane AF of 2 can be applied both at 1.5 or 3 T scanners where the number of coil elements used is much less than 30, reconstruction of these acquisitions will be prone to image artifacts due to the increased spatial correlation among the fewer coil elements. Going to in-plane acceleration factors of 2 lowers the signal-to-noise ratio (SNR), but by going from 1.5 T to 3 T, we improve the SNR due to increased field strength. A secondary benefit of using acceleration factor of 2 is a decrease in SAR due to the decreased number of phase-encode lines.

Results
Overall, there is no evidence that 3 T fetal imaging poses significant increased risk relative to imaging at 1.5 T if standard safety precautions are strictly followed. Examples of artifacts will be shown. In general, correcting for the signal dropouts due to dielectric effects at 3 T would require RF pulse design algorithms that make the transmit field uniform throughout the FOV. However, this is a challenging task given the currently available transmit hardware on the clinical 3 T systems which have one transmit channel. 3 T system with 4-8 transmit RF amplifiers could enable one to effectively correct for the transmit field inhomogeneities while reducing the SAR of the sequence in the same time. However, these systems with multiple transmit amplifiers are not yet available for clinical practice. Thus, what can currently be done is to make sure that there are no signal dropouts in the specific area of interest within the excited FOV. For example, if the dark band is occurring in the middle of the fetus' head, and the head is the objective of that acquisition, then a pre-scan that gives a transmit field map over the entire FOV can be done, which would enable adjustment of the flip angle of the sequence, so that there are no signal dropouts over the fetus' head. This would basically move the dark band to a different location,
which would not be a problem given that the fetus' head is the objective of the acquisition. Example of 1.5 T and 3 T images will be shown to demonstrate differences in image quality and image artifacts. Our current 3 T protocol will be provided.

Conclusions

3 T imaging offers benefits in improved image quality and the potential to improve diagnostic accuracy in the prenatal period without significant increases in risk compared to 1.5 T. Common artifacts can be reduced by adjusting exam technique and image quality optimized by protocol adjustment.

KEYWORDS: Fetal MR Imaging, Prenatal MR Imaging

**eEdE-199**

**An Algorithmic Approach to Posterior Fossa Cystic Malformations**

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**Purpose**
1. Discuss posterior fossa cystic malformations and their imaging features. 2. Provide an algorithm that can be utilized as an organized approach to differentiate amongst the malformations.

**Materials and Methods**

Review embryologic development of the posterior fossa. Discuss imaging findings of posterior fossa cystic malformations. Provide a generalized algorithm to differentiate amongst the malformations.

**Results**

Posterior fossa cystic malformations include Dandy-Walker Malformation, persistent Blake's pouch cyst, arachnoid cyst, mega cisterna magna and epidermoid cyst. Although the imaging characteristics of these malformations have been well documented, their overlapping features make it confusing when applying them to daily clinical encounters. Differentiating amongst the entities is important because of their implications in treatment. We review the normal embryologic development of the posterior fossa, describe the posterior fossa cystic malformations, and discuss a generalized algorithm that assists in differentiating amongst the malformations. The algorithm begins by assessing the morphology of the cerebellar vermis; An abnormal vermis is indicative of Dandy-Walker Continuum, which includes Dandy-Walker Varient and Dandy-Walker Malformation. To differentiate amongst these two entities, one then evaluates for the presence of hydrocephalus. This, along with an enlarged posterior fossa, displacement of the transverse sinuses, tentorium and torcula are suggestive of Dandy-Walker Malformation. Alternatively, the absence of hydrocephalus, normal posterior fossa size, partial agenesis of the vermis, and abnormal vallecula are indicative of Dandy-Walker Varient. Conversely, if the vermis is normal in morphology then dilatation of the fourth ventricle should be assessed; if present this suggests of a persistent Blake's pouch cyst. If the vermis and the 4th ventricle are normal, then a mega cisterna magna, arachnoid cyst or an epidermoid cyst should be entertained. Next, compression of the fourth ventricle or cerebellum is assessed. If this is
lacking, and there is communication with the surrounding CSF spaces as indicated by a CINE CSF flow study, then a mega cisterna magna is suggested. Compression of the cerebellum or 4th ventricle can be seen in arachnoid cysts or epidermoid cysts and diffusion restriction can help distinguish amongst these.

Conclusions
After completing this electronic educational exhibit, the reader will gain a better understanding of the various posterior fossa cystic malformations and will be able to apply an algorithm that offers a simplified approach to differentiate amongst the various entities in order to improve diagnostic accuracy.

KEYWORDS: Congenital Anomalies, Cyst

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eEdE-179

An Easy Approach to Diagnose Inborn Metabolic Disorders in Children: How to Make Things Easier
Purpose
To present an "easier" approach to diagnose or at least to suggest the most probable list of
diagnoses in children presenting with a clinical picture of progressive encephalopathy and with
an eventual diagnosis of inborn metabolic disorder.
Materials and Methods
We retrospectively reviewed the clinical charts and neuroimaging studies in 130 children with
inborn metabolic diseases studied in the last 18 years. MR imaging (MRI) was performed on a
1.5 T GE Signa Horizon and 1.5 T GE Excite. Available sequences included sagittal T1 and T1
3D SPGR, axial T1, T2, FLAIR, GRE and DWI, as well as coronal T2. Magnetic resonance
spectroscopy (MRS) was obtained in some patients, and gadolinium chelates were administered
in all. A neuroradiologist with 18 years experience (BL) evaluated all the images. The diagnosis
was confirmed by blood or urine evaluation, MR spectroscopy, skin biopsy, and/or clinical
evaluation.
Results
Based on the neuroimaging features and clinical picture, along with the results from the blood,
urine and cerebrospinal fluid (CSF), EEG and ophthalmologic studies, the vast majority of cases
could be categorized into the following groups: 1- Diseases that affect only (or mainly) boys; 2-
Diseases with typical changes in hair and/or skin; 3- Diseases with macrocephaly; 4- Diseases
presenting with neonatal epilepsy; 5- Diseases with a strong predilection for the brainstem and/or
cerebellum; 6- Diseases that produce cysts in the brain parenchyma.
Conclusions
Inborn metabolic disorders are a common cause of developmental arrest in children. Some
patients also present with seizures, macrocephaly, hypotonia, and impaired vision and hearing.
These disorders are usually classified according to the affected cell (i.e., lysosomes, etc.) or
organelle (i.e., mitochondria, etc.). However, this approach is not helpful from a radiological
perspective. Evaluation of the MRI findings, along with the clinical information as well as the
results of ancillary laboratory and EEG studies is helpful to categorize patients and to restrict the
scope of differential diagnosis. The use of the proposed schematic approach may be helpful in
the everyday radiological practice.

KEYWORDS: Macrocephaly, Metabolic, MR Spectroscopy

eEdE-176
6:30AM - 9:00PM

Baby’s buttocks tell what anomalies inside: Imaging of spinal dysraphism.

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Purpose
Spinal dysraphism is a heterogeneous group of anomalies. Classification for spinal dysraphism is
complex and also various. Patients with spinal dysraphism refer to imaging studies because of
abnormalities in their buttocks: Mass or pit. And if we classify spinal dysraphism along with these findings, this complex entity becomes simpler. In this educational review, we classify spinal dysraphism along with findings of patient's buttocks. Clinical manifestations, embryology and imaging findings and prognosis of each anomaly will be presented.

Materials and Methods
In this educational review, we classify spinal dysraphism along with findings of patient's buttocks. Clinical manifestations, embryology and imaging findings and prognosis of each anomaly will be presented.

Results
Content organization: 1. Mass on buttocks: A. Mass not covered with skin: Myelomeningocele, meningocele, or myeloschisis. B. Mass covered with skin: Lipomyelomeningocele, lipomyelocele, or terminal myelocystocele with or without intra spinal lipoma. 2. Pit in buttocks: A. Pit above gluteal cleft: Dermal sinus, which may associate with tethered cord and dermoid cyst. B. Pit between gluteal cleft: Sacrococcygeal skin dimple, which is usually without severe abnormalities. 3. Normal looking buttocks: Under normal looking buttocks, spina bifida, intraspinal lipoma, and caudal regression syndrome may be hidden.

Conclusions
Spinal dysraphism is a heterogeneous group of anomalies. However, patient's buttocks suggest which abnormality is under them and help understanding of spinal dysraphism.

KEYWORDS: Fetal MR Imaging, MR Imaging Spine, Spinal Dysraphism

eEdE-173

Calvarial Pathology in Children Portrayed by 320 Detector 3D Volumetric CT

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Purpose
Various disease processes can affect the neurocranium. Specific patterns, morphology, and extent of calvarial pathology may be underappreciated on cross-sectional images alone. Three-dimensional (3D) computed tomography (CT) images can provide a more global picture of the skull. The purpose of this exhibit is to demonstrate examples of congenital, developmental, and post-traumatic disease processes depicted by 320 detector 3D CT.

Materials and Methods
Selected 3D CT cases from children (ages 0-18) exemplifying various disease processes of the skull are reviewed and exhibited. Normal 3D CT images of the skull also are displayed. All exams were performed using a volumetric acquisition with a 320 detector CT scanner (Toshiba Aquilion 320, Toshiba Inc., Tokyo, Japan), without intravenous contrast material. Five mm thickness axial, sagittal, and coronal bone and soft tissue algorithm multiplanar reconstructions were created by the CT scanner. Three-dimensional volume reconstructions of the skull were produced by CT scanner software with transverse rotation and anterior-posterior tumble images created at 18 degree intervals.
Results
Various disease processes affect the developing skull. Three-dimensional CT images provide an excellent global view of the calvarium, enhancing pattern recognition that may not be evident on segmental images viewed in cross-section or in reformatted planes. Case examples of congenital/developmental defects, craniosynostosis, luckenschadel skull, dermoid associated with metopic wormian bones, fibrous dysplasia, osteogenesis imperfecta, achondroplasia, Goldenhar syndrome, bruxism enthesopathy, and traumatic pathology (both blunt and penetrating traumatic injuries) are presented.

Conclusions
Three-dimensional CT images of the calvarium are a useful adjunct to cross-sectional images in the evaluation of osseous disease processes. The patterns and extent of congenital skull anomalies, bone lesions, and fractures are all readily evaluated on 3D CT.

KEYWORDS: Calvarial, CT, Skull

Central Nervous System Manifestations and Treatment-related Complications of Hematologic Malignancies in Children

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Purpose
Hematologic malignancies result in a wide array of central nervous system (CNS) abnormalities
in children. These varied pathologies may relate to the patient's primary disease or its treatment. The purpose of our study is to review the clinical and imaging features of disease and treatment-related neurological complications of hematologic-based malignancies in children.

Materials and Methods

We retrospectively analyzed the neuroimaging findings of 14 patients with hematologic derived malignancies: acute myelogenous leukemia (AML), acute lymphoblastic leukemia (ALL), lymphoma, Langerhans cell histiocytosis (LCH) and hemophagocytic lymphohistiocytosis (HLH). All patients had CNS tumor, cranial/intracranial involvement, or treatment-related complications that were characterized on contrast-enhanced brain and, where applicable, spine MR imaging (MRI).

Results

Among the 14 patients, eight had primary tumor-related findings. Two patients with AML had parenchymal and/or meningeal leukemia compatible with myeloid sarcoma. A patient with recurrent ALL had a posterior third ventricular/pineal region mass, a rare presentation for this subtype of leukemia. The patient also had abnormally thick enhancement of the pituitary stalk, with the constellation of findings overall suggestive of a germinoma. Another patient with ALL had abnormal enhancement of thickened dura in addition to more typical marrow abnormality. One patient with lymphoma had a parenchymal mass as well as an extra-axial mass, and had been treated for demyelination on the basis of prior imaging in which his malignancy mimicked white matter lesions. Two patients with LCH had isolated skull masses, with another lacking the normal T1 hyperintensity corresponding to the posterior pituitary gland. Another LCH patient with initial mastoid involvement recurred in the left frontal region, with disease extending into thickened dura. Imaging in the patient with neurodegenerative LCH showed areas of supra- and infratentorial brain T2/FLAIR white matter hyperintensity, including within the middle cerebellar peduncles and cerebellar white matter. Seven patients had treatment-related complications. Four ALL patients had leukoencephalopathy related to methotrexate. One HLH patient and one ALL patient had cerebrovascular abnormalities resulting in white matter signal abnormalities, and another postradiation changes.

Conclusions

Treatment advances in hematopoietic-based malignancies have improved survival, increasing the incidence of CNS disease as well as associated complications. MR characterization of these abnormalities also continues to improve, with increasing availability of higher strength magnets and implementation of advanced techniques such as perfusion imaging. Familiarization with the extensive range of imaging characteristics in this setting is essential for the radiologist. While the imaging findings occasionally may be rare or mimic other conditions, accurate assessment at the onset of new symptoms and in the evaluation of treatment response have the potential to impact further management options (such as medication regimen or bone marrow transplant) and thereby alter the clinical course.

KEYWORDS: Pediatric Brain Tumors, Pediatric Neoplasms

eEdE-186

Embryology for Neuroradiologists: a Visual Primer

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Purpose
To illustrate the embryology of brain, head and neck, and spine imaging integrated by basic concepts through a pictorial essay.

Materials and Methods
We demonstrate complex embryology through easy-to-understand illustrations and imaging of typical brain, head and neck, and spine pathologies such as: anencephaly, encephalocele/myelomeningocele, Arnold-Chiari malformation, Dandy-Walker complex, holoprosencephaly, rhombencephalosynapsis, notochord remnant, vertebral anomaly, thymoglossal duct cyst, branchial cleft anomalies, ear anomalies, persistent hyperplastic primary vitreous, foregut malformation, and CHARGE association. We also briefly discuss associated gene expressions/mutations.

Results
The central nervous system is formed during week 3 of development as the neural plate of neuroectoderm becomes the neural tube, giving rise to the brain and spinal cord. The notochord induces the ectoderm to form the neural plate. The peripheral nervous system is derived from neural crest cells, the neural tube (nerve fibers), and mesoderm (dura matter, endo-, peri- and epineurium). The head and neck are formed by pharyngeal arches (somitomeric mesoderm, neural crest cells), pharyngeal pouches (evagination of endoderm), pharyngeal grooves (evagination of ectoderm), and pharyngeal membranes (ectoderm). These structures form the middle ear cavity (pharyngeal pouch 1), malleus and incus (pharyngeal arch 1), stapes (pharyngeal arch 2), tympanic membrane (pharyngeal membrane), external ear meatus (pharyngeal groove 1), palatine tonsil crypts (pharyngeal pouch 2), and parathyroid gland and thymus(pharyngeal pouch 3 and 4). Placodes are localized thickenings of surface ectoderm (lens placode, otic placode, olfactory placode). The endodermal lining of the foregut forms the thyroid diverticulum. Cranial nerves 5, 7, 9, and 10 supply the structures of pharyngeal arches 1, 2, 3, 4, and 6. The internal ear develops in week four from the surface ectoderm (otic placode) invagination into mesenchyme to the rhombencephalon to form the otic vesicle. The optic vesicle from the diencephalon invaginates into the optic stalk and forms the optic nerve and choroidal fissure permitting access of the hyaloid artery. Failure at any of these points gives rise to abnormalities/syndromes with which the neuroradiologist should be familiar.

Conclusions
We demonstrate complex embryology through easy-to-understand illustrations and imaging of typical brain, head and neck, and spine pathologies. An integrated knowledge of embryology is essential for understanding the anatomy and pathophysiology for image interpretation of diseases and syndromes. This educational exhibit provides a visual primer of embryology for neuroradiologists.

KEYWORDS: CT, Embryology, MR Imaging

eEdE-180

Fetal MRI technique: What are we looking for?
Purpose
To demonstrate a step by step approach of interpreting fetal MR imaging (MRI) with respect to central nervous system (CNS) and Head and Neck pathologies based on specific pulse sequences.

Materials and Methods
Our fetal MRI protocol includes scout T1 images of the maternal pelvis in three planes, axial T1-weighted images (VIBE) along the maternal axis, three planes T2-weighted images (HASTE or TrueFISP), axial echo planar images (EPI), axial T1-weighted images and axial diffusion-weighted images (DWI) of the brain along the fetal axis. Key imaging findings in each pulse sequence will be documented, with respect to pathology detection and diagnosis. Correlation with postnatal imaging and clinical outcome will be provided, if available.

Results
We will demonstrate several cases of congenital CNS and Head and Neck pathology detected from fetal MRI. Imaging checklists and key imaging findings in each MRI pulse sequence will be highlighted as a tool for interpretation. Scout and T1 image checklists include fetal orientation, placental position, fetal situs, congenital pathology of the thyroid, and subacute CNS blood products. T2 image checklists include CNS anatomy with respect to ventricular size, symmetry, supratentorial and posterior fossa malformations, and sulcation pattern. EPI image checklist includes blood products and vessel thrombosis. The DWI checklist includes acute infarct and potential tumor grading. The various congenital pathologies we will demonstrate using this method include neural tube closure defects (encephalocele, and myelomeningocele with and without Chiari malformation), disorders of diverticulation (holoprosencephaly, corpus callosal anomalies, and absent septum pellucidum), neuronal migration and sulcation abnormalities (polymicrogyria and schizencephaly), Dandy-Walker malformation, hydrocephalus (aqueductal stenosis), infarction and/or hemorrhage (hydranencephaly), facial malformation (cleft lip and cleft palate), benign brain lesions (arachnoid cysts), congenital tumors (epignathus, head and neck teratoma, choroid plexus tumor, sacrococcygeal teratoma), and vascular lesions (hemangioma, venolymphatic malformation, sinus thrombosis, and vein of Galen malformation). Figure A demonstrates a 24-week fetus with a posterior scalp mass. Axial T1 VIBE shows a mass with internal linear hyperintensity (white arrow) consistent with vascularity. A sagittal T2 HASTE shows the circumscribed mass with prominent flow voids (white arrow) and associated cardiomegaly with ascites (black arrows), indicating high output heart failure from a fetal hemangioma.

Conclusions
Fetal MRI is a valuable imaging modality in diagnostic dilemmas when ultrasound examination is inconclusive. This information will help parents make decisions during the pregnancy, and possible advanced treatment during the pre and postnatal period. Understanding the importance of imaging sequences and having a diagnostic checklist in each sequence can improve accuracy in interpretation, assisting clinicians in optimizing patient counseling, management of pregnancy and delivery, and postnatal treatment planning.

KEYWORDS: Fetal Brain Development, Fetal Brain Injury, Fetal MR Imaging
Imaging of pediatric CNS inflammatory demyelinating disorders

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Purpose
1-To review basic background about pediatric central nervous system (CNS) inflammatory demyelinating disorders (CIDD). 2-To illustrate classification of pediatric CIDD. 3-To discuss typical and atypical imaging appearance of pediatric CIDD. 4-Role of advanced imaging in diagnosis of pediatric CIDD.

Materials and Methods
1-Consensus definitions proposed for pediatric multiple sclerosis and related disorders. 2-Update classification of pediatric CIDD. 3-Prevalence and incidence, world distribution, current diagnosis criteria, treatment strategies. 4-Imaging appearance of pediatric multiple sclerosis. 5-
Imaging of acute disseminated encephalomyelitis and its variants as recurrent and multiphasic. 6- Imaging of pediatric neuromyelitis optica. 7- Imaging of pediatric clinically isolated syndrome. 8- Role of advanced MR imaging in pediatric CIDD. 9- Imaging findings used to differentiate pediatric CIDD from other simulating lesions. 10- Summary and future directions.

Results
MR imaging helps for diagnosis of pediatric multiple sclerosis and differentiating from simulating disorders. We discuss the MR imaging appearance of acute disseminated encephalomyelitis and its variants as recurrent and multiphasic. Also, imaging is important for diagnosis of pediatric neuromyelitis optica and pediatric clinically isolated syndrome. Advanced MR imaging has a role in diagnosis of pediatric CIDD. Imaging findings used to differentiate pediatric CIDD from other simulating lesions.

Conclusions
We concluded that routine and advanced MR imaging in conjunction with clinical findings are useful for diagnosis of pediatric CIDDs and differentiating them from simulating lesions.

KEYWORDS: Diffusion MR Imaging, Multiple Sclerosis Plaques

eEdE-196

IMAGING OF PEDIATRIC INTRAVENTRICULAR TUMORS

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Purpose
Intraventricular tumors occur with a higher incidence in children than in adults. Intraventricular tumors in children can be found in both supratentorial and infratentorial compartments which can pose a serious diagnostic challenge. Early and accurate identification is an essential step in the management of these tumors. This exhibit aims to provide a broad understanding of the imaging features of various intraventricular tumors occurring in the pediatric age group.

Materials and Methods
Imaging anatomy of the ventricular system with color plates, CT and MR imaging (MRI) will be discussed initially to understand the intraventricular tumors. The intraventricular tumors will be classified as supratentorial and infratentorial. Supratentorial tumors will further be discussed as lateral and third ventricular tumors. Relevant clinical cases will be used to highlight the imaging features of various intraventricular tumors. Also, developmental lesions occurring in the ventricles will be discussed. An emphasis on appropriate imaging techniques will be made, for example the utility of diffusion sequence to distinguish medulloblastoma from other tumors in the fourth ventricle. An imaging algorithm will be provided at the end of the presentation to facilitate the imaging analysis of the various pediatric intraventricular tumors. An emphasis on imaging of neuraxis also will be discussed to identify and exclude CSF spread of tumors in the appropriate situations.

Results
Important intraventricular tumors in the supratentorial compartment include choroid plexus papilloma, subependymal giant cell astrocytoma, subependymoma, central neurocytoma,
meningioma and ependymoma in the lateral ventricles. The important tumors which can be found in the third ventricle include germinoma, choroid plexus papilloma, ependymoma and craniopharyngioma. Along with the imaging features, the clinical features of intraventricular tumors will be discussed to improve the accuracy of diagnosis. A discussion on colloid cyst in the roof of the third ventricle will be made. Tumor mimics of intra third ventricular tumors like pineal tumors and basilar bifurcation aneurysm will be discussed. Developmental lesions including subependymal heterotopia, arachnoid cyst, dermoid/epidermoid and cavernoma of the lateral and third ventricles will be discussed to complete the features of supratentorial intraventricular tumors. In the fourth ventricle, medulloblastoma, ependymoma, choroid plexus papilloma and subependymoma will be discussed. Also developmental lesions dermoid/epidermoid of the fourth ventricle will be discussed. Exophytic tumors mimicking intraventricular tumors such as pilocytic astrocytoma of the cerebellum/brainstem, tuber cinereum hamartoma, etc., will be highlighted. A discussion on tumor seedling through ependymal spread will be made. Finally, imaging features of intraventricular cysticercosis will be discussed to complete a comprehensive coverage of pediatric intraventricular tumors.

Conclusions
A review of the exhibit will help one to understand the intraventricular tumors occurring in the pediatric population, identify their imaging features, guide the appropriate imaging technique and recognize the post-treatment changes.

KEYWORDS: Pediatric Brain Tumors, Ventricles

Imaging the peritumoral zone of pediatric brain tumors using DTI: the good , the bad and the ugly.

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Purpose
Delineating the boundary of brain tumors is important to guide surgical resection. This can be difficult on conventional imaging due to the infiltrative behavior of some high grade tumors. The goal of this exhibit is to review a wide range of pediatric brain tumors and illustrate various appearances of the peritumoral zone on diffusion tensor imaging (DTI), correlating also with conventional imaging. Diffusion tensor imaging has been used to improve delineation and characterization of tumor margins in adult brain neoplasms but there is relatively little work in pediatric tumors. This exhibit will compare and contrast the DTI findings in low grade or noninfiltrative neoplasms ("the good"), infiltrative aggressive neoplasms ("the bad") and discuss potential pitfalls and artifacts that interfere with proper assessment ("the ugly").

Materials and Methods
Pediatric patients with intra-axial brain tumors were identified through our institution's radiology information system. Initial pre-operative MR imaging (MRI) was reviewed. Operative reports were reviewed to determine any specific difficulties in identifying tumor margin during the procedure. Pathology reports and postoperative imaging also were reviewed to determine the completeness of resection. A case-based presentation illustrating the various patterns of white
matter involvement by tumor, correlating conventional imaging and DTI was constructed. The fractional anisotropy maps, mean diffusivity map, and color map were analyzed for each case. Diffusion tractography was used to analyze the effect of tumor on adjacent white matter tracts, if applicable. The relationship of these findings to surgical planning and completeness of resection was discussed for each case.

Results
A wide range of tumor types was illustrated. Supratentorial tumors included juvenile pilocytic astrocytoma, anaplastic astrocytoma, glioblastoma multiforme, choroid plexus carcinoma with parenchymal invasion, optic nerve glioma, oligodendroglioma, PNET. Infratentorial tumors included medulloblastoma, ependymoma, anaplastic ependymoma, juvenile pilocytic astrocytoma, tectal glioma, pontine glioma and atypical teratoid rhabdoid tumor. The high grade tumors including anaplastic astrocytoma, glioblastoma multiforme, atypical teratoid rhabdoid tumor, and invasive choroid plexus carcinoma showed peritumoral zones with decreased fractional anisotropy and infiltration of white matter tracts. The low grade tumors by contrast displaced rather than infiltrating the adjacent white matter, with no peritumoral loss of fractional anisotropy. Findings were similar to those reported for adult neoplasms.

Conclusions
Diffusion tensor imaging provides a valuable complement to conventional MRI in assessment of the peritumoral zone of pediatric brain tumors, and could help distinguish low grade from high grade neoplasms. Familiarity with these findings will help the radiologist provide better pre-operative imaging assessment of pediatric brain neoplasms.

KEYWORDS: Diffusion Tensor Image, Pediatric Brain Tumors

eEde-175

6:30AM - 9:00PM

Implications of absence of Cavum Septum Pellucidum on Forebrain Commissures: An embryology based approach

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Purpose
The cavum septum pellucidum (CSP) is an important landmark to identify on fetal ultrasound examination, as its absence often heralds commissural abnormalities. Anatomically and developmentally related to the CSP, various patterns of Corpus Callosal (CC) abnormalities are evident on follow-up MR imaging (MRI). However, due to the widespread misconception of an anterior to posterior sequential development of the CC, there is a dichotomy in understanding the patterns of "typical" (normally formed anterior callosum in the absence of posterior callosum) versus "atypical" callosal agenesis (normally formed posterior callosum in the absence of the anterior callosum) in the holoprocencephaly spectrum of disorders (HPE). As a result, a quagmire of terms is used in the clinical description of these abnormalities. Understanding CSP development is therefore quintessential in demystifying mid-line developmental abnormalities and anticipating their patterns in general.
Materials and Methods
1. Using simple illustration, this exhibit reviews the embryological origin and development of the CSP, CC, as well its relationship to the anterior and hippocampal commissures. 2. Significance of age-appropriate imaging features of the CSP, and its implications on prenatal screening timing. 3. Discuss the prevalence of absent CSP in various developmental disorders, and the role of absent CSP as a potential surrogate marker for midline defects on prenatal ultrasound. 4. Characterization of the patterns of possible commissural abnormalities in absent CSP on MRI.

Results
1. Embryology: CC is one of three major commissures of the forebrain that develops from a glial sling at the lamina reunions (LR), around 12 weeks; the CSP is developmentally related to anterior callosum. The growth of the CSP closely shadows the dorsoventral expansion of the developing forebrain. The posterior callosum originates independently, further dorsal to the hippocampal commissure. 2. A wide spectrum of morphologically abnormal CC is possible in the developmental absence of the CSP. a: Callosal agenesis (complete and partial): The lack of formation of the glial sling, crucial for the crossing pioneering neurons, manifests as complete agenesis of the CC. The migrating neurons therefore are misdirected posteriorly. Diffusion tensor imaging provides exquisite detail of the architecture of the heterotopic white matter fascicles in commissural abnormalities. Partial agenesis of the CC results from regional defects of the neocortex, due to focal defects of the callosal anlage, and poor dorsal expansion of the callosum happening due to expansion of cerebral hemispheres. b. In milder forms of HPE, including midline syntelencephaly, the callosal defect corresponds to the extent of interhemispheric fusion, which more severely affects the anterior callosum as it develops from the ventral LR. The posterior callosum, which develops in the dorsal LR is relatively spared ("atypical" agenesis). c. Disorders of cerebral cortex with absent CSP and agenesis of CC occurs frequently due to neuronal migration disorders. d. Schizencephaly and Septo-optic dysplasia: Absent CSP is common feature in these disorders. Common underlying genetic factors (e.g., Lhx-2 gene) have been identified which influence the CSP development.

Conclusions
The developmental absence of CSP indicates associated commissural disorders of variable clinical consequences. Knowing the embryological development of CSP and commissures simplifies the understanding patterns of these developmental disorders. The manifestations of such disorders are most apparent on the corpus callosum which is the largest commissure of the brain.

KEYWORDS: Callosal Dysgenesis, Corpus Callosum, Septo-Optic Dysplasia
Mimics of Inherited Metabolic Disorders in Children:

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Purpose
Interpreting radiologic exams white matter disease in children often is challenging for radiologists. One of the first questions to be asked when dealing with such an exam is if it is indeed an inherited metabolic process or some other acquired disease process producing similar appearance. Multiple disease entities can present with imaging features mimicking inherited metabolic disorders. These disorders represent a spectrum of white matter disease characterized by damage to neurons or axons with resultant breakdown of myelin resulting from pure demyelination to necrosis with subsequent demyelination.

Materials and Methods
The goal of this exhibit is to give a brief overview of clinical features of mimics of inherited metabolic disorders. We will review the imaging features and provide important radiologic and clinical clues to differentiate them from metabolic disorders. The obvious clinical implication of this is to arrive at correct and early correct diagnosis and avoid expensive and unnecessary metabolic work up.

Results
Entities which will be reviewed in this exhibit include: inflammatory and infectious processes like pediatric multiple sclerosis, acute disseminated encephalomyelitis (ADEM), posterior
reversible encephalopathy syndrome (PRES), postmeasles virus-induced subacute sclerosing panencephalitis (SSPE), cytomegalovirus (CMV) related white matter changes; acquired toxic injuries and nutritional deficiencies like Wilson's disease, vitamin B12 deficiency, Wernicke's encephalopathy, postradiation leukoencephalopathy, drug-induced (like methotrexate) leukoencephalopathy; vascular causes like cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL), primary CNS vasculopathy; and other disorders including neurofibromatosis type I, postischemic leukoencephalopathy, acute necrotizing encephalopathy of childhood (ANEC). To narrow the differential diagnosis combination of the clinical and laboratory data, whenever available, with the imaging features is important. Additionally, serial imaging helps to differentiate these mimickers, which tend to be stable or improve on follow-up imaging studies, in contrast to inherited metabolic disorders which are typically progressive.

Conclusions
There are numerous diseases which present as with either white matter or gray matter abnormality, in a pattern similar to inherited metabolic disorders. This assessment can be quite challenging. Knowledge of clinical and imaging features of these disorders is important to differentiate them from more complex groups of inherited disorders. This can lead to early diagnosis and avoid more expensive and often unnecessary metabolic work up.

KEYWORDS: Inflammatory, Metabolic, Pediatric Brain

Moyamoya disease and syndrome in children: spectrum of neuroimaging findings

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Purpose
Moyamoya (MM) vasculopathy is a vascular condition which results in progressive narrowing of the distal intracranial internal carotid arteries and its supraclinoidal branches which may lead to acute or chronic ischemic injury of the brain. Moyamoya disease (MMD) refers to the idiopathic cause of the characteristic vasculopathy, whereas, moyamoya syndrome (MMS) is associated with other clinical conditions and risk factors (e.g., sickle cell disease, Down syndrome, neurofibromatosis type 1, postradiation treatment). The vasculopathy is typically bilateral in MMD; however, it may present unilateral with contralateral findings developing over time in MMS. Also, MMS may involve the vessels of the posterior circulation. It is essential to recognize MM vasculopathy if a systemic disease or condition is diagnosed which is known to be linked to MMS.

Materials and Methods
We reviewed our pediatric MRI database searching for pediatric MM vasculopathy.

Results
After a brief discussion of "how to perform neuroimaging" in MM vasculopathy, we present a review with selected case histories to illustrate the characteristic primary and secondary neuroimaging findings of MMD and MMS. In addition, a selection of the various diseases linked
to MMS will be described including Down syndrome, Keutel syndrome, sickle cell disease, neurofibromatosis, and radiation therapy. The neuroimaging findings after revascularization (e.g., pial synangiosis and encephalogaleal synangiosis) will be reviewed. The importance of recognition and utilization of various neuroimaging modalities will be highlighted.

Conclusions
Moyamoya disease and MMS are recognized, yet rather distinct causes of pediatric stroke and cerebrovascular disease. Neuroimaging plays a pivotal role in the early recognition, diagnosis, management, and follow up to prevent pediatric stroke and neurological sequelae. In addition, neuroimaging should be applied to differentiate MMD from MMS. Familiarity with the various pathologies and diseases linked to MMS is essential.

KEYWORDS: Childhood, Moyamoya, MR Imaging

MR Imaging Appearance of the Various Congenital Anomalies of the Brain

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Purpose
This exhibit will utilize primarily magnetic resonance imaging (MRI) to illustrate and help further the understanding of the various congenital anomalies of the brain. We will discuss the relevant anatomy and embryologic origin of the various malformations, to facilitate a better understanding of the different congenital abnormalities.

Materials and Methods
• Brief discussion of the relevant anatomy and embryologic origin of the various congenital anomalies of the brain and organization based on their embryologic origin as follows: neural tube closure disorders; disorders of diverticulation; neuronal migration disorders; malformations from abnormal neuronal and glial proliferation, apoptosis or necrosis; malformations in late neuronal migration and cortical organization; malformations related to abnormal pial basement membrane formation; cerebellar hypoplasia malformations; and cerebellar dysplasia malformations. • Multimodality imaging findings of the various congenital malformations of the brain. • Discussion of syndromes and associated abnormalities seen with these different congenital anomalies.

Results
Congenital anomalies of the brain are not uncommonly encountered in the daily practice of a neuroradiologist; therefore, a familiarity of the different anomalies is crucial. Congenital brain malformations, which will be discussed, include: Chiari Malformations, Holoprosencephaly, Septo-optic Dysplasia, Arhinia/Arrhinenecephaly, Lissencephaly, Pachygyria, Gray Matter Heterotopia, Schizencephaly, Hemimegalencephaly, Microcephaly, Sotos syndrome, Polymicrogyria, Focal Cortical Dysplasia, Walker-Warburg Phenotype, Muscle Eye Brain Phenotype, Fukuyama Congenital Muscular Dystrophy, Dandy Walker Malformations, Joubert syndrome, Rhombencephalosynapsis and Lhermitte-Duclos disease.

Conclusions
This project will aim to familiarize the exhibit viewer with the various congenital anomalies of
the brain, which will facilitate identification of clinically significant pathology and incidental benign variants. Further understanding of associated abnormalities and complications can aide in accurate diagnosis by the practicing radiologist.

KEYWORDS: Congenital Brain Malformations

eEdE-195

MRI of congenital spine anomalies

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Purpose
Congenital spinal anomalies present with a constellation of pathologies and symptoms. It is important to understand the morphological characteristics and embryology of congenital anomalies for correct diagnosis to guide treatment of these patients. MR imaging (MRI) is an excellent tool for visualization of congenital spinal anomalies.

Materials and Methods

Results
We have observed various congenital spinal anomalies over many years using MRI at our institution. Chiari I anomaly demonstrates a small posterior fossa and skull base anomalies. Chiari II demonstrates the above findings as well as associated corpus callosum and migrational abnormalities, high-riding cerebellum, tectal beaks, sulcal interdigitation, and open associated spinal dysraphism. Atlanto-occipital assimilation/subluxation or retroflexed odontoid is commonly associated with cervicomедullary compression, increased atlanto-dental interval as well as incomplete C2-3 segmentation. Klippel-Feil syndrome is a segmentation failure of two or more cervical and thoracic/lumbar vertebrae: C2-3 (50%), C5-6 (33%), and is associated with odontoid dysplasia, syringomyelia, diastematomyelia (20%), Chiari I (8%), neuroenteric cysts/dermoids, Sprengel deformity/omovertebral bone (15-30%), sensorineural hearing loss (30%), external auditory canal abnormalities, genitourinary abnormalities (35%), CHD (14%), and facial anomalies. In addition, dysraphism is associated with kyphoscoliosis, osseous anomalies, syrinx (30-75%), Chiari II (almost 100%). Caudal regression syndrome is secondary to maternal hyperglycemia/diabetes, infections, toxins, and ischemic insults. Signaling defects by retinoic acid and sonic hedgehog during blastogenesis prior to the 4th gestational week is a
known cause. Caudal regression is associated with defects in HLBX9 homeobox gene (Chromosome 7) as well as cardiac defects (24%), genitourinary anomalies (24%), renal hypoplasia, ano-rectal anomalies- particularly atresia, and lower extremity abnormalities. Diastematomyelia also known as split notocord syndrome is associated with dorsal enteric fistula/sinus, and dorsal enteric cysts/diverticula.

Conclusions
Morphological characteristics of congenital anomalies are best demonstrated with MRI. It is important to understand the constellation of findings as well as symptoms and treatment to improve the radiologists' communication of pertinent findings to the clinician in order to improve patient care and the child's quality of life.

KEYWORDS: Congenital Anomalies, MR Imaging Spine, Spinal Imaging
Purpose
Multimodality imaging review of pediatric orbital neoplasms.

Materials and Methods
Discuss multimodality imaging characteristics of pediatric orbital neoplasms, including ocular lesions.

Results
Pediatric orbital neoplasms are distinct from neoplasms in the adult population and consist of a wide variety of lesions from congenital to neoplastic in nature. Pediatric orbital tumors and tumor-like lesions, including ocular lesions, are discussed in this exhibit. Examples include:

- Retinoblastoma: most common intraocular pediatric tumor, arises from immature retina [exhibit explains how to differentiate this entity from mimickers like pseudoretinoblastoma (a persistence and hyperplasia of fibrovascular tissue), Coats disease (a unilateral vascular malformation of retina), and retinopathy of prematurity].
- Optic nerve glioma: juvenile pilocytic astrocytomas may involve any portion of the optic pathway and the hypothalamus, most common intraconal pediatric tumor.
- Leukemia, lymphoproliferative disease.
- Osseous origin tumors: Dermoid inclusion cyst, fibrous dysplasia, juvenile ossifying fibroma, osteosarcoma, and bone metastases (i.e., neuroblastoma).
- Infantile hemangioma: most common vascular tumor in infants. These lesions are discussed with their specific imaging characteristics that help in arriving at the accurate diagnosis. Figure shows a large heterogeneous lesion arising from the left orbit with T1 hyperintense contents consistent with teratoma.

Conclusions
Early diagnosis of pediatric orbital neoplasms is important because of their significant impact on vision even with the benign lesions. Imaging characterization of pediatric orbital neoplasms provides important information regarding prognosis and available surgical and adjuvant therapies.

KEYWORDS: Orbital Tumor, Pediatric Neoplasms
Neuroimaging in Metabolic Disorders: A Pattern Based Approach.

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Purpose
This presentation will review a pattern-based approach to generating a differential diagnosis for suspected metabolic disorders based on their imaging appearance.

Materials and Methods
An algorithm for the classification of metabolic diseases with examples of diseases from each category and a description of their differentiating imaging features will be provided.

Results
Metabolic disorders are diseases caused by a gene mutation that leads to synthesis of an abnormal protein which then causes disruption of normal metabolic pathways. This is a widely diverse group of disorders which may or may not have neurologic involvement in addition to
systemic involvement. As such, the imaging appearance of these diseases also is widely variable, and diagnosis can be challenging. However, the features of these diseases can be used to categorize them and to generate a differential diagnosis. A commonly used method of classifying metabolic diseases is to group them as having a predominant pattern of involvement of the white matter, gray matter, both gray and white matter, or those with cerebellar involvement. White matter diseases can be further stratified as those with early periventricular predominance, those with subcortical dysmyelination, as hypomyelinating leukodystrophies, or other nonspecific pattern. Gray matter predominate diseases can be grouped as those with cortical predominance or those with predominant involvement of the deep gray nuclei. Although many diseases show overlap between these categories, particularly in their later stages, this categorization system can be used to generate a reasonable differential diagnosis for suspected metabolic diseases. In addition, some metabolic diseases have characteristic findings on spectroscopy and diffusion-weighted imaging. In combination with the pattern of disease involvement, the spectroscopy and/or diffusion findings in these diseases can add specificity to the diagnosis. Example cases in which spectroscopy and/or diffusion findings are useful, for example Maple Syrup Urine disease, Canavan disease, galactosemia, and metachromatic leukodystrophy, among others, will be shown.

Conclusions
Although diagnosis is challenging, metabolic diseases can be classified by their pattern of disease involvement. While these diseases are rare, it is important to be able to recognize them and to provide an accurate differential due to implications both for patient management and family counseling.

KEYWORDS: Metabolic

eEdE-202

Neuroimaging in Pediatric Encephalitis

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Purpose
The purpose of this educational exhibit is to describe the common imaging findings, clinical and laboratory findings and associated complications of commonly encountered forms of pediatric encephalitides, as well as some infrequently encountered ones.

Materials and Methods
Cases of clinically diagnosed encephalitis in patients aged 0-18 years are presented with emphasis on neuroimaging features and clinical data including laboratory findings. This exhibit also will discuss the challenge of determining the specific etiology in some patients with a clinical diagnosis of encephalitis.

Results
Pediatric encephalitis encompasses a wide range of causative agents and clinical syndromes. Though the cause of encephalitis remains unknown in a large number of cases, some specific causes of encephalitis have classic clinical and imaging features. This exhibit is an organized
review of pediatric encephalitis with the various diseases grouped under broad categories as described below. 1. Primary infectious (predominantly viral, bacterial, fungal, parasitic): e.g., encephalitis caused by enterovirus, influenza virus, varicella virus or herpes virus etc. 2. Postinfectious or Parainfectious (immune mediated): e.g., ADEM. 3. Paraneoplastic (malignancy related): eg. Limbic encephalitis.

Conclusions
Pediatric encephalitis is an important topic given the associated morbidity and mortality. It often is thought of as unfamiliar territory by neuroradiologists. This review will focus on key points in diagnosis with emphasis on neuroimaging, including the critical role of imaging in distinguishing encephalitis from other clinically similar entities. This exhibit will help further expand and enhance knowledge about pediatric encephalitides.

KEYWORDS: Encephalitis, Encephalopathy, Infections

eEdE-183

Neuroimaging pattern-recognition approach of subthalamic nucleus involvement in children

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Purpose
Neuroimaging-based pattern-recognition approach has been very helpful in the diagnosis and classification of a wide range of pediatric central nervous system diseases. The subthalamic nucleus (STN) is a key structure in the basal ganglia circuit and serves as an important relay station within the corticostriothalamocortical circuit. Involvement of the STN has been described extensively in adults with movement disorders. Subthalamic nucleus in children and its selective involvement in pediatric neurological disorders, however, seldom have been reported.

Materials and Methods
We reviewed our pediatric MR imaging (MRI) database searching for subthalamic nucleus involvement.

Results
After a short introduction about anatomy, function and age-related normal neuroimaging appearance of the STN, we present a review with selected case histories to illustrate STN involvement on MRI in various pediatric neurological disorders that may selectively affect the subthalamic nucleus in children including Leigh syndrome, succinic semialdehyde dehydrogenase deficiency, kernicterus, hepatic encephalopathy, and neonatal hypoxic ischemic injury. The involvement of structures in addition to the STN will be described to formulate a pattern recognition approach in order to narrow the differential considerations.

Conclusions
Neuroimaging-based pattern-recognition approach is a versatile tool in narrowing differential considerations to focus the diagnostic investigation pathway in a wide range of pediatric neurological diseases. The consideration of the constellation of clinical history and findings as
well as neuroimaging findings with involvement of certain structures in addition to STN (e.g., basal ganglia, thalami, brain stem structures, and dentate nuclei), should allow planning the appropriate diagnostic investigations to make the correct diagnosis in children with STN involvement.

KEYWORDS: Childhood, MR Imaging, Subthalamic Nucleus

Neuroimaging spectrum in Joubert syndrome

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Purpose

Joubert syndrome (JS) is a rare ciliopathy characterized by hypotonia, ataxia, ocular motor apraxia, facial dysmorphism, and irregular neonatal breathing. Cognitive functions are impaired in almost all patients. The diagnosis of JS is based on the recognition of the molar tooth sign (MTS) on neuroimaging. The MTS results from a midbrain-hindbrain malformation characterized by thickened, elongated, and horizontally orientated superior cerebellar peduncles and an abnormally deep interpeduncular fossa. Additionally, hypoplasia and dysplasia of the cerebellar vermis is a well known, characteristic neuroimaging finding of JS. The full neuroimaging spectrum in JS, however, is beyond MTS and hypoplasia and dysplasia of the cerebellar vermis. We aim to review the wide neuroimaging spectrum in JS and discuss the role of neuroimaging in the diagnosis and classification of patients with JS.

Materials and Methods

We reviewed neuroimaging studies of JS patients included in our pediatric MRI databases and the National Institutes of Health study "Clinical and Molecular Investigations into Ciliopathies" (www.clinicaltrials.gov, trial NCT00068224)".

Results

We present a review with selected case histories to illustrate the wide neuroimaging spectrum of JS including variability of the MTS (e.g., parallel, A-like or V-like superior cerebellar peduncles, decaying MTS due to marked asymmetry of the cerebral peduncles), enlargement of the posterior fossa, dysplasia of the cerebellar hemispheres, different morphological abnormalities of the brain stem, interpeduncular heterotopia, two different types of cephaloceles (occipital and at the level of the foramen magnum) and supratentorial anomalies including hypothalamic hamartoma, migration disorders (e.g., polymicrogyria), and callosal abnormalities.

Conclusions

We show a wide spectrum of neuroimaging findings in JS. This wide spectrum of neuroimaging findings supports the heterogeneity of JS, not only from the clinical and neurogenetic but also from the neuroimaging point of view. Variable findings in affected siblings support the intrafamilial heterogeneity in JS. Although neuroimaging is mandatory for the diagnosis of JS, it
remains of limited value in classifying patients with JS into subtypes. The pattern MTS and hypothalamic hamartoma represents the only pattern that allows to diagnose oral-facial-digital syndrome type VI, one of the sixth phenotypes of JS.

KEYWORDS: Childhood, Joubert Syndrome, MR Imaging Brain

eEdE-200
6:30AM - 9:00PM

Neurological complications in the Hematological disorders: What radiologist should know?

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Purpose
To review the imaging findings of various acute and chronic neurological complications in hematological disorders.

Materials and Methods
We retrospectively studied 341 patients from our PACS, who had hematological disorders with neurological manifestations. All studies were reviewed by two neuroradiologist. These findings were correlated with the clinical findings, hematological, biochemical and CSF analysis (whenever available).

Results
For better understanding of the disease process we categorized our data into following categories: 1) RBC disorders: Fe++ /Vit B12 def, polycythemia vera, thalassemia, sickle cell disease, 2) Proliferative disorders: leukemia, lymphoma, myelomatosis, 3) Hemorrhagic disorders: hemophilia, VIII def, DIC, TTP, thrombocytopenia, H uremic syndrome, 4) Coagulation disorders: anti phospholipid antibody syndrome, hereditary thrombophilia, homocystinemia, 5) Hematological malignancy.

Conclusions
1. Neurological complications in the course of hematologic disease are frequent and varied. Early diagnosis of these complications is very vital for better neurological outcome. 2. We review the neurological complications related to hematological disorders with various illustrations with diagnostic pearl to the specific diagnosis. 3. We also discuss the treatment related complications of the hematological malignancies.

KEYWORDS: Pediatric Brain

eEdE-210
6:30AM - 9:00PM

Neuroradiological Evaluation of Stem Cell Transplantation

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Purpose
Stem cell transplantation has become the definitive treatment modality of many diseases which were previously regarded incurable (1). These disorders include malignancies (hematologic and solid tumors) and nonmalignant diseases such as metabolic disorders (e.g., Adrenoleukodystrophy, Krabbe disease or Hurler disease), immune deficiencies or hemoglobinopathies. Here we present the role of neuroimaging assessment of the diseases treated with stem cell transplantation from pretreatment to post-treatment follow up.

Materials and Methods

Results
Indications of bone marrow transplantation and the number of patients transplanted are expanding continuously. Accordingly, more patients are being evaluated by neuroimaging studies during their course of the disease. Patients should be screened for infections before administration of conditioning regimen. After receiving stem cell transplantation patients are closely monitored for possible complications such as opportunistic infections, intracranial bleeding, drug toxicity and rejection. Post-treatment assessment also includes regression of white matter involvement, and screening for recurrence of the disease (2).

Conclusions
Understanding the diagnosis, pretreatment evaluation, post-treatment follow-up findings, and possible complications is crucial for neuroradiologists for clinical management of patients treated with stem cell transplantation.

KEYWORDS: Cancer, Metabolic, Stem Cell

Ossifying aka Cementifying aka "Confuse-ifying" Fibroma: Imaging Review of Ossifying Fibroma and Other Fibro-osseous Lesions

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Purpose
To review the imaging characteristics of ossifying fibromas and other fibro-osseous lesions of the jaws in children.

Materials and Methods
We review pertinent anatomy and radiologic findings and show several illustrative case examples of ossifying fibroma from our institution. In addition, we present examples of benign and malignant jaw lesions in the differential diagnosis for ossifying fibroma and highlight methods to attempt to distinguish among these lesions radiologically.
Results
Ossifying fibroma is a rare benign fibro-osseous lesion occurring in children and adolescents that has a penchant for a more aggressive course than the classic ossifying fibroma seen in adults. For this reason, it has been called juvenile aggressive ossifying fibroma. There are two types - trabecular and psammomatoid - which are indistinguishable radiologically but vary slightly in their demographics and typical location. Because of the variable appearance and overlap of histopathological findings among the fibro-osseous lesions, the nomenclature of this group of lesions can be quite confusing. In this exhibit, we present a case of a gigantic trabecular juvenile ossifying fibroma (JOF) seen on plain radiographs and computed tomography (CT). We present additional cases of JOF emphasizing their appearance on MR imaging (MRI). Other jaw lesions in the differential diagnosis of JOF also are reviewed; imaging features of these lesions are compared and contrasted with JOF.

Conclusions
We present three cases of ossifying fibroma including one gigantic trabecular juvenile ossifying fibroma from our institution and highlight the plain radiographic, CT and MRI appearance of these lesions. We review distinguishing features of other jaw lesions in the differential diagnosis.

KEYWORDS: Jaw, Pediatric Head And Neck, Pediatric Neoplasms

eEdE-206

6:30AM - 9:00PM

Oxygenation-based Brain MR Imaging: Advanced Concept and Clinical Application

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Purpose
Aerobic metabolism is vital to the central nervous system for maintaining the basic function and meeting normal energy demand of the neuronal and axonal activities. Oxygen metabolism is directly related to neuronal activity and cerebral blood flow (CBF). Quantitative evaluation of brain oxygen metabolism and hemodynamic responses has the potential to enhance numerous studies of neurodegenerative diseases regarding the brain pathophysiology and function. Since oxygen itself can be an intrinsic contrast agent, this study will review oxygenation-based MR imaging (MRI) concept and the advances in these techniques as well as the exciting insights into the pathophysiology revealed by these techniques.

Materials and Methods
Several novel imaging techniques that are based on blood oxygenation will be reviewed. These include: (1) blood oxygen level dependent (BOLD) MRI, (2) calibrated-BOLD MRI using vasoactive stimulus, (3) resting-state functional MRI (RS-fMRI), (4) susceptibility-weighted imaging (SWI), (5) T2-relaxation-under-spin-tagging (TRUST), and (6) quantitative susceptibility mapping (QSM). The fundamental imaging contrast concept of these techniques will be discussed. In addition, the brief clinical applications based on these techniques will be introduced.

Results
The fundamentals of neurovascular-coupling and -uncoupling will be reviewed. The following techniques for estimation of oxygen metabolism will be discussed. (1) BOLD signal is based on
the mismatch that the fractional CBF change is ~2-4 times larger than fractional change of oxygen utilization during neuronal activation. Event-related BOLD fMRI signal image processing, interpretation, and clinical application will be discussed. (2) calibrated-BOLD involves vasoactive stimulus (i.e., breathing CO2) to quantify BOLD and CBF responses and measure fractional change in cerebral metabolic rate of oxygen (CMRO2), while baseline absolute CMRO2 cannot be generated from this approach. The calibrated BOLD image processing modeling based on multimodal equations will be discussed. (3) RS-fMRI is a method to evaluate regional interactions at rest based on spontaneous fluctuations in BOLD signal. RS-fMRI is useful to explore functional network and organization disruption in many neurological and psychiatric diseases. The change of respiratory pattern or CO2 challenge on RS-fMRI network patterns will be discussed. (4) Susceptibility-weighted imaging (SWI) is a 3D gradient echo sequence using phase to enhance the visibility of venous vasculature that is dependent on blood deoxygenation level. Its clinical implication in several neurodegenerative diseases will be discussed. (5) T2-relaxation-under-spin-tagging is a relatively new technique to calculate absolute baseline CMRO2 without using vasoactive stimulus. It combines venous spin labeling and T2 relaxation rate techniques to estimate venous oxygenation in isolated superior sagittal sinus. The application of TRUST in Alzheimer disease and multiple sclerosis will be reviewed. (6) Recently, QSM, a technique using local field inhomogeneity information on phase to compute susceptibility map, provides a new quantitative contrast of blood oxygenation, the pros and cons of this technique will be discussed.

Conclusions
The oxygenation-related MRI techniques all have great potential to explore the critical physiological properties of brain such as oxygen metabolism, neuronal activity, and hemodynamic responses.

KEYWORDS: BOLD fMRI, Brain Metabolites, Oxygen

Parturitional injury of the head and neck

Parturitional injury represents injury sustained during labor and delivery. The skull, brain and head and neck regions may be affected by parturitional injuries. Parturitional injuries are classified into two major categories on the basis of their etiology, namely birth injury and birth trauma. Birth-related trauma and injury may have potential significant neurological sequela. Hence, it is of paramount importance to recognize parturitional injury and accurately differentiate them into various compartments.

Purpose
Parturitional injury of the head and neck

Materials and Methods
We reviewed our pediatric CT, US and MR imaging (MRI) databases searching for parturitional injuries of the calvarium, brain, spine, head and neck regions.
Results
We present a review with selected patients to illustrate the neuroimaging findings of parturitional injuries involving various compartments; namely, scalp and soft tissues (e.g., caput succedaneum, subgaleal hematoma, and cephalohematoma), calvarium (e.g., fractures and sutural diastasis), extra-axial compartment (e.g., epidural hematoma, subdural hematoma and subarachnoid hemorrhage), and intraparenchymal hemorrhage. The mimickers of parturitional injury which may appear as a "bump" (leptomeningeal cyst, sinus pericranii, and focal brain herniation through burr hole) will be reviewed. Finally, skeletal and spine injuries as well as congenital predisposing factors for skeletal trauma and injury (e.g., osteogenesis imperfecta) will be discussed briefly. The strength of various neuroimaging modalities in the identification and classification of these injuries will be highlighted.

Conclusions
Parturitional injuries represent a wide range of conditions in the calvarium extending from the skin surface of the scalp to the brain parenchyma involving multiple compartments and structures. Familiarity with the anatomy is a sine qua non for accurate identification and localization. The clinical presentation of a neonate may vary from being in shock due to loss of a large amount of blood volume in the subgaleal space to being encephalopathic secondary to underlying brain parenchymal injury. Therefore, a thorough and detailed neuroimaging evaluation is required to establish the cause, guide treatment, and prevent complications. Each neuroimaging modality, namely, US, CT and MRI have their respective strengths in contributing to the evaluation. In addition, mimics of parturitional injury and predisposition to birth related trauma and injury should be identified.

KEYWORDS: Neonatal, Traumatic Brain Injury

Pediatric Multiple Sclerosis and Other Immune Mediated Demyelinating Disorders of Childhood

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Purpose
In this exhibit we will present the clinical criteria and imaging characteristics of pediatric multiple sclerosis and other immune mediated CNS demyelinating disorders of childhood. Findings will be presented in a case based format.

Materials and Methods
The Boston Children's Hospital departmental radiology database was queried to identify patients between 0 and 18 years of age, who were treated for demyelinating disease and had undergone an MR imaging (MRI) examination of the brain and/or spine. In addition, a review of the pertinent literature was performed.

Results
The following demyelinating disorders will be reviewed in a case-based format: Pediatric multiple sclerosis and its variants, acute disseminated encephalomyelitis, neuromyelitis optica.
and the Aquaporin 4 autoimmunity spectrum, clinically isolated syndrome, and radiologically isolated syndrome. Specific attention will be given to imaging characteristics that aid the radiologist in distinguishing between these various entities and differential considerations will be discussed. In addition, the recent 2013 revisions to the 2007 International Pediatric Multiple Sclerosis Study Group classification criteria will be highlighted as they relate to clinical and imaging findings. Additional emphasis will be placed on the following topics: 1, the growing spectrum of aquaporin 4 autoimmunity disorders; 2, the debate surrounding the management of radiologically isolated syndrome; and 3, tumefactive multiple sclerosis and its differentiation from intracranial masses.

Conclusions
In this presentation, distinctive as well as overlapping clinical and imaging features of pediatric demyelinating diseases will be reviewed and the recent 2013 proposed modifications to definitions and clinical and imaging criteria for pediatric demyelinating disorders will be discussed. This review will facilitate further understanding of the various diagnostic categories of pediatric demyelinating disorders, which is essential for the interpreting radiologist to appreciate in order to improve consistency in terminology, and to promote a uniform clinical approach to these complex disease entities.

KEYWORDS: ADEM, Demyelination, Multiple Sclerosis

eEdE-188
Pediatric On Call Neuroimaging – A Resident’s Survival Guide

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Purpose
To educate residents on pediatric emergency neuroimaging including how to distinguish disease from normal childhood anatomy and specific imaging artifacts.

Materials and Methods
Simulating real-life referrals for urgent imaging, a selection of cases from Great Ormond Street Children's Hospital will be used to illustrate CT and MR imaging (MRI) features of pediatric nervous system disease with a focus on “do-not-miss” diagnoses and interpretational pitfalls. Examples include dural venous sinus thrombosis, arteriovascular disease and ischemic stroke, traumatic brain injury, spontaneous intracranial hemorrhage, hydrocephalus, infection, neonatal hypoglycemic brain injury, hypoxic ischemic encephalopathy, metabolic encephalopathy, spinal trauma and cord disease. Using a step-wise question and answer format for each case, the reader will be given a brief history before choosing an appropriate imaging method and protocol. A selection of high quality CT and/or MR images will be provided leading to the diagnosis followed by a discussion relevant to the case.

Results
For residents unfamiliar with the subject, pediatric neuroimaging can be daunting, especially when there is pressure to make a diagnosis in a sick child. Planning before scanning is essential and depending on the patient's age and condition, the need for a general anesthetic should be
considered. MR imaging is usually the preferred modality for pediatric neuroimaging, but may
be difficult to perform in an unstable child or where facilities are limited. The imaging protocol
should be tailored according to the patient's age and suspected pathology. Knowledge of normal
anatomy and artifacts typical to pediatric imaging will aid the diagnosis.
Conclusions
Having worked through this educational exhibit, the reader will be able to initiate appropriately
protocolled neuroimaging and recognize the features of serious neurological conditions in
children more confidently.

KEYWORDS: Emergencies, Pediatric Brain

eEdE-204
Postoperative MRI in Patients with Chiari 0 and 1 Malformation
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Purpose
The goal of this exhibit is to review the various surgical modalities that are used for the treatment
of Chiari 0 and 1 malformations and the corresponding features on MR imaging (MRI).
Materials and Methods
Several types of surgical interventions are available for treatment of abnormalities in patients
with Chiari 0 and 1 malformation, including posterior fossa decompression with or without upper
cervical laminectomy, cerebellar tonsil cauterhy, fourth ventricular stenting, third
ventriculostomy, syringohydromyelia decompression, and ventricular shunting. MR imaging of
the craniocervical junction including sagittal FIESTA and cine phase contrast CSF flow studies
provide useful insights in postoperative anatomy and physiology.
Results
The following topics will be reviewed: * Optimal postoperative MRI protocols. * Expected
postoperative anatomy and physiology on imaging. * Complications, including persistent
obstructive symptoms at the foramen magnum, pseudomeningoceles, craniocervical instability,
dural graft reaction, and failed ventriculostomy. * Pitfalls, including the consequences of
operating on patients with conditions that mimic Chiari I malformation, such as acquired
tonsillar ectopia. Implications for management.
Conclusions
At institutions that specialize in treating patients with Chiari 0 and 1 malformation, MRI with
phase contrast cine CSF flow studies often is performed to evaluate patients after surgery. Thus,
it is important to be familiar with the expected imaging findings related to the different types of
interventions and to recognize potential complications and pitfalls.

KEYWORDS: Cranio-Cervical Junction, Shunt, Skull

eEdE-197
Rasmussen's Encephalitis: Imaging, Histopathology, and How Radiologists can Impact a Devastating Disease

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Purpose
Rasmussen's encephalitis (RE) is an uncommon but devastating neurologic disorder of childhood. The underlying etiology has not been clearly established, but potential causes include chronic viral infection, circulating GluR3 antibodies, and T-Cell mediated inflammation. Unfortunately, the clinical and pathological presentations are confusing. Because normal and afflicted parenchyma often are interspersed, false negative biopsies may occur; moreover, the classic sign of epilepsia partialis continua is only variably present. The challenges of pathological characterization, clinical diagnosis and treatment underscore the role of the radiologist. Because standard anti-convulsant therapies are of little value, and alternative therapies must be initiated rapidly, the radiologist may facilitate early detection before irreversible tissue damage occurs. Longitudinally, value is added to the interdisciplinary team by assessing treatment response, which is unpredictable in RE. The radiologist may even have a role in localizing epileptic foci with novel fMRI-EEG. This electronic educational exhibit presents the clinical, histopathological, epidemiologic and imaging findings of RE with special emphasis on the changing and positive role of the radiologist over the course of the disease.

Materials and Methods
All cases are taken from Baystate Hospital, between 2005-2013, with histopathological correlate. Imaging is presented in conjunction with EEG, physical exam and clinical data.

Results
Rasmussen's encephalitis is a chronic inflammatory disease with a mean onset of six years. In a study by Rasmussen et al, two thirds of patients with RE had a prior exposure to an infectious or inflammatory episode before the onset of symptoms. Fara et al also reported preceding viral infections. Histopathological findings include perivascular lymphocytic cell infiltration and clusters of chronic inflammatory cells in the brain parenchyma. The majority of inflammatory cells found in RE are T lymphocytes. In the prodromal stage in RE, findings are variable and nonspecific. The child has low frequency seizures and, rarely, mild hemiparesis. In the acute phase the child's seizures classically increase in frequency (Epilepsia partialis continua) and dense hemiparesis, cognitive deterioration, and sometimes aphasia may follow. The final stage is marked by permanent and progressive neuronal death. On MR, the earliest imaging findings include unilateral enlargement of the CSF spaces and increased T2 signal intensity in the cerebral cortex and subcortical white matter, with the tempoparietal lobe most commonly effected. Critically, these findings occur well before the onset of irreversible atrophy. Later in the disease process, atrophy and gliosis predominate. Significantly, the degree of T2 hyperintensity tends to correlate to the aggressiveness of the disease rather than its duration. Treatment response may be assessed both with conventional MR and MR spectroscopy, which shows increased lactate and decreased NAA, reflecting cell turnover and active disease. Encouragingly, Cuspineda et al recently utilized combined EEG-fMRI to map epileptogenic foci in a child with RE. If these foci could be localized noninvasively, ablation could avoid the obvious morbidity of hemispherectomy.
Conclusions
Rasmussen's encephalitis is a rare and devastating inflammatory disease of childhood. The etiology of RE is uncertain and its treatment, to this point, has been ineffectual. Despite this, the radiologist positively can impact the child's course with early diagnosis, accurate prognosis, assessment of treatment response, and noninvasive mapping of epileptogenic foci which may obviate the morbidity of an anatomical or functional hemispherectomy.

KEYWORDS: Encephalitis

![Image](TCT_eEdE-197_axflair0002.jpg)

eEdE-193

Spectrum of Imaging Findings in MELAS

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Purpose
MELAS is a rare disorder of mitochondrial dysfunction caused by a mutation in the mitochondrial DNA (mtDNA). The disease manifests in myopathy, encephalopathy, lactic acidosis, and stroke-like episodes (1). Imaging is key in the evaluation of encephalopathy and acute stroke-like symptoms. It is important for the radiologist to be aware of the spectrum of imaging findings and clinical presentation in patients.

Materials and Methods
We review the spectrum of imaging findings in a patient with biopsy proven MELAS. The imaging findings are presented over several serial CT, MRI, and MR spectroscopy evaluations. These imaging findings are correlated with the patient's clinical presentation and evolving symptoms over serial presentations.

Results
A multimodality imaging approach is necessary in the acute and chronic evaluation of MELAS. In the setting of acute stroke-like symptoms initial CT evaluation is of benefit in ruling out other causes of symptoms such as hemorrhage, and has some utility in visualization of acute edema. Classic findings include edema and swelling commonly involving posterior cortical and subcortical regions (1). Edema may be associated with restricted diffusion commonly crossing vascular territories (2). MR imaging evaluation is of further benefit in characterizing chronic and waxing and waning parenchymal changes involving the cortex and subcortical white matter which may show "shifting" edema without restricted diffusion (2). MR spectroscopy is a diagnostic supplement in demonstrating elevated cerebral lactate levels and may demonstrate characteristic lactate peaks suggestive of the diagnosis (1).

Conclusions
Recognizing the multimodality imaging findings of MELAS is critical for the radiologist in evaluation of patients in the acute setting of stroke-like symptoms and in evaluation of chronic waxing and waning findings of encephalopathy. Although imaging does not provide the conclusive diagnosis in MELAS disease, it plays a critical role and the radiologist must be familiar with imaging findings.

KEYWORDS: Encephalopathy, Mitochondrial Disease, Myelopathy

18 y/o F presents with headache and left homonymous hemianopsia
Same patient, now 19 y/o F presents with headache and right homonymous hemianopsia

(Filename: TCT_eEdE-193_MELAS.jpg)
SUSCEPTIBILITY WEIGHTED IMAGING AND MALFORMATION OF CORTICAL DEVELOPMENT

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Purpose
Susceptibility-weighted imaging (SWI) is a sensitive sequence in the identification of hemorrhage, calcifications and it is a powerful tool to visualize venous structures. In Tuberous Sclerosis Complex (TSC) the cortical tuber often demonstrates blooming artifact due to calcification; a finding that has been reported as more epileptogenic. The cortical tubers; a malformation of the cortical development (MCD), are not the only lesions that demonstrate blooming in the spectrum. Often the presence of developmental venous anomaly (DVA) or de novo areas of blooming artifact in SWI sequence can guide the radiologist to search for MCD.

Materials and Methods
The aim of this presentation is to review cases of MCD and determine if SWI can contribute in the identification and characterization of these malformations. The contribution of SWI in the diagnosis of hemimegalencephaly, tumors associated with disordered cortex (DNET, ganglioglioma, gangliocitoma), etc., will be demonstrated. Whenever available the findings will be compared to CT, for better assessment of the calcification and/or bleed.

Results
Literature describes that blooming artifacts in susceptibility-weighted imaging highly correlates with epileptogenic focus including vascular malformations, postinfectious granulomas and tumors. Susceptibility artifacts can be seen also in MCD like tuberous sclerosis, tumors associated to disordered cortex, hemimegalencephaly and they highly correlate with the epileptogenic focus.

Conclusions
Susceptibility-weighted imaging appears reliable for characterizing blood flow dynamics in brain malformations. When blooming artifacts are present, this can be a red flag for the radiologist to search for another underlying lesion such as MCD.

KEYWORDS: Malformation Of Cortical, Susceptibility-Weighted Imaging
Purpose
To compare ultrafast MR Imaging (MRI) technique as a replacement for noncontrast CT head (NCCTh) as an initial imaging modality in cases of suspected nonaccidental trauma.

Materials and Methods
We are prospectively offering ultrafast MRI as a follow up to initial NCCTh from the emergency department for cases of suspected nonaccidental trauma as a pilot study starting from August 2013. Our ultrafast MRI sequences include axial and coronal T2 HASTE, axial single shot diffusion-weighted imaging (DWI), axial T2* echo planar imaging (EPI) and sagittal T1 FLASH 3D. The ultrafast MRI technique takes less than one minute per sequence to complete and can be accomplished without sedation in the pediatric population. Key imaging findings with high specificity to nonaccidental trauma will be reviewed in each pulse sequence of the ultrafast MRI in comparison with a NCCTh and routine MRI brain, if available. Findings will be correlated with ultimate clinical outcome and patient disposition from available clinical histories.

Results
Ultrafast MRI techniques in patients with suspected nonaccidental trauma can provide greater or complementary information than NCCTh from greater inherent tissue contrast, allowing the distinction of differing ages of intracranial hemorrhage from hemoglobin degradation. While ultrafast MRI sequences have less resolution and contrast than conventional spin echo MRI sequences, we will show that the available sequences in our ultrafast protocol is sufficient to evaluate for gross intracranial traumatic injury sufficient to change patient management. The lack of radiation exposure compared to NCCTh, as well as possible sedation complications from a conventional MRI exam increases patient safety along with possible cost savings if ultrafast MRI replaces NCCTh and/or conventional MRI. The greatest limitation of ultrafast MRI, as well as conventional MRI, in trauma is the sensitivity to the detection of skull fractures, for which reliance on skull films within the skeletal survey may suffice. Literature review of the appearance of intracranial hemorrhages and parenchymal injury highly specific to child abuse will be performed and demonstrated in this exhibit, with documentation of these findings on ultrafast MRI compared to NCCTh. Figures: Axial CT of the head in a four-month-old female with bilateral retinal hemorrhages demonstrates bilateral chronic subdural hematomas (white arrows). Axial T2 HASTE imaging reveals multiple neomembranes (black arrows) within the subdural collections, suggesting chronic subdurs of multiple chronicity.

Conclusions
Using ultrafast MRI techniques potentially can provide greater imaging specificity than NCCTh for nonaccidental trauma. In addition to improved patient safety and potential cost savings, this could positively change the imaging management guideline for nonaccidental trauma.

KEYWORDS: MR Imaging, Nonaccidental Trauma
Uncommon Pediatric Pontine Disorders: Case Based Review of the “Unusual Suspects”

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Purpose
Because pediatric pontine disorders often are treated empirically without biopsy proof of their pathology, radiologists play a particularly critical role in evaluating these lesions in children. Knowledge of uncommon central nervous disorders and systemic processes that may involve the pons is essential to narrow the differential diagnosis. After viewing this educational exhibit, the learner should be able to: (1) List uncommon pathologies that affect the pediatric pons, (2) Describe key imaging features, and (3) Construct a differential diagnosis for focal and diffuse pontine disorders in children.

Materials and Methods
Using an image rich, case-based format, this educational exhibit will demonstrate the approach to pediatric pontine lesions by highlighting characteristic clinical history and key imaging features. Pathological processes included are gliomatosis cerebri, various inflammatory disorders...
(multiple sclerosis, acute disseminating encephalomyelitis, hypertensive encephalopathy and primary cerebral angiitis), traumatic brain injury, metabolic disorders (central pontine myelinolysis and maple syrup urine disease) and systemic disorders (hemolytic uremic syndrome and drug induced changes).

Results
As CT findings are often nonspecific, MR imaging is the initial study of choice in children with pontine lesions. It allows imagers to divide lesions into focal versus diffuse categories, thus narrowing the possible diagnoses. Most pontine disorders in children are generally T1 hypo- and T2 hyperintense. However, correlation with clinical history and additional imaging features, such as enhancement pattern, diffusion characteristics and other lesions seen in the central nervous system, may allow one to suggest a specific disorder or limited differential.

Conclusions
The radiologist has a critical role in the assessment of pediatric pontine disorders, which often are diagnosed based on history and imaging findings alone. This case-based exhibit will guide learners through an imaging approach to uncommon pediatric pontine disorders emphasizing key MR imaging (MRI) features and useful clinical history. Learners will actively formulate a limited, and sometimes specific, differential diagnosis and use imaging to make treatment decisions in cases shown.

KEYWORDS: Brainstem, MR Imaging Brain, Pediatric Brain

eEdE-178  
6:30AM - 9:00PM

Use of imaging studies in the diagnosis and management of intracranial abnormalities in patients with the most common Neurocutaneous syndromes.

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Purpose
Neurocutaneous syndromes are a heterogeneous group of congenital disorders which primarily involve structures derived from the embryological neuroectoderm. Characteristically, patient presentation is diverse and disease expression varies; therefore, diagnostic studies play an important role at the time of diagnosis and surveillance of patients with established disease. Our objective is to review current imaging study recommendations for diagnosis and routine follow up of patients with the most common phakomatoses to ensure best study recommendation to the referring clinician by the radiologist.

Materials and Methods

Results
1. Introduction to Neurocutaneous syndromes: a. Demographics, b. Genetics, c. Clinical presentation, d. Natural history and treatment, 2. Review of imaging study recommendations in
diagnosis and routine follow up of patients with the most common Neurocutaneous disorders: a. Tuberous sclerosis, b. Neurofibromatosis Type I, c. Neurofibromatosis Type II, d. Sturge-Weber syndrome.

Conclusions
Patients with phakomatoses require lifetime, multidisciplinary surveillance of cutaneous and intracranial abnormalities. The role of imaging is crucial from initial evaluation to routine follow up. This educational exhibit will provide the radiology resident and practicing radiologist with up-to-date recommendations on imaging studies for patients diagnosed with Tuberous Sclerosis, Neurofibromatosis, Types I and II, and Sturge-Weber syndrome.

KEYWORDS: Phakomatoses
Vascular Anomalies of the Pediatric Brain and Spinal Cord: Same lesions, new names

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Purpose
The purpose of this exhibit is to present a simple approach to pediatric vascular anomalies of the brain and spinal cord using modern classification. The learner will work through a case-based review of vascular lesions using the modern classification system.

Materials and Methods
After reviewing the modern classification system and tables that summarize imaging features and treatment, learners will apply their skills to cases of pediatric vascular lesions. Cases shown will emphasize key imaging features, discuss initial treatment, and clarify new versus old terminology, including the rationale for use of new terms. Take home points will be presented at conclusion of the exhibit.

Results
Accurate classification of vascular anomalies has a significant impact on children receiving the correct diagnosis and treatment. Thus, pediatric imagers and others caring for children with vascular anomalies have widely adopted the 1992 International Society for the Study of Vascular Anomalies (ISSVA) classification system. It eliminates confusing, overlapping terms of the past and applies a system that consistently correlates the initial diagnosis with lesion clinical course, treatment, and outcome.

Conclusions
After viewing this exhibit, the learner will be able to apply the ISSVA system to classify vascular anomalies, list key imaging features of pediatric vascular anomalies and state initial treatment options. Learners also will be able to state the differences between old versus new terminology, and describe how the new system allows consistent correlation between diagnosis, imaging, treatment and outcome.

KEYWORDS: Pediatric Brain, Pediatric Neoplasms, Pediatric Spine
Watch His Mouth: Micrognathism in Rare Congenital Craniofacial Syndromes - From Embryology to CT Findings

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Purpose
Various rare congenital syndromes are associated with micrognathia and other craniofacial deformities. Radiological evaluation of these syndromes plays a critical role in patient management and reconstructive surgery planning. Specifically, multiplanar imaging techniques using high resolution CT and 3D reconstruction allow excellent delineation of bony anatomy and abnormalities in patients with these syndromes. In this exhibit, we will present characteristic facial bone deformities in rare congenital syndromes with exemplary high resolution CT images including 3D reconstruction. In addition, associated ocular, nasal, and facial soft tissue findings
are highlighted to aid the assessment of the full extent of craniofacial malformation in these syndromes. Knowledge and recognition of these imaging features will allow radiologists to make correct diagnoses and suggest appropriate differential diagnostic considerations.

Materials and Methods

We will review the embryologic evolution of the maxillofacial region with illustrations. Then, exemplary facial and head CT images are presented to demonstrate characteristic facial features in various congenital disorders that are associated with micrognathia and other craniofacial malformations including Treacher Collins syndrome, Goldenhar syndrome, hemifacial microsomia, and Pierre Robin sequence.

Results

Treacher Collins syndrome: Bilateral and relatively symmetric craniofacial deformities are seen in patients with the Treacher Collins syndrome. The mandible and zygomatic complex often are hypoplastic. Hypoplasia or aplasia of the condyle and coronoid processes of the mandible may be seen. The maxilla also may be hypoplastic. Nasal malformation and auricular anomalies including microtia, aplasia of the external auditory meatus and middle ear malformations also are demonstrated radiographically. Hemifacial microsomia: Asymmetric development of the one side of the face is seen. Hypoplasia of the maxilla and mandible including hypoplasia of the condyle and coronoid process is seen in this disorder. Unilateral auricular deformity of the external ear and ocular anomalies including a coloboma of the upper eyelid may be revealed radiographically. Goldenhar syndrome: When epibulbar dermoids and asymmetric skull and vertebral anomalies are seen in addition to other findings of hemifacial microsomia, the syndrome is called Goldenhar syndrome. Pierre Robin sequence: Micrognathia, glossoptosis, and cleft palate are classically associated with this disorder. Relatively symmetric hypoplasia of the mandible is seen in this disorder. There may be associated condylar and coronoid hypoplasia. Bimaxillary retrognathia also may be seen. Glossoptosis is caused by posterior displacement or retraction of the tongue, which can contribute to upper airway obstruction.

Conclusions

Understanding the developmental anatomy, characteristic imaging findings, and pertinent clinical history not only will allow radiologists to formulate accurate diagnoses but will ensure the full extent evaluation of these complex congenital craniofacial malformation syndromes associated with micrognathism.

KEYWORDS: Congenital, Craniofacial Findings, CT Anatomy

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Education Exhibits (eEdE) - Socioeconomics
eEdE-213
6:30AM - 9:00PM

"So you think you can bring something new to our practice?": Developing an Advanced Neuroimaging Program in a Non-Academic Community Hospital

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Purpose
The vast majority of radiologists in the United States work in nonacademic centers, and neuroradiologists entering these practices may be surprised to realize the relative lack of advanced imaging performed in the community compared to academia. However, there are unique issues in performing advanced imaging in a nonacademic practice that one should consider prior to implementing these techniques.

Materials and Methods
I will present my early experiences in developing an advanced imaging program in a large multispecialty, HMO practice based at a nonacademic community hospital serving over 500,000 patients. I will address issues unique to nonacademic radiologists. I also will present an interactive checklist to summarize the major areas of concern.

Results
Several questions and difficulties arise when implementing an advanced imaging program at a nonacademic center including but not limited to the following: 1) What modalities do you hope to bring to the table (CT/MR perfusion, spectroscopy, DTI, SWI, fMRI, novel MRA techniques, etc.)? 2) Is it appropriate given your patient population and referrers and what value will you add? How may you and your practice benefit? 3) Do you have the capability in software, hardware, ancillary staff, and scheduling time? 4) Do you have the experience, patience, and time to convince and possibly train your technologists and radiologist colleagues to perform and/or interpret these studies, respectively? This is in contrast to academia where there may be several expert radiologists, physicists, researchers, dedicated advanced imaging technologists, and vendor support readily available. 5) How will you balance your time developing the program with the demands of clinical productivity, which often is stressed in community practices? 6) How will you garner interest among referring clinicians and do you have the appropriate evidence justifying these techniques? 7) How will you ensure quality and are there any potential PQI projects that may improve the practice?

Conclusions
Developing an advanced imaging program at a nonacademic practice presents a unique set of challenges, but may be worthwhile as it is ultimately beneficial to patient care.

KEYWORDS: Advanced MR Imaging, Quality Improvement, Second Opinion Consultation

eEdE-212
6:30AM - 9:00PM

Shukla, A.
George Washington University
Washington, DC

eEdE-214
6:30AM - 9:00PM
Combining a Spaced Memory Training Program with a Neuroradiology Case Bank to Improve Resident and Fellow Education
Purpose
Spaced repetition is a long-standing concept in cognitive science that has gained novel applications with innovations in tablet and mobile based electronics (1, 2). The memory training program Anki (http://ankisrs.net/) is a free desktop program with a separate fee for the iPad version that harnesses this concept in an adaptable fashion. We sought to apply this program to a pre-existing educational resource, the neuroradiology education website HeadNeckBrainSpine (HNBS; http://headneckbrainspine.com/) which has to date received almost three million visits.

Materials and Methods
Using the 424 cases collected on the HeadNeckBrainSpine website, an Anki deck was constructed. Each case was categorized as falling under brain, head and neck, and spine. The cases were imported on a free desktop Anki client before being synced to an iPad version of the application.

Results
Figure 1 shows an example of an HNBS case in a typical Anki interface on an iPad 2. The initial images are shown on the first part of the iPad screen while the answer is shown on the latter part. The re-test intervals are color coded for ease of selection and correspond to the ease with which the question is answered. Challenging cases are retested more frequently while easier cases are retested at longer intervals.

Conclusions
Memory training with spaced repetition can be applied to a well characterized neuroradiology teaching file. This application may allow for more efficient review of radiological educational case-based material in the training of residents and fellows. Future work will focus on other subspecialties.

KEYWORDS: Educational, Fellowship, Resident Training
Intracranial Post-Transplant Complications: Review of Imaging Findings with Clinical and Pathologic Correlation

Purpose
The therapeutic use of hematopoietic stem cell transplant and solid organ transplant have continued to rise over the past decade to improved immunotherapy and antimicrobial treatment/prophylaxis. As a result the number of post-transplant patients seen in clinical practice have increased as well. We aim to discuss key principles of transplant medicine and to help
Radiologists develop an understanding of CNS susceptibilities and/or complications during the pre and post-transplantation time period.

Materials and Methods
1. Introduction to transplant principles used in evaluation including bone marrow and solid organ transplantation. 2. Case-based approach to review common and uncommon complications and/or CNS pathologies encountered during pre and post-transplantation phases. 3. Summarize key elements in a flow-chart to provide reader with a chart for quick future references.

Results
1. Introduction to transplant medicine including criteria used for organ transplantation, pre-engraftment clinical requirements including key CNS processes that may preclude and/or postpone patient's transplantation. 2. Case-based approach reviewing post-transplantation CNS findings that are key to patient's management and survival. Cases will include primary disease recurrence in CNS system (e.g., leptomeningeal carcinomatosis, myeloid sarcoma, etc.), infections (TB, bacterial meningitis, toxoplasmosis, abscess, aspergillosis, cryptococcosis), post-transplant lymphoproliferative disorder (PTLD), drug toxicity (PRES, periventricular leukencephalomalacia, etc.) and graft versus host disease. Key clinical features, imaging findings (radiographs, nuclear medicine, CT and/or MRI), treatment and prognosis of all the presented entities will be discussed.

Conclusions
Transplant medicine has continued to grow over the last decade worldwide due to improved clinical management of post-transplant patients (immunotherapies and prophylaxis). Imaging plays a key role in monitory of post-transplant patients. Radiologists can help further improve clinical outcomes in these patients by familiarizing themselves with the common and uncommon set of pathologies that affect these patients and alerting referring physicians appropriately. By the conclusion of this presentation, the viewer should be able to generate a more precise differential diagnosis based on the patient's risk factors including age, gender, phase of transplant (pre-/post-transplant), medications, etc.

KEYWORDS: Immune, Infections, Inflammatory
Understanding and Mitigating Unexpected Artifacts in Head CTs: A Practical Experience

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Purpose
A spectrum of varying artifacts may occur on head CT scans that can mimic or obscure pathology and be the source of erroneous diagnosis. In addition to the commonly encountered CT artifacts (e.g., streak artifact, beam hardening), a potpourri of rarely mentioned artifacts are surveyed, borne out of our experience in a multifaceted academic neuroradiology practice.

Materials and Methods
A series of artifacts are presented in a 3-step format of diagnosis, understanding, and mitigation.
1. Diagnosis: Head CT images are presented with questions that scrutinize image quality and identify the artifact. 2. Understanding: A physicist weighs in with concise explanations that bring...
technical insight. 3. Mitigation: A radiologist offers perspective pertaining to the artifact's clinical significance and practical steps for its prevention.

Results
We review unexpected artifacts rooted in technologist practice, scanner technology limitations, and protocol design (or implementation). One such artifact is pseudo acute infarct due to patient off-center positioning, which is explained in relation to the beam-shaping bowtie filter. Another artifact is periodic hyperattenuation subjacent to the calvaria, which is due to cone beam artifact. We also consider the effects of exceedingly high pitch (1.75), excessively fast rotation time (0.5 seconds), table interference during obliqued sequential scans, and other interference-type artifacts.

Conclusions
Artifacts can be a source of diagnostic errors on head CT scans and therefore need to be recognized and reduced. Radiologists play an active role in image quality improvement by recognizing these artifacts, diagnosing root causes, and mitigating them. This usually involves interactive collaboration with a comprehensive team of technologists, physicists, and vendor specialists. By understanding and mitigating unexpected artifacts in head CT scans, these diagnostic errors can be avoided.

KEYWORDS: Artifacts, CT Artifacts

**eEdE-216**

6:30AM - 9:00PM

**Vision and Perception: A Teaching Module to Improve the Detection of Lesions on Head CT**

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Purpose
The task facing the neuroradiologist; that is, the act of detection and recognition of lesions with varying shapes, contours, and shades against a background of numerous visual stimuli, is not unlike the job of an air traffic controller or professional race car driver. Our purpose is to help the viewer avoid perceptual errors and expedite lesion detection, introducing concepts integral to pattern, search, and detection theories. We have developed an interactive and case-based tutorial that emphasizes a pattern recognition approach and standard sequence of analysis that refines visuospatial recognition.

Materials and Methods
We retrospectively reviewed the neuroradiological misses in our database for the past five years at our level I trauma center. In order to ascertain the causes of these errors, we broadly categorized them as perceptual (visual) or cognitive (interpretive). A pretest containing selected head CT cases with subtle findings is given to assess the viewer's skill level. Afterward, the viewer is led through a series of instructional slides illustrating basic concepts of visual theory, progressing from simplified block representations of the brain to actual CT images. Finally, a post-test to assess the level of improvement is administered. To encourage the viewer to utilize a search pattern approach, we vary the allotted time interval for cases in the pre- and post-tests.
Results
In analyzing an image, neuroradiologists correlate incoming visual stimuli to a mental template of a normal study. We see with our central (foveal) and peripheral vision. At 60 cm, the distance between neuroradiologist and monitor, the detailed foveal vision is about the size of a dime. The remaining image is part of the peripheral field. High contrast findings (e.g., hemorrhage and air) stand out from the background and are seen easily by the peripheral vision, with no need to focus. Peripheral vision is motion sensitive, serving an adaptive purpose during our evolution, when it was necessary to scan for threats. When one scrolls rapidly, lesions flicker into view, activating peripheral vision detectors. Increasing volume and complexity of ancillary lesions can distract from more important findings (satisfaction of search). A methodical approach begins with assessing for symmetry. Focusing on the midline with foveal vision, one may simultaneously use peripheral vision to detect surrounding contrast differences, which then can be further scrutinized. A new finding may induce one to redirect the search, as when evaluating for a contrecoup lesion. Updating the search pattern as additional evidence is acquired is a form of Bayesian inference. Contrast may be accentuated by windowing, which may help in stroke detection. An interesting phenomenon is background contrast effect, where the perceived brightness of an object is affected by a neighboring area. Focal sparing of gray matter within an infarct may mimic hemorrhage. While one may readily identify contours with high contrast, situations with little contrast may be encountered. Subjective contour formation of unrelated structures, with overlapping shapes and similar densities, may contribute to the appearance of pathology. Additional reformats may help define the boundaries of a lesion. These concepts are fundamental to pattern theory, which explores how to identify and understand complex visual information.

Conclusions
Interpretation of a head CT is a complex perceptual endeavor. The expert neuroradiologist will focus his/her attention on regions where lesions are more likely to occur. Once a lesion is noted, the next phase of analysis can occur--feature detection, in which incoming stimuli are broken down into their component parts, including anatomical, morphological, and density characteristics. A comprehensive strategy must be developed as not all lesions are equally probable. We explore the relevance of several models of applied mathematics, such as pattern theory (represents and analyzes complex systems), search theory (uses available information to determine the most efficient search path), and detection theory (discerns visual stimuli from background noise). These models of applied mathematics may help elucidate how a neuroradiologist perceives an abnormality.

KEYWORDS: Brain, Brain Abnormalities, Quality Improvement

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Education Exhibits (eEdE) - Spine
eEdE-235
6:30AM - 9:00PM
Purpose
To review relevant cervical spine anatomy, biomechanics, injury patterns, and imaging techniques in cervical spine trauma.

Materials and Methods
We will review spinal anatomy and the classification/mechanics of spine injury, with attention to the appropriate imaging management of cervical spine injury and an approach to the identification of unstable injuries.

Results
Cervical spine trauma is a common condition, with an estimated incidence of between 2%–6% in blunt trauma victims. The identification of patients with an unstable spine is essential as this group is at high risk for neurologic impairment. Stability of the cervical spine relies on the integrity of both osseous and ligamentous structures. The Denis 3-column concept provides a basic framework for identifying unstable injuries, but probably oversimplifies the complex functional relationships that determine mechanical function. The anatomy of both the ligamentous and osseous structures contributing to each column will be reviewed. Computed tomography (CT) is well established in the diagnosis of cervical spine fractures, but its sensitivity for diagnosis of ligamentous injury remains a matter of controversy. Its reported sensitivity ranges from poor to equivalent to MR imaging (MRI). To an extent the differences in reported sensitivity depend on the gold standard, MR finding of abnormality, which favors MR, or evidence of functional instability, which suggests that CT is quite reliable. We will review these arguments, and illustrate CT findings of ligamentous injury. MR imaging may identify abnormalities whose functional significance is unclear. These include high ligamentous signal, adjacent fluid, or ligament thinning without disruption. We will relate these to biomechanical considerations and discuss their possible implications for ligamentous integrity. As a result of these issues, the clinical setting and overall pattern of injury are needed for appropriate MRI evaluation. Although MRI may have a high false positive rate with its added sensitivity, a combination of CT and MRI evaluation is standard and considered the safest approach in the setting of abnormal neurologic exam, obtunded state, or suspected abnormality on CT.

Conclusions
The evaluation of cervical spine trauma is a common and important topic in radiology practice. Understanding the anatomy and biomechanics of the cervical spine is critical in the interpretation of cervical spine imaging and the identification of unstable injuries. Although controversies exist regarding the significance and diagnosis of ligamentous injuries on MRI, the overall pattern of injury, including clinical, CT, and MRI findings can be helpful in assessing spine stability.

KEYWORDS: Cervical Spine, Ligaments
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Purpose
Spinal pain and radiculopathy are very common debilitating conditions which in many cases can be treated successfully using fluoroscopic or computed tomography (CT)-guided percutaneous injection of local anesthetics or long-acting steroids. We illustrate techniques for cervical, thoracic, lumbosacral, and sacroiliac image-guided percutaneous zygapophysial joint, selective spinal nerve, epidural, and sacroiliac joint injections including preprocedural evaluation and postprocedural patient follow up.

Materials and Methods
Using three-dimensional animations to illustrate relevant anatomy and intraprocedural imaging to highlight treatment approach we present a series of cases involving percutaneous injection of the cervical, thoracic, lumbosacral spine. Level by level correlation with preprocedural cross-sectional imaging identifying relevant pathology will be presented. Pre and postprocedural patient evaluation, treatment efficacy, and patient outcomes as evidenced by literature review will be discussed.

Results
Clinical and radiographic factors affecting proper patient selection as well as decision to perform zygapophysial joint, epidural, sacroiliac, or selective spinal nerve injection will be discussed. Advantages and disadvantages of CT or fluoroscopic guidance for certain anatomical sites and treatment approaches will be reviewed. Techniques including patient positioning, appropriate needle placement, and medication selection will be emphasized. Important features such as postprocedural follow up and complication avoidance will be highlighted.

Conclusions
Given the increasing demand for image-guided percutaneous spine injections, proper patient selection and technique is critical for safe performance with minimum patient discomfort. Preprocedural patient evaluation including relevant imaging, knowledge of anatomy, and appropriate follow up is crucial to ensure good patient outcomes and will be effectively reviewed using animations and intraprocedural imaging.

KEYWORDS: Pain, Spine Injections, Spine Interventions
Example of 3D animation which will be used to illustrate technique and anatomy

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eEdE-228

6:30AM - 9:00PM

Extramedullary Intraspinal Injuries without Osseous involvement: Diagnostic Challenges on MR and CT
Purpose
Intraspinal pathology that does not involve the surrounding bone and is not intrinsic to the spinal cord may create a diagnostic dilemma, both on CT, where soft tissue contrast is limited, and even on MR, where injuries such as epidural or subdural hematoma can demonstrate a multilevel abnormality without significant contrast enhancement. This exhibit will demonstrate these findings as well as other entities with similar imaging features including an atypical sequestered disk, a spinal meningeal cyst and an epidural phlegmon associated with paraspinal myofasciitis. With careful analysis, the correct diagnosis, or at least an appropriate differential diagnosis, can be established. Many, but not all, such cases will require surgical management.

Materials and Methods
Computed tomography and MR cases accumulated in the neuroradiology teaching file of a Level I trauma center over the prior three years were reviewed retrospectively, and several which demonstrated the characteristics of intraspinal fluid collection, hematoma or other extramedullary mass without osseous involvement were selected for inclusion in the exhibit after review of the pertinent literature.

Results
Pathologic entities included in the exhibit included an intraspinal subdural hematoma which was almost certainly secondary to nonaccidental trauma, i.e, "shaken baby" syndrome, an epidural hematoma due to iatrogenic steroid injection, a mass-like sequestered disk posterior to the thecal sac, an epidural phlegmon with paraspinal myofasciitis, but without associated diskitis-osteomyelitis, and a spinal-meningeal cyst for which the etiology was either congenital, or the result of remote trauma. Identification of these abnormalities was made possible by signal changes on MR, including both T1 and T2 shortening, in the extramedullary spaces. In the case of inflammatory disease, involvement of the paraspinal musculature was a supportive finding. Mass effect, often multisegmental, on the spinal cord or cauda equina is useful to help distinguish pathology from complex flow artifacts which can occur with MR of the spinal axis. The absence of contrast enhancement, except at the periphery of several of the abnormalities, is helpful in delineating epidural abnormalities, and in excluding a neoplasm but is otherwise nonspecific. CT, and in one case CT myelography, was of adjunctive benefit.

Conclusions
Traumatic spinal injuries are identified most readily on cross-sectional imaging in the presence of fracture and/or disruption of the supporting spinal ligaments. The cases presented here lack those features and therefore present an added diagnostic challenge. It is important to recognize that nonaccidental trauma in childhood often is associated with intraspinal subdural hematoma, which is quite rare in accidental childhood injury. By contrast, epidural hematoma as a result of therapeutic injection is very unusual, but warrants immediate consideration in a patient who develops increased pain and neurologic deficit following one of these commonly performed procedures. The additional unusual cases presented demonstrate that congenital, inflammatory and degenerative entities also are relevant when formulating a differential diagnosis.

KEYWORDS: Spinal Cysts, Spinal Trauma, Subdural Hemorrhage
eEdE-234

Fluoroscopically Guided Lumbar Puncture. Teaching Points.

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Purpose
Evidence-based protocols for fluoroscopically guided lumbar puncture (LP) do not exist. This presentation describes the different fluoroscopically guided LP techniques used by neuroradiologists.

Materials and Methods
The authors searched MEDLINE, PubMed, EMBASE, Cochrane Library and Scopus for articles published up to November 2013. Studies about fluoroscopically guided LP were considered. The following search strategy was used: (lumbar OR spine) AND puncture AND guided AND fluoroscopy.

Results
We reviewed seven parameters of the fluoroscopically guided LP: thecal sac puncture position, spinal level, direction of needle during the puncture, opening pressure measurement technique, needle type and length, observation post LP, fluoroscopy setup. We resume the most important indications, contraindications and complications of LP.

Conclusions
Neuroradiologists generally appear to perform fluoroscopically LP in a similar fashion. The main steps in this technique were described. Post Lp headache observation has been related to the needle type. A randomized double-blind study evaluating different needle types is actually going
on. Practice guidelines for standardizing the fluoroscopically guided LP technique would improve the accuracy of opening pressure measurement.

KEYWORDS: Fluoroscopy, Lumbar Puncture

6:30AM - 9:00PM

Intramedullary thoracic spinal cord epidermoid in a 20 year-old male: case report and review of the imaging features of the most common intramedullary tumors of the spinal cord in adults.

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Purpose
In adults primary spinal cord tumors are rare, accounting for 2-4 percent of all central nervous system tumors with intramedullary spinal cord tumors accounting for 8-10 percent. Among the intramedullary spinal cord tumors, ependymomas, astrocytomas and hemangioblastomas [of which 15% to 25% are associated with von Hippel-Lindau (VHL) syndrome] represent the majority of all intramedullary tumors. Intramedullary epidermoid tumors are rare, and are more common in pediatric patients. We report a case of an intramedullary thoracic epidermoid tumor in a 20-year-old male and review of the imaging features of the most common intramedullary tumors of the spinal cord in adults.

Materials and Methods
Case report of an intramedullary epidermoid tumor in the thoracic spinal cord of a 20-year-old male presenting with right leg weakness and progressive asymmetric growth over a period of five years, with new onset of bowel and bladder incontinence, sustained clonus, hyperreflexia and positive Babinski reflex on the right. MR imaging (MRI) of the spine demonstrated expansile, partially cystic, minimally enhancing, intramedullary lesion involving the upper thoracic spinal cord. The diffusion-weighted sequences were nondiagnostic due to significant motion artifact.

Results
The mass initially was believed to be an astrocytoma or an ependymoma based on its imaging characteristics. Patient underwent gross total excision of the mass and histopathology revealed an epidermoid tumor. We compare and contrast MRI characteristics of the most common intramedullary spinal cord tumors (astrocytoma, ependymoma and hemangioblastoma) and a rare intramedullary thoracic epidermoid to illustrate the distinguishing imaging features on MRI.

Conclusions
While certain imaging features of intramedullary spinal cord tumors overlap, some specific features point toward one diagnosis rather than the other. In younger age group, differential diagnoses of an intramedullary tumor should include ependymomas, astrocytomas and hemangioblastomas (particularly in patients with VHL syndrome) as well as neurodevelopmental tumors, such as epidermoid tumors, dermoid tumors, lipomas and teratomas. Diffusion-weighted imaging (DWI) sequences can be helpful in differentiating more common lesions from rare epidermoid tumors that usually demonstrate restricted diffusion. Familiarity with the imaging
features of the intramedullary tumors of the thoracic cord can help in the diagnosis of spinal cord tumors.

KEYWORDS: Epidermoid, Intramedullary, Spinal Cord

Oooh! My back aches! Why should I consult a Radiologist for relief?

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Purpose
Using an interactive model, to select and perform image-guided percutaneous procedures for patients presenting with backache, based on patient assessment and previous imaging findings.

Materials and Methods
Each procedure presented as a case with relevant clinical history and previous imaging findings. Based on these findings, decision made on the procedure to be performed using multiple choice
questions for interaction. Justification for each procedure selected followed by technique and possible complications are explained.

Results
Technique for image-guided procedures used in spine pain management including relevant anatomy and instrumentation discussed in detail. The procedures include epidural block, nerve root and facet blocks, lumbar synovial cyst rupture, ganglion impar block, radiofrequency ablation of nerve roots and osteoid osteoma, diskography and vertebroplasty (amongst others). The potential pitfalls, complications and measures to avoid them also are reviewed.

Conclusions
The Exhibit provides insight to the various percutaneous needle techniques for diagnosis and treatment of backache. It also emphasis the fact the radiologist is no longer an innocent spectator providing guidance for fluoroscopy but has a very significant role in pain management.

KEYWORDS: Epidural, Lumbar Spine, Nerve Root Block

Optimized Imaging of the Postoperative Spine
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Purpose
There are few imaging tasks more challenging than optimizing evaluations of the instrumented spine secondary to artifacts induced by implanted metal devices on MR imaging (MRI) and CT examinations. MR imaging artifacts are due primarily to volume magnetic susceptibility mismatch between metal devices and tissue. In CT the issues are beam hardening and streak artifacts. Purpose: 1. To review the essential techniques for optimization of MR and CT imaging of the postoperative spine. 2. To explain the nature and cause of artifacts that hinder evaluations of the instrumented spine. 3. To demonstrate the value of advanced CT techniques such as dual energy in imaging the postoperative spine. 4. To demonstrate the value of novel MR sequences such as chemical shift, and multispectral imaging in imaging the postoperative spine.

Materials and Methods
1. Brief review of the principles underlying optimized imaging for postoperative spine focusing on key technical factor adjustments, the value of innovations such as dual energy CT, and new MR techniques such as metal artifact reduction and chemical shift imaging. 2. Illustration cases with stepwise implementation of optimizations will be presented. 3. Highlight the advantages and pearls of the new imaging methods. 4. Discuss the potential pitfalls and limitations of basic and advanced techniques.

Results
We reviewed the modifiable variables of the CT acquisition parameters and advanced CT techniques such as dual energy CT, including multiple types of dual or single sources (sequential and layered) images, the optimum MR sequences, including higher bandwidth, long echo train, small voxels, fast spin echo and adjusting the frequency coding directions and the advanced fast suppression techniques with chemical shift fat suppression and advanced multispectral imaging methods including hybrid techniques. These new enhancements demonstrated an improvement in the negative effects associated with metal implants, thus optimizing image quality.

Conclusions
Applying fundamental principles in postoperative spine CT and MR studies can significantly improve image quality. Newer and soon to be available enhancements further reduce the negative effects associated with metal implants, thus optimizing image quality.

KEYWORDS: Metal Artifact
Dixon imaging Neurofibroma. Clockwise from upper left: Water (fat suppressed) T2, pre contrast T1. Note the additional value of the in phase image which facilitates comparison with the non fat suppressed pre contrast scan. Fat suppression improves dynamic range and can lead to overestimation of enhancement.

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**eEdE-239**

**Pictorial Essay of Complications after Spinal Intervention**

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Purpose
This is a pictorial essay displaying the complications of spinal intervention. It includes rare complications of common spinal intervention as well as complications of procedures not commonly performed.

Materials and Methods
Spinal intervention, such as microdiskectomy and spinal hardware instrumentation to less invasive procedures such as myelograms, lumbar drains, epidural steroid injections and blood patches are common procedures performed in most hospital settings. Complications are uncommon and range from relatively benign mishaps such subdural injections to more devastating outcomes such as fistulas-pseudoaneurysms and spinal cord infarcts. Emphasis on imaging characteristics of rare and serious complications for early detection as well the clinical aspects will be the focus of this presentation.

Results
Complications from spinal intervention can range from the rare vascular injury resulting in fistula and pseudoaneurysm from microdiskectomy to direct cord injection from attempted myelography or diskography resulting in spinal cord infarct. Spinal cord infarcts also can occur from hardware instrumentation or myelography due to rapid changes in cerebrospinal fluid (CSF) pressure. Lumbar drain catheters can be sheared and retained in the thecal sac during placement or removal resulting in persistent myelopathy. Recognition of the imaging findings and awareness of potential complications by the operator during the procedure are the most important for prevention. However, appropriate recognition of complications is crucial in reducing the morbidity when it occurs.

Conclusions
Complications from spinal intervention are uncommon but can have devastating consequences if not recognized. Prompt recognition and appropriate intervention are crucial to minimize the extent of morbidity when it occurs.

KEYWORDS: Complications
Preoperative embolization of hypervascular spinal metastases: A Visual Approach from Cervical Spine to Sacrum

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Purpose
Hypervascular spinal metastases associated with vertebral instability require surgical management and often times result in high intraoperative blood loss. Preoperative tumor embolization is proven to reduce intra-operative blood loss through tumor devascularization. A practical approach to patient selection, technical aspects and complications of preoperative vertebral metastases embolization will be discussed. Relevant anatomy, imaging findings, and treatment efficacy will be reviewed.

Materials and Methods
Using three-dimensional animations to illustrate relevant anatomy and intraprocedural imaging to highlight treatment approach we present a series of cases involving the embolization of cervical, thoracic, lumbosacral spine hypervascular metastases. Potential postprocedural complications will be reviewed. Treatment efficacy and outcomes as evidenced by literature review will be discussed.

Results
Preoperative imaging findings including digital subtraction angiography demonstrating arterial anatomy for different vertebral segments will be discussed. The principles of appropriate embolic agent selection and embolization technique will be reviewed. Features such as satisfactory postembolization appearance and complication avoidance will be emphasized.

Conclusions
Pre-operative embolization of hypervascular spinal metastases is an effective procedure that reduces perioperative blood loss and facilitates tumor resection. Knowledge of anatomy, technique and potential complications are crucial to ensuring good patient outcomes. These techniques are reviewed effectively using animations and intraprocedural imaging.

KEYWORDS: Embolization, Metastases, Spine Interventions
Example of 3D animation which will be used to illustrate technique and anatomy

(Filename: TCT_eEdE-222_Picture1.jpg)

eEdE-219

6:30AM - 9:00PM

Review of Neuroimaging Spectrum of Pathology Involving the Lumbar Spine Paraspinal Muscles and Psoas Muscles
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Purpose
The purpose is to highlight the wide range of pathology involving the lumbar spine paraspinal muscles and psoas muscles. The goal is to familiarize the radiologist with the different pathologic entities affecting these muscle groups and their unique imaging characteristics, so that when presented with a case with an abnormality the radiologists are able to provide appropriate diagnosis and improve clinical care.

Materials and Methods
A retrospective review of abnormal lumbar spine paraspinal and psoas muscle demonstrated on MR imaging (MRI) and CT of the lumbar spine performed at William Beaumont Hospital from the previous three-year period. The imaging findings were correlated with the clinical history.

Results
A wide range of pathology was found involving the paraspinal muscles of the lumbar spine and the psoas muscles. The categories of pathology that we found were: neoplasm, including primary neoplasm and metastatic disease; infectious disease, including bacterial processes and tuberculosis; posttraumatic changes, including hematomas; myositis; rhabdomyolysis; unilateral and bilateral denervation changes, including those with the etiology of spinal stenosis, facet degenerative changes, and polio. Each of the entities with characteristic imaging findings will be presented. A description of each disease entity and its clinical findings along with characteristic imaging findings will be included in our presentation along with CT and MR images. Reviewers of our exhibit will be able to learn about each pathological entity and should be able to provide an appropriate differential diagnosis, which will aid them in the future when they are presented with abnormalities of the lumbar spine paraspinal musculature and psoas muscles.

Conclusions
There is a wide spectrum of common and uncommon disease entities that affect the lumbar spine paraspinal musculature and the psoas muscles. After the radiologist reviews our exhibit they will be familiar with each category of pathology presented. With this knowledge they will be able to provide an appropriate differential diagnosis when presented with different pathologic entities of the lumbar spine paraspinal muscles and psoas muscles. This then will benefit the referring clinician and ultimately will improve patient care.

KEYWORDS: Infections, Neoplasm, Spinal Imaging

Spinal Calcifications and Ossifications: Boring, Beautiful and Bizarre. A Pictorial Review.

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Purpose
Calcifications and ossifications, although routinely encountered in radiology practice, can present a diagnostic challenge when encountered in the spine. Our aim is to review typical and
unusual manifestations of common entities, as well as some rare conditions. After the completion of this exhibit, the radiologist should be able to identify classic imaging features of spinal calcifications and ossifications, as well as their mimickers, and learn how to avoid diagnostic pitfalls.

Materials and Methods
We present a systematic review of typical ossification and calcification patterns involving the spine, using a multimodality approach. Disease categories include arthritides, degenerative and inflammatory conditions, crystal deposition disorders, tumors with mineralized matrix, renal osteodystrophy and mimickers of calcifications. For each category, emphasis is placed on key anatomical features and imaging pearls that help make the diagnosis.

Results
An understanding of calcifying and ossifying disorders is essential for diagnosing musculoskeletal spinal lesions. Of particular importance is crystal deposition disease such as hydroxyapatite deposition disease (HADD), calcium pyrophosphate deposition disease (CPPD) and gout. Case examples include spinal cord stenosis secondary to HADD of the ligamentum flavum, acute calcific tendinitis of the longus colli muscle mimicking retropharyngeal abscess, widespread spinal involvement by gout, and the multiple appearances of spinal CPPD. Early and late findings of ankylosing spondylitis and diffuse idiopathic skeletal hyperostosis will be reviewed along with unusual injury patterns frequently encountered with these disorders. Spinal tumors with mineralized matrix and systemic diseases, including renal osteodystrophy, also are presented.

Conclusions
Spinal calcifications and ossifications commonly are encountered in clinical practice. Unusual manifestations of common entities and rare conditions are highlighted in this electronic exhibit.

KEYWORDS: Spinal Osteophyte, Spinal Stenosis

eEdE-218

Spinal Cysts: Imaging and Clinical features

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Purpose
Multiple types of spinal cysts have been described, each one with different imaging characteristics and clinical implications. The aim of this exhibit is to discuss the spectrum of cystic lesions that affect various compartments of the spine including peri-spinal structures, vertebral column, extradural, intradural and intramedullary compartments, their imaging findings, and who these imaging findings correlate clinically and affect treatment.

Materials and Methods
This educational exhibit discusses the myelographic, ultrasound (US), computed tomography (CT) and MR imaging (MRI) features of cystic lesions of the spine. For it, we search our teaching files for the following keywords: cyst, cystic lesion, tumor, cystic tumor, meningocele, Tarlov, diverticula, parasites, syrinx, hydromyelia, terminal ventricle, myelomalacia, and
epidermoid. A pertinent literature review is provided emphasizing their differential diagnosis, clinical presentation, and treatments.

Results
In the evaluated US, CT and MR examinations, various cystic lesions originating from different compartments of the spine were identified, including synovial/ganglion cysts, simple bone cysts, hydatid cysts, aneurysmal bone cysts, diskal cysts, lateral spinal meningoceles, spinal perineural cysts (Tarlov cyst), spontaneous meningeal diverticula, occult intrasacral meningocele, neuroenteric cysts, arachnoid cysts, epidermoid cysts, dermoid cysts, spinal cysticercosis, ventriculus terminalis, syringohydromyelia, cystic myelomalacia, cystic hematoma and cystic tumors. Cysts of several different types may develop within the spinal canal. They can be found incidentally or they may cause myelopathy and/or radiculopathy. For the purposes of this exhibit we divided the different cystic lesions by their nature in congenital/developmental, neoplastic or inflammatory, and according to their location in the paraspinal soft tissues, vertebral column, spinal extradural compartment, intradural compartment and intramedullary.

Conclusions
A broad spectrum of cystic lesions can occur in the different compartments of the spine and paraspinal areas. Therefore, the diagnosis and differentiation between them can be made on a basis of a multimodality imaging approach including US, CT and MRI. MR imaging is an excellent noninvasive technique in the detection and evaluation of the spinal cystic lesions. Ultrasound is essential and the modality of choice in many pediatric patients, while CT is helpful specially in the vertebral column lesions. Advanced imaging techniques such as diffusion-weighted imaging can be used as a problem-solving tool in some spinal cystic lesions.

KEYWORDS: Cysts, MR Imaging Spine

eEdE-231

Spinal Hardware Complications

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Purpose
To illustrate the imaging appearances of common and uncommon, early and late complications of spinal instrumentation.

Materials and Methods
Imaging of patients with postoperative spinal instrumentation complications was reviewed. The imaging modalities used included plain radiographs, computed tomography (CT) and MR imaging (MRI). Radiography is the mainstay for imaging postoperative patients and has the advantage of being quick and inexpensive. MDCT also may be used, but is associated with an increased radiation dose. MR imaging is most useful at assessing for postoperative infection.

Results
We illustrate complications such as instrument malpositioning of pedicle screws, cages, bone grafts and plates. Late complications such as adjacent segment degenerative disease, failure of fusion, hardware fracture, loosening or displacement also were demonstrated, as well as postoperative infection.
Conclusions
It is important that the radiologist is aware of the possible complications associated with spinal instrumentation and their imaging appearances in order to allow early detection and treatment. Systematic evaluation is required. Although radiography remains the primary modality, MDCT and MRI also have a role in further evaluation.

KEYWORDS: Spinal Imaging, Spinal Instumentation

Spinal imaging findings of CSF hypovolemia syndrome

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Purpose
This educational exhibit aims to: 1. Describe pertinent spinal imaging findings of cerebrospinal fluid (CSF) hypovolemia syndrome. 2. Illustrate the pathophysiology of CSF hypovolemia syndrome. 3. Discuss role of different modalities used to image spine in diagnosis of CSF hypovolemia. 4. Identify common differential diagnoses to be considered. 5. Suggest optimal management of CSF hypovolemia.

Materials and Methods
Spinal Imaging findings using different modalities including myelography, CT myelography, MRI, MR myelography, nuclear cisternography. In patients with diagnosis of CSF hypovolemia were evaluated. Findings were thoroughly assessed and utilized to prepare an educational exhibit describing: 1. Pathophysiology of CSF hypovolemia syndrome, 2. Common appearances on spinal imaging, 3. Differential diagnoses, 4. Pediatric versus Adult CSF hypovolemia, 5. Brain imaging findings in CSF hypovolemia in brief.

Results
• CSF hypovolemia is an important clinicoradiological entity and can be diagnosed on various modalities for imaging spine provided a high index of suspicion is present. • Coexistent findings on brain imaging can support the diagnosis.

Conclusions
A thorough knowledge of normal pathophysiology, common spinal imaging appearances on various modalities and differential diagnoses can help diagnose CSF hypovolemia with confidence and avoid misdiagnosis.

KEYWORDS: CT, MRI Spine, Spinal CSF Leak

Spinal Subdural Hematomas - Etiologies, Imaging Characteristics, Pitfalls and Techniques

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Purpose
Spinal subdural hematomas are rare but can have devastating neurologic consequences and therefore are important to rapidly and accurately diagnose. We will review the etiologies of subdural hemorrhage in the spine, imaging identification, aging of hemorrhage, imaging pearls and natural course of hemorrhage.

Materials and Methods
Spine subdural hemorrhage can be idiopathic or secondary. Spine subdural hemorrhage may be secondary to trauma, lumbar puncture, spinal anesthesia, spine surgery, bleeding diathesis, anticoagulation therapy or vascular malformations. Rarely, they can be seen in association with intracranial hemorrhage and after posterior fossa decompressive surgeries. Nonaccidental trauma is an important consideration in infants with subdural hemorrhage. This poster will review the pathophysiology and different etiologies of spinal hematomas providing imaging examples of each. In addition we will cover the characteristic MR imaging findings of spinal subdural hematomas as well as imaging difficulties and techniques for diagnosis.

Results
The subdural space in the spine is a potential space between the dura and the arachnoid matter. Unlike the epidural space which contains the epidural venous plexus the spinal subdural space does not contain any major blood vessels. Spinal subdural hematomas are defined as blood products within the subdural space. This is a rare finding that can have significant clinical consequences. Patients usually present with acute neurological symptoms due to mass effect on the spinal cord or cauda equina. Smaller collections can have a more subtle presentation such as back pain or radicular pain. There are several well recognized etiologies of spinal subdural hematoma; post-traumatic, postoperative, postlumbar puncture, spontaneous due to anticoagulation, tumors, or vascular malformations, and nonaccidental trauma. MRI is the best imaging modality for: •detecting spinal subdural hematomas, •determining the extent of the hematoma, •accurately age blood products, •Assess the mass effect and compression on the nerve roots and/or spinal cord. There are several imaging pitfalls to be wary of when a patient presents with clinical history concerning for a spinal hemorrhage. Hyper acute spinal subdural hematomas (<12 hours) contain oxyhemoglobin, which is isointense on T1-weighted images, and hyperintense on T2-weighted images. This can cause difficultly distinguishing the hematoma from the surrounding structures due to the isointensity on T1-weighted images, the small space, and surrounding structures. In these cases gradient-echo imaging can be of used, as it will demonstrate a characteristic low-signal rim surrounding the hematoma. A second issue arises with subacute spinal hematomas. Subacute hematomas (3-14 days) may contain either intracellular or extracellular methemoglobin depending on the age. Methemoglobin is hyperintense on T1-weighted images, which can be difficult to distinguish from benign epidural fat. Fat suppressed T1-weighted images can be of help.

Conclusions
Spinal subdural hematomas are rare neurologic emergencies which can result from several different etiologies. MR imaging is the best imaging modality for diagnosis; however, there are several pitfalls one must be aware of to ensure accurate diagnosis.

KEYWORDS: Spinal Imaging, Subdural, Subdural Hemorrhage
The Broken Neck: A pictorial review of CT and MR findings in traumatic cervical spine injury

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Purpose
Cervical spine injuries (CSI) are both common and potentially devastating. In the USA, there are approximately 8,500 patients with CSIs who present for treatment annually. The mean age at injury is 30.7 years, but injury most frequently occurs at age 19. The three most common causes of spinal fractures are motor vehicle accident (50%), falls (25%), and sports injuries (10%). The consequences resulting from neck injuries range from simple neck pain, to quadriplegia, or even death. The spinal cord injury occurs at the time of trauma in 85% of patients and as a late complication in 15%. The initial post-injury period is critical with regard to neurologic recovery or deterioration and the delay of injury recognition or improper stabilization of the cervical spine may lead to irreversible spinal cord injury and permanent neurologic damage. This educational exhibit will review the pathophysiology, mechanism of injury (MOI), characteristic imaging findings and management strategies of cervical spine injury by examining CT and MRI findings in patients at our institution. We also will provide a review of the indications for radiological evaluation and the most common associated complications of neck trauma.

Materials and Methods
Radiological images and relevant clinical information were extracted from our PACS station and MEDITECH™ integrated healthcare system at Puerto Rico's Trauma Center. Images were retrieved for recent cervical spine imaging studies to review a wide spectrum of the major pathologies found in patients admitted for trauma.

Results
In this educational exhibit we intend to review a wide range of cervical spine pathologies encountered in neck trauma patients at our institution to include, but not limited to: simple and complex c-spine fractures, ligamentous injury, traumatic disk herniation, arterial dissection, post-traumatic vascular thrombosis and spinal cord injury. Particular attention was paid to noncontrast cervical spine CT findings, as this is usually the first study performed in this setting. Ancillary use of MRI, MRA, CTA and other specialized techniques will be presented for selected injuries where further management changing information may be obtained. Discussion of pathophysiology, MOI, management, common complications and characteristic imaging findings with pertinent radiological illustrations will provide adequate exposure to the most commonly encountered clinical scenarios after significant neck trauma.

Conclusions
Cervical spine injuries (CSI) are both common and potentially devastating. The initial postinjury period is critical with regard to neurologic recovery or deterioration. Delayed recognition of an injury or improper management and stabilization of the cervical spine may lead to irreversible spinal cord injury and permanent neurologic damage. Reviewing the pathophysiology, MOI,
common complications, indications for radiological evaluation, characteristic imaging findings and management of traumatic cervical spine injuries will help improve the outcome of patients presenting with acute craniocervical.

KEYWORDS: Cervical Fractures, Cervical Spine, Spinal Trauma

eEdE-227

6:30AM - 9:00PM

The Third Dimension of Cervical Spine Imaging – S.P.A.C.E.: The Final Frontier

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Purpose
Cervical spine imaging using sagittal 3-dimensional (3D) T2-weighted (T2W) magnetic resonance imaging (MRI) sequences offers a robust technique for diagnostic evaluation with high spatial and contrast resolution, the ability for multiplanar reconstruction, and reduced cerebrospinal fluid (CSF) flow and metallic artifacts; this yields improved delineation of cervical anatomy and a range of pathology when compared to conventional T2W fast spin echo (FSE) or turbo spin echo (TSE) sequences. Scan times can also decrease by foregoing separate sagittal and axial FSE/TSE T2W sequence acquisitions.

Materials and Methods
Multiple nonsurgical and postsurgical patients with variable anatomy, pathology, and postoperative hardware were imaged using both conventional axial/sagittal T2W TSE as well as a sagittal T2W 3D volumetric, high resolution Sampling Perfection with Application optimized Contrasts using different flip angle Evolution (SPACE) sequence. Postprocessing of SPACE images included 3D myelographic reconstruction and volume/CSF segmentation.

Results
Highlights include detailed evaluation of essential cervical spine anatomy, identifying duplicated and anomalous nerve rootlets, examples of pathologic compression and tumor involvement of specific cervical nerve rootlets, and improved visualization of pathology in the setting of prior cervical surgical instrumentation, among others. Comparison is made to conventional T2W FSE images to demonstrate the advantages and improved diagnostic capabilities offered by T2W SPACE imaging, which often identifies additional clinically relevant findings.

Conclusions
High-resolution, volumetric 3D T2W imaging of the cervical spine offers a superior structural imaging method to visualize anatomical and pathologic changes in nonsurgical and postsurgical patients as well as permitting advanced imaging reconstruction, which has the potential added benefit of shorter scan times.

KEYWORDS: Anatomy, Cervical Spine, MR Imaging Spine
Utility of Diffusion Weighted Imaging for Evaluation of Benign and Malignant Spinal Tumors.

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Purpose
Radiologist frequently encounter tumor and tumor-like lesions as incidental findings on spine MRIs. These can result from a number of processes which can be benign or malignant. Deciphering between the two can be challenging and is critical for patient care as miss of a malignant lesion can prove to be fatal. This educational exhibit will be a case-based presentation of common and uncommon causes of benign and malignant processes that result in lytic and/or sclerotic lesions in the skeletal system on CT and have variable appearance on routine T1 and T2 sequences. We will focus on the utility of diffusion-weighted imaging in these cases in deciphering benign from malignant lesion.

Materials and Methods
1. Case-based presentation will include clinical features, key imaging findings, radiology-pathology correlation, treatment and prognosis of common and uncommon causes of benign and malignant spinal column neoplasms. 2. Case examples include: fibrous dysplasia, enchondroma, chondrosarcoma, sarcoma, lymphoma, metastasis (carcinoid, prostate, lung, melanoma, etc). 3. Chart of salient features for quick reference.

Results
1. Review physics of diffusion-weighted imaging (B-values: 50, 400, and 800 s/mm$^2$) with ADC mapping. 2. Review imaging findings of various spinal tumors. 3. Discuss limitations and pitfalls of diffusion-weighted imaging in the musculoskeletal system.

Conclusions
Osseous spinal tumors frequently are encountered incidentally on radiologic imaging and nonspecific imaging findings cause a diagnostic dilemma. Being familiar with discriminating imaging findings including diffusion-weighted imaging (DWI) can help characterize a tumor as benign or malignant thus assisting radiologists in guiding clinical management of the lesion.

KEYWORDS: Neoplasm
Vertebral Body: In Sickness and in Health

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Purpose
Many local and systemic disease processes alter the appearance and configuration of the vertebral body. The purpose of this exhibit is for the user to improve upon their knowledge of anatomy and imaging of the vertebral body. This exhibit will review various diseases that affect the vertebral body and demonstrate an image-based algorithm to aid in diagnosis.

Materials and Methods
1. Review the normal radiographic appearance of the vertebral body. 2. Learn imaging features

CT reveals mixed lytic-sclerotic lesion at multiple spinal levels.
MRI reveals T1 hypointense and T2 hyperintense lesions, which demonstrated restricted diffusion, likely representing osseous metastases. These were positive on bone scan and biopsy proven to be metastatic prostate cancer.

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of diseases that affect the vertebral body. 3. Demonstrate an image-based algorithm to aid in diagnosis.

Results
A review of the normal appearance of the vertebral body is followed by a discussion of various diseases that alter the appearance of the vertebral body. Computed tomography (CT) and MR correlation will be provided in select cases. Cases are presented in a quiz format to emphasize major teaching points. Categories presented include: Enlarged shape/size: fibrous dysplasia, Paget's disease, Vertebra plana: lymphoma, Langerhan's cell histiocytosis, Abnormal shape and density: amyloid destructive spondyloarthropathy, diskitis/vertebral osteomyelitis, Pott's disease, sickle cell disease, avascular necrosis, Increased density: osteopetrosis, renal osteodystrophy, metastatic prostate cancer, hemangioma. Decreased density: multiple myeloma, severe osteoporosis.

Conclusions
Many local and systemic disease processes alter the appearance of the vertebral body. After completing this educational exhibit, the user will know the normal radiographic appearance of the vertebral body and based on changes in appearance and configuration, suggest a reasonable differential diagnosis.

KEYWORDS: Spinal Imaging, Spine Bone Marrow, Vertebra Plana

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Excerpta - Adult Brain
EE-24

A case diffuse cerebral micro haemorrhages in a patient who had received extra corporeal membrane oxygenation

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Purpose
To describe a case of cerebral microhemorrhages secondary to extracorporeal membrane oxygenation (ECMO) in a young patient and highlight that these changes can occur.

Materials and Methods
A 29-year-old male with a past medical history of two years previously developed ARDS secondary to pneumonia, during this illness he underwent extracorporeal membrane oxygenation support as part of intensive care therapy. He made a subsequent full recovery and underwent a MR imaging (MRI) examination for left-sided hearing loss with tinnitus.

Results
The MRI demonstrated multiple foci of low signal change on gradient echo sequences throughout both cerebral hemispheres. These were in a subcortical location with sparing of the basal ganglia. The appearances were in keeping with cerebral microhemorrhages. No other abnormalities were identified. The micr hemorrhages are presumed to be secondary to ECMO
therapy and the concurrent anticoagulation. The appearances are similar to amyloid angiopathy although this diagnosis is not seen routinely in this age group.

Conclusions
This case highlights a complication of ECMO which has not been identified previously within an adult population. Multiple cases of microhemorrhages and infarctions have been reported in children and infants receiving ECMO. The combination of large volume fluid transfusions with anticoagulation are a risk factor for both intracranial and visceral hemorrhage. As ECMO treatment becomes more widespread in the adult population it is important to consider the complications that may not be immediately apparent clinically.

KEYWORDS: Gradient Recall Echo, Microbleeds

EE-19

A Case of Basilar Perforating Artery Aneurysm Rupture and Thrombosis: Challenges in Imaging and Treatment

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Purpose
Rare basilar perforating artery aneurysms pose unique challenges in imaging and treatment. A case is presented, with review of the literature.

Materials and Methods
A 61-year-old male awoke with severe headache and neck pain, and was brought to the hospital by family. Head computed tomography (CT) revealed acute subarachnoid hemorrhage centered in the prepontine cistern, and hemorrhage within the third and fourth ventricles with mild noncommunicating hydrocephalus, suspicious for a ruptured aneurysm. Same day head CT angiography (CTA) and catheter cerebral angiogram showed no aneurysm. He became increasingly somnolent with diminished responsiveness, requiring intubation and external ventricular drain (EVD) placement. His condition improved and he was extubated the following day. His EVD was removed with placement of a lumbar-peritoneal shunt six days after presentation prior to discharge home. Follow-up head CTA 26 days after presentation revealed a 2mm aneurysm arising from the posterior distal basilar artery proximal to the basilar tip. Catheter cerebral angiogram performed three days later showed a faint arterial blush at this site, with inability to select any vessel or defect along the dorsal basilar artery wall using a SL10 catheter with 90-degree shape and Synchro-2 micro-guidewire. Forty-five days after initial presentation, the patient returned complaining of several days of occipital pressure, difficulty ambulating, and intermittent double vision and slurred speech. Exam revealed vertical nystagmus with truncal ataxia and a wide-based gait. Brain MR imaging (MRI) revealed an acute right superior pontine and right midbrain ischemic infarct, and thrombosis of the distal basilar perforating artery aneurysm, confirmed on same day brain MR angiography (MRA) and head CTA. His symptoms had nearly resolved two weeks later.

Results
Sagittal-view thick-slab image (left) from CT angiogram performed 26 days after presentation, and PA-view 3D-shaded surface rendered image (right) from catheter cerebral angiogram performed 29 days after presentation are shown. A 2mm aneurysm is seen arising from the posterior distal basilar artery proximal to the basilar tip. No early draining vein was identified to suggest a small AVM.

Conclusions
Basilar perforating artery aneurysms are rare, with five previously reported cases. All presented with acute subarachnoid hemorrhage. Four aneurysms were occult on initial CT and/or catheter angiograms, revealed on angiograms performed five days to two months after presentation. Two aneurysms had re-hemorrhaged at follow up. Four aneurysms arose from distal basilar perforators and one arose from a midbasilar perforator. Slow filling was reported in two cases, and partial thrombosis was present in three cases. Endovascular repair was attempted unsuccessfully in four cases. All cases underwent surgical repair with pterional and/or subtemporal craniotomy and aneurysm clipping, feeding artery coagulation and division, or aneurysm wrapping. Postoperative hemiparesis and dysphagia, CNIII palsy, or anisocoria occurred in three cases, with resolution over time. We have presented a sixth case, with similar presentation and imaging findings, unsuccessful attempt at endovascular treatment, and subsequent spontaneous thrombosis resulting in a small infarct. Imaging diagnosis and endovascular treatment are challenged by small size, slow-filling and thrombosis of these aneurysms. Follow-up imaging is essential to identify initially occult aneurysms. Endovascular access of the feeding artery may be precluded by an average outer diameter of 0.26mm and horizontal orientation of most basilar perforators, forming an average bifurcation angle of 93
degrees with the basilar artery. Open surgical repair has been successful, and sacrifice of the feeding perforator may be performed; however, care must be taken to avoid occlusion or injury to adjacent perforators providing collateral perfusion, and damage to cranial nerves.

KEYWORDS: Aneurysm, Basilar Artery, Perforators

A case of crossed cerebellar diaschisis in a middle aged patient.

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Purpose
To highlight the radiological appearances of crossed cerebellar diaschisis in a middle-aged patient with a history of previous cerebral infarction.

Materials and Methods
A 46-year-old woman who previously had suffered a left middle cerebral artery infarction underwent an acute computed tomography (CT) brain examination after a prolonged tonic-clonic seizure.

Results
The CT brain demonstrated atrophy of the left cerebral hemisphere and ex-vacuo dilation of the left lateral ventricle consistent with known previous cerebral infarction. In addition there was atrophy of the right (contralateral) cerebellar hemisphere. The imaging appearances and clinical history are in keeping with diagnosis of crossed cerebellar diaschisis.

Conclusions
Crossed cerebellar diaschisis is believed to be related to reduction of blood flow and metabolism affecting the cerebellar hemisphere contralateral to a supra-tentorial insult. Common insult may
be an infarction, hemorrhage, radiation necrosis or tumor. The cerebellar changes are thought to occur due to interruption of cortico-ponto-cerebellar connections causing reduced afferent connections and reduced metabolism within the contralateral cerebellar hemisphere.

KEYWORDS: Atrophy, Cerebellum, Infarct

A case of neurosarcoidosis with intracranial hemorrhage

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Purpose
To describe the imaging findings of a case of neurosarcoidosis with multiple intracranial hemorrhages, which is an extremely rare complication of sarcoidosis.

Materials and Methods
A 27-year-old man with no past history presented with a year history of headache and three-month history of fever during the night. Stagger emerged from a week ago and dysarthria and restlessness developed from a day ago. Computed tomography (CT) showed multiple subcortical hemorrhages in the bilateral frontotemporal lobes. Echocardiography and angiography could not
reveal any causes of hemorrhage. Serum ACE was significantly high and CT showed diffuse miliary nodules of the lung and systemic lymph node swelling. Contrast-enhanced T1-weighted MR imaging (MRI) showed widespread nodular enhancement of pia-subarachnoid pattern. In brain biopsy noncaseating granuloma consistent with sarcoidosis was detected. Reports of sarcoidosis with intracranial hemorrhage were only 15 cases so far. Forty-six percent of cases do not have a prior diagnosis of sarcoidosis and 31% were central nervous system (CNS)-isolated disease.

Results
Computed tomography shows multiple subcortical hemorrhages with mild edema. MR imaging demonstrates diffuse leptomeningeal enhancement around the cerebrum and cerebellum. Hilar and mediastinal lymphadenopathies and miliary nodules with perilymphatic distribution are shown on chest CT. These findings are thought of as typical sarcoidosis except for multiple hemorrhages.

Conclusions
We described very rare case of neurosarcoidosis with multiple intracranial hemorrhage. Some cases of sarcoidosis with hemorrhage may have been overlooked. On cases with young-onset intracranial hemorrhage, it is necessary to consider the possibility of sarcoidosis.

KEYWORDS: Intracranial Hemorrhage, Neurosarcoidosis
Acute Amnesia due to Isolated Mamillary Body Infarct

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Purpose
The mammillothalamic tract (MTT) is a part of the Papez circuit, and connects the mammillary body with the anterior thalamic nucleus. Recent evidence suggests that the circuit involving the mammillary bodies, the MTT and the anterior thalamus is particularly critical in the formation of new memories. There are limited case reports describing patients with acute onset amnesia after either unilateral or bilateral mammillothalamic tract infarction. To the best of our knowledge, an acute infarction isolated to the mammillary body in a patient without prior MTT injury has never been reported. We present the first case of anterograde amnesia after acute infarction isolated to the mammillary body.

Materials and Methods
A 50-year-old woman with history of hypertension, diabetes and hyperlipidemia was brought to the emergency room by her daughter for acute onset of confusion and abnormal behavior. On mental status testing, she was found to have severe anterograde amnesia with otherwise no focal neurologic deficits. An MR imaging (MRI) of the brain was performed which showed restricted diffusion abnormality involving the left mammillary body. The differential at that time included stroke, sequel of seizure, atypical Wernicke encephalopathy or an inflammatory process such as sarcoidosis. During the course of her hospitalization, a repeat brain MRI showed a growth in size of the restricted diffusion of her left mammillary body, as well as new foci of restricted diffusion in her left temporal lobe and left basal ganglia. Additional imaging examinations including MR spectroscopy (MRS) and MR angiogram, concluded the diagnosis of an initial acute mammillary body infarction due to in situ thrombosis of the P1 segment of the left posterior cerebral artery, at the origin of the perforating mammillary branch. On discharge 13 days later, the patient continued to demonstrate significant anterograde and retrograde amnesia.

Results
Axial diffusion-weighted sequence demonstrates focal restricted diffusion involving the left mammillary body. MR angiogram image demonstrates focal area of narrowing of the P1 segment of the left posterior cerebral artery, at the origin of the perforating mammillary branch.

Conclusions
The thalamus and the mammillary bodies are some of the most commonly implicated sites for memory dysfunction. Recent evidence suggests that the circuit involving the mammillary bodies, the mammillothalamic tract (MTT) and the anterior thalamus is particularly critical in the formation of new memories. To date, there have been only a few case reports that specifically document memory dysfunction following MTT infarction. We present the first case of anterograde amnesia after acute infarction isolated to the mammillary body in a patient without prior MTT injury. The mammillary body is a highly vascularized area of the hypothalamus, and is supplied mostly by perforating mammillary branches of the P1 segment of the posterior cerebral artery. In situ thrombotic or embolic events involving these perforating branches could cause infarction isolated to the mammillary body if perfusion to the MTT and thalamus is
maintained via anterior circulatory tuberotalamic arterial supply. Determining the contribution of an individual structure to memory is difficult because it is unusual to find circumscribed damage to only one anatomical region in an acute clinical setting. We present this unique case of severe amnesia due to isolated unilateral damage to the mammillary body in a patient with no history of prior MTT or thalamic damage in order to shed light on this fascinating anatomy and its contribution to the process of memory formation.

KEYWORDS: Infarct, Memory, Posterior Circulation

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EE-06

Acute Hemorrhagic Leukoencephalitis in a Postpartum Patient with H1N1 Influenza.

A Pal¹, M Post¹, E Sklar¹

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Purpose
The purpose of this exhibit is to describe the imaging findings of a rare case of acute hemorrhagic leukoencephalitis in a patient with H1N1 influenza. The goal is to create awareness of the entity so that a prompt diagnosis can be made and mortality from the condition potentially can be avoided.

Materials and Methods
A 39-year-old postpartum female initially presented with productive cough to her primary care provider. The patient was exposed to H1N1 influenza in her home environment, and was prescribed Tamiflu (Oseltamivir). She unfortunately could not afford the prescribed medication, and subsequently was admitted to the ICU with a diagnosis of postpartum sepsis and ARDS. Tracheal secretions in the patient were confirmed to be positive for H1N1 influenza. Initial computed tomography (CT) of the brain was obtained secondary to the patient's poor responsiveness and was negative for acute intracranial pathology. Follow-up CT towards the end of her hospital course was performed secondary to sluggish pupillary reaction. While the CT demonstrated clear signs of global anoxia and transtentorial herniation, there were additional confluent areas of strikingly low attenuation and parenchymal hemorrhage in the periventricular and deep white matter. These findings have been described in patients with acute hemorrhagic leukoencephalitis associated with H1N1 influenza, and made this the likely diagnosis in our patient. The patient ultimately expired.

Results
Computed tomography of the brain demonstrates confluent, strikingly low attenuation and areas of parenchymal hemorrhage in the periventricular and deep white matter, which have been described in the setting of acute hemorrhagic leukoencephalitis associated with H1N1 influenza. Diffuse sulcal effacement with a "white cerebellar sign" are consistent with global anoxia. Evidence of transtentorial herniation also is noted.

Conclusions
Acute hemorrhagic leukoencephalitis is an autoimmune mediated demyelinating process, and is considered to be a rare fulminant form of acute disseminated encephalomyelitis. The entity typically follows a respiratory infection and neurological signs are nonspecific including headache, seizures, encephalopathy and coma. Imaging will demonstrate marked areas of white matter edema in addition to parenchymal hemorrhage. Pathology shows areas of vascular necrosis and perivascular hemorrhage along with neutrophilic infiltrates. Early diagnosis of this disease is critical as morbidity and mortality is high if not treated within a few days. For this reason MR imaging (MRI) with susceptibility-weighted imaging may be of particular benefit in conjunction with CT for early recognition. Treatment with combinations of corticosteroids, cyclophosphamide, and/or plasma exchange, in addition to oseltamivir for the treatment of H1N1, has been shown to improve survival.

KEYWORDS: Acute Disseminated Encephalomyelitis, Influenza Encephalopathy, Leukoencephalopathy
Angiocentric Glioma: A rare cause of intractable seizures in a pediatric patient.

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Purpose
We report a case of a pediatric patient with intractable seizures resulting from pathology proven angiocentric glioma, a distinct epilepsy associated WHO grade I tumor added to the WHO central nervous system tumor classification in 2007.

Materials and Methods
A previously healthy five-year-old girl first presented with difficulty enunciating words, later progressing to irregular tongue movements and twitching diagnosed as a tic at an outside hospital. She continued to have "eye rolling" and "rhythmic jaw movements" as well as multiple falling episodes eventually diagnosed as simple partial and complex partial seizures. The patient experienced approximately five to six episodes per day refractory to anti-epileptic medication. An MR imaging (MRI) performed several months after initial presentation revealed a mass centered in the right frontal lobe. Subsequent right frontal craniotomy with resection of the underlying mass resulted in resolution of seizure activity. Findings on pathology were consistent with angiocentric glioma.

Results
MR imaging demonstrated a T2 hyperintense, T1 iso- to hypo-intense, nonenhancing right frontal lobe cortically based expansile mass scalloping the inner table. Minimal surrounding edema was noted. Spectroscopy was nonspecific, showing relatively elevated choline peaks as well as a small lactate peak.

Conclusions
Angiocentric glioma is now recognized as a distinct neuroepithelial mass, relatively recently added to the WHO classification system in 2007. Greater than 95% of patients present with intractable epilepsy. While there are too few cases to reliably establish imaging characteristics, findings of a nonenhancing T2 hyperintense cortically based mass in a young patient are suggestive. Additional findings reported in the literature include extension towards the ventricles and occasionally a T1 hyperintense rim. Awareness of angiocentric glioma as a distinct clinical entity is important with respect to treatment and prognostic considerations. As it is established as a WHO grade I mass, angiocentric glioma is considered to have no malignant potential, and generally, resection results in resolution of seizure activity.

KEYWORDS: Epilepsy, Neoplasm
Carotidynia: A Diagnostic Challenge

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Purpose
Carotidynia is an inflammatory syndrome presenting with acute onset of unilateral headache and neck pain with tenderness, swelling, and pulsations over the neck carotid artery. Clinicians may refer the patient for neuroimaging to rule out carotid artery dissection. The unfamiliar radiologist may report the carotid narrowing to be consistent with carotid artery dissection, thereby delaying the diagnosis and complications from treatment of a carotid artery dissection may occur. We report two patients who present with unilateral neck pain and headache who are suspected to have a carotid artery dissection clinically. Initial neck computed tomography (CT) with iv contrast showed focal narrowing of the affected neck carotid artery, suspicious for a carotid artery dissection but follow-up neck MR imaging (MRI) and MR angiography (MRA) showed characteristic imaging findings of carotidynia, leading to successful treatment.

Materials and Methods
Case 1 is a 33-year-old female presenting with progressive deep right neck pain which has become worse for the last 48 hours prior to presenting to the emergency room for evaluation. Case 2 is a 43-year-old female who presents with a three-day history of left neck pain. Both patients underwent CT scan and subsequent MRI where the diagnosis was confirmed. In each case, the patients demonstrated significant improvement in symptoms after administration of NSAIDs.
Results
Typically, imaging findings are localized to the distal common carotid or carotid bifurcation area. There is circumferential thickening of the carotid wall without luminal stenosis. MRI imaging is specific for making the diagnosis where enhancing soft tissue surrounding the carotid artery can be seen. MR angiography aids in the diagnosis by excluding luminal stenosis. MR imaging also serves to exclude other entities in the differential which includes giant cell arteritis, dissection, fibromuscular dysplasia, hematoma, and Takayasu arteritis.

Conclusions
Carotidynia is a self-limiting entity with classic symptoms and imaging findings. The radiologist should be alert to its existence to prevent misdiagnosis as a dissection and delay in treatment.

KEYWORDS: Carotid Artery, Carotid Artery Stenosis, Carotid Dissection

Central nervous system IgG4-related disease

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Purpose
To demonstrate some of the imaging findings of this novel entity and its proposed histopathological and imaging criteria and discuss the spectrum of differential diagnoses.

Materials and Methods
A 44-year-old female initially presented in 1998 with headaches and gradual left vision loss. Initial imaging work up of the same year showed enlarged pituitary gland and a suprasellar mass lesion. Pathology indicated lymphocytic hypophysitis. The patient had been on steroid therapy and monitored with annual imaging follow up. This year she presented with recurrent symptoms and slight progression on imaging. A repeat recent biopsy of the dura fulfilled some of the criteria for IgG4-related pachymeningitis. Serum IgG4 were elevated slightly.
Results
Series of sagittal T1-weighted pre and postcontrast and coronal T2-weighted images of the pituitary fossa over time, show thickening of the infundibular stalk and expansion of the pituitary gland. After steroid therapy there initially was regression with stable appearances over serial follow up. Most recent imaging shows minimal interval progression. There is involvement of the cavernous sinuses with gradual narrowing of the cavernous segments of the internal carotid arteries and development of a rim of very low T2-weighted signal changes enveloping the pituitary gland and the cavernous sinuses.

Conclusions
Central nervous system (CNS) IgG4-related disease is a novel entity and the spectrum of differential diagnoses (as in our case) is wide including: 1. Inflammation: Lymphocytic hypophysitis, 2. Granulomatous process: neurosarcoidosis, 3. Infectious causes, and 4. Neoplastic: lymphoma, leukemia, metastases, neurohypophysial specific glial tumors. Neuroradiologists should be aware of this rare novel entity which can present with imaging findings of hypophysitis, pachymeningitis or inflammatory pseudotumor.

KEYWORDS: IgG4 Related Disease, Pachymeningitis, Pituitary Gland

EE-20
6:30AM - 9:00PM

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Purpose
To present a rare case of intracranial involvement in hemophagocytic lymphohistiocytosis (HLH) and to review the spectrum of brain MR imaging (MRI) findings in this uncommon condition.

Materials and Methods
A 56-year-old, previously healthy female developed weight loss, fatigue, fevers, and night sweats. She was evaluated by her local oncologist and no etiology was identified. She continued to decline clinically, developing profound weakness and encephalopathy. She underwent extensive outside work up without determination of an underlying cause. She then was referred to our institution for further evaluation. Laboratory studies revealed severe anemia and other cytopenias, monocytosis, and elevated ferritin and liver enzymes. Cytology from a prior paracentesis showed erythrophagocytosis, making HLH a diagnostic consideration. Pathology samples from prior liver and bone marrow biopsies were re-evaluated and hemophagocytosis was present in both tissues, leading to a diagnosis of HLH. Brain MRI demonstrated diffuse abnormalities, consistent with central nervous system involvement by a process such as HLH. The patient was started on aggressive treatment with chemotherapy and high dose steroids. She initially improved; unfortunately, she was readmitted four months later for increasing weakness and stroke symptoms. MR imaging demonstrated progression of brain abnormalities and the patient was treated for recurrent, progressive HLH. Early clinical improvement was again noted; however, she subsequently developed polymicrobial bacteremia and died six months after the initial diagnosis.
Results
The first brain MRI demonstrated diffuse leptomeningeal and mild pachymeningeal gadolinium enhancement. Follow-up MRI demonstrated innumerable new foci of T2 hyperintensity scattered within the white matter, several of which had restricted diffusion, compatible with hypercellular infiltration. The abnormal meningeal enhancement had nearly completely resolved. With worsening of the clinical status, a third MRI showed marked interval enlargement of the numerous T2 hyperintense areas within the bihemispheric white matter (Figure 1A, axial PROPELLER T2 FLAIR) and basal ganglia, many of which had associated restricted diffusion and gadolinium enhancement (Figure 1B, post-gad axial T1 CUBE). A few of these areas also demonstrated hypointensity on gradient echo sequences, suggestive of hemorrhage. These imaging features were compatible with inflammatory meningitis and diffuse cerebritis secondary to intracranial HLH and correlated with the patient's clinical course.

Conclusions
HLH is a hyperinflammatory syndrome with uncontrolled proliferation of activated, non-neoplastic lymphocytes and macrophages with overproduction of inflammatory cytokines. HLH is subdivided into primary and secondary subsets, related to genetic abnormalities or acquired viral infections or malignancies respectively. An underlying process is not always elucidated and mortality is high. In the absence of a gene mutation, the clinical diagnosis of HLH is based on the presence of five out of eight HLH criteria. Fever, splenomegaly, cytopenias, hypertriglyceridemia, hyperferritinemia, and hemophagocytosis in reticuloendothelial organs are often the diagnostic markers of HLH. While not unusual, the typical presentation of HLH is not neurologic; but, when seen, is a poor prognostic indicator. The imaging presentation of HLH can be nonspecific and overlaps with various infectious, inflammatory, demyelinating, and neoplastic etiologies; though the imaging correlates of perivascular inflammatory cell infiltration are expected. The brain MRI findings in our patient align with those previously reported in the literature, although only two adult cases have been described to our knowledge. Neuroimaging is useful for monitoring treatment response and the neuroradiologist should recognize the patterns of brain involvement.

KEYWORDS: Inflammatory, Intracranial, Meningitis
Cerebral infarct caused by spontaneous thrombosis of a developmental venous anomaly

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Purpose
To present the clinical course and magnetic resonance imaging (MRI) findings associated with a very rare case of ischemic complication of developmental venous anomaly (DVA).

Materials and Methods
A 23-year-old woman presented with homonymous lower quadrantanopsia. She complained that she saw a blinking object in left lower visual field. She had been in excellent health before the above-mentioned symptoms. Images show mass-like lesion in the medial side of the right
occipital lobe. At first, the differential diagnosis was broad. These include demyelinating lesion, brain tumor, infarct due to the vasculitis and so on. The laboratory studies including anticoagulant factor were all negative. Myelin basic protein, antibodies against collagen vascular diseases, immunoglobulin, tumor markers also were negative. In the clinical course, the degree of the symptom has been unchanged. No other symptoms were added. Physicians tried to perform steroid pulse therapy, but she showed no improvement. When we review the radiological findings, the diagnosis was considered as the infarct due to DVA. In one month, lesion was markedly decreased without treatment.

Results
Initial computed tomography (CT) shows low density area in the medial side of right occipital lobe. On the initial MRI, the lesion shows high signal on both diffusion-weighted imaging and apparent diffusion coefficient maps. Fluid-attenuated inversion recovery and T2-weighted imaging also show high signal area, which contains radial shaped linear low signal structure. The linear structure which proved to be DVA without drainage vein caused by thrombosis, referring to the susceptibility-weighted imaging and contrast enhanced study.

Conclusions
Developmental venous anomaly is the most frequently encountered vascular lesion noted on routine brain imaging. As DVAs are asymptomatic, treatment is not considered necessary and surgery is not an option because these provide venous drainage of normal brain. Hemorrhage is a well known complication of venous thrombosis and is thought to occur from the thrombosis of the draining vein of a DVA. Nonhemorrhagic infarct is very rare. The etiology of DVA-associated infarcts is thrombosis of drainage vein. The risk is considered as hypercoagulable state, using oral contraceptives and so on, but she had no risk factor. Because at first there is no drainage vein due to the thrombosis, at first we considered the lesion permeates the normal vein, but considering the shape of radical shape, DVA shoud have been considered. From now on, we should consider it when we see the radial-shaped linear structure suggesting vein within the lesion.

KEYWORDS: Developmental Venous Anomalies
DRESS Syndrome with Cerebral Vasculitis. About Two Cases of a Very Rare Entity.

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Purpose
DRESS (drug rash with eosinophilia and systemic symptoms) syndrome is a severe reaction triggered by drugs that manifests as pyrexia and eosinophilia with involvement of the skin and internal organs. We aim to show that DRESS syndrome may be associated with the presence of cerebral vasculitic involvement, which is a concept not very well known in the literature.

Materials and Methods
We describe two cases of DRESS syndrome with cerebral vasculitic involvement.

Results
The first patient is about a 46-year-old caucasian woman who was treated initially for an anaerobic cerebral abscess using 'Ceftriaxone/Flagyl' therapy. Evolution was characterized by improvement of infectious biological markers with occurrence of fever, severe headache and weakness of inferior extremities. At the same time, hot and widespread erythroderma appeared. Increased eosinophil count was found. Severe cholestatic hepatitis also was present. MR imaging (MRI) demonstrated perivascular supra and infratentorial diffuse contrast enhancement. Clinical, biological and imaging evolution was favorable after changing antibiotics and administrating high-dose steroid therapy. The second patient is about a 47-year-old caucasian woman who was treated by 'Minocycline' for an infectious diarrhea. In this case, MRI showed the same pattern of perivascular diffuse contrast enhancement. Furthermore, it demonstrated one hemorrhagic focus on the right semi-oval center and ischemic lesions involving not only borderline vascular territories but also middle and anterior cerebral arteries circulation. Evolution was favorable after high-dose steroid therapy.

Conclusions
The diagnosis of cerebral vasculitis must be considered in patients with DRESS syndrome since it can be reversed completely with high-dose steroid timely treatment.

KEYWORDS: Allergic, Arteriopathy, Stroke

EE-42
6:30AM - 9:00PM

Ectopic Intracranial Germinoma: A case report and review of literature.

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Purpose
We are presenting a case of ectopic intracranial germinoma arising in the corpus callosum and will discuss the imaging features, clinical profile and reported atypical locations.

Materials and Methods
This is a case report of a 24-year-old male who developed progressive insatiable thirst, urinary frequency, impotence, muscle aches and fatigue for one year. Endocrinologic work up revealed panhypopituitarism. MR imaging (MRI) demonstrated three intracranial lesions in the pituitary infundibulum, pineal region and left corpus callosum. The initial differential diagnosis included sarcoidosis, chronic basal meningitis, and possibly germ cell tumor. Stereotactic biopsy was performed of the left corpus callosal lesion and histological examination concluded this mass to be a gerinoma.
Results
Contrast-enhanced MR imaging of the brain demonstrated three enhancing intracranial lesions. There was marked thickening and enhancement of the pituitary infundibulum. A round enhancing solid mass was present in the pineal region. Additionally, there was a cystic and solid lesion in the left corpus callosum with the solid portion showing enhancement. The patient received chemotherapy followed by radiation treatment. Follow-up imaging at three months showed complete resolution of the abnormal enhancement at all three sites with no abnormal enhancement at six month follow up.

Conclusions
Intracranial germinomas preferentially arise in the pineal and neurohypophyseal regions. Less common locations include the basal ganglia and thalami. Germinomas have rarely been reported in the corpus callosum, corona radiata, frontal lobe and temporal lobe. Intra-axial germinoma should be considered in the differential of a young male patient with the characteristic cystic and solid intra-axial mass, especially with concurrent pineal and pituitary infundibular lesions.

KEYWORDS: Germinoma
EE-27 6:30AM - 9:00PM

Enhancing Brain Stones in an HIV Patient: An Unusual Presentation of Toxoplasmic Encephalitis Immune Reconstitution Inflammatory Syndrome (TE-IRIS)

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Purpose
Brain stones or cerebral calculi are uncommon intracranial calculi of sundry etiologies. We present a case of rim-enhancing cerebral calculi in an immunocompromised patient, focusing on the differential diagnosis and important imaging features.

Materials and Methods
A 30-year-old HIV positive female Eritrean refugee with history of traumatic brain injury and seizures presented with three-day history of fever, difficulty walking, and neck stiffness. She started highly active antiretroviral therapy (HAART) three weeks prior, at which point her viral load was 450,000 and CD4 count was 369. Computed tomography (CT) demonstrated multiple calcified parenchymal lesions within the cortical gray matter, subcortical white matter, and left basal ganglia, two of which (parafalcine left parietal lobe and left basal ganglia) demonstrated peripheral enhancement. Marked hypoattenuation of the surrounding white matter was seen. On MRI, lesions were T1 isointense and T2 hypointense, with peripheral enhancement and susceptibility artifact on susceptibility-weighted imaging (SWI). The parafalcine left parietal lobe lesion demonstrated central reduced diffusivity, compatible with an abscess. Confluent T2/FLAIR hyperintensity within the surrounding white matter was compatible with vasogenic edema. Thallium-201 SPECT was negative for radionuclide accumulation within the lesions. In light of the clinical history, the diagnosis of TB-IRIS or TE-IRIS was favored. Lumbar puncture revealed 32 WBC, 71% lymphocytes, normal glucose, and elevated protein. She was started on empiric treatment for possible central nervous system (CNS) toxoplasmosis and subsequently demonstrated positive serum toxoplasma IgG. Symptomatic and imaging improvement were demonstrated with anti-toxoplasma therapy.

Results
Brain stones characteristically demonstrate calcific density on NECT. On MRI, they show markedly low signal intensity on T2-weighted imaging, GRE, and susceptibility-weighted imaging (SWI) without true “blooming” artifact. On T1-weighted imaging, lesions may be iso- or hypointense. Contrast enhancement is variable, depending on the underlying etiology. A compartmental model of intra-axial and extra-axial localization is useful for establishing an appropriate differential diagnosis. Extra-axial brain stones are most commonly neoplastic and may reflect dural osteomas, craniopharyngiomas, meningiomas, rare calcified/ossified tumors/metastases, calcifying pseudoneoplasms of the neuroaxis, or exuberant physiologic calcification. Intra-axial brain stones may reflect neoplastic, infectious, vascular, traumatic, metabolic, or congenital etiologies, which we detail in this presentation. Clinical history, as in this case, is a powerful discriminator for directing an appropriate differential diagnosis.
Conclusions
Cerebral calculi are an uncommon finding with numerous etiologies. Localization of the lesions as intra-axial or extra-axial is useful for establishing an appropriate differential diagnosis. An enhancing brain stone in an HIV+ patient recently started on HAART should raise concern for TE-IRIS or TB-IRIS.

KEYWORDS: Calcifications, Immune Reconstitution Inflammatory, Toxoplasmosis
Materials and Methods
A 23-year-old male patient presented to the ER with a history of heroin abuse, anxiety and attention deficit hyperactive disorder (ADHD). He last was reported to have used heroin six months ago with marijuana use two weeks ago. He was prescribed risperidone and methylphenidate by his therapist for treatment of ADHD. Approximately four days after initiation of treatment, the patient complained of headaches and nausea. He went to bed early that evening, and was found unresponsive the next morning and was brought to the ER. Complete work up was performed for the patient, including an MR imaging (MRI) of the brain. Characteristic imaging features were noted on the MRI, suspicious for heroin-inhaled toxicity. After four days of appropriate treatment initiation however, the patient was found to have developed myoclonic jerks.

Results
MR imaging of the brain revealed extensive areas of white matter signal abnormality representing diffuse encephalopathy. There was restricted diffusion in the supratentorial white matter with a posterior predominance with involvement of the right globus pallidus, splenium and bilateral cerebellar hemispheres. Symmetric T2/FLAIR hyperintensities were noted in the supratentorial white matter predominantly involving the parietal and occipital lobes, bilateral globus pallidi and splenium. Additionally T2/FLAIR hyperintensities were present in the posterior limbs of bilateral internal capsules and cerebellar hemispheres. These findings are characteristic for heroin-inhaled toxicity, also known as chasing the dragon.

Conclusions
An association between leukoencephalopathy and smoking heroin has been recognized for over 25 years, although the exact pathogenesis still is not well understood. In 'chasing the dragon', heroin is placed on a piece of aluminum foil, heated with a flame from below, and the resulting vapor (pyrolysate) is inhaled with a straw or other tube-like structure(1). The stages involved in heroin-inhaled toxicity are: 1.Cerebellar symptoms, 2.Extrapyramidal symptoms, 3.Spasms, mutism and death. These clinically recognized stages are associated with the extent of white matter involvement on MRI(2). There is symmetric spongiform degeneration of the cerebral and cerebellar white matter and corticospinal tracts. Classically on MRI, heroin-inhaled toxicity involves the posterior limbs of bilateral internal capsules and cerebellar white matter. There is symmetric involvement of the supratentorial white matter, with posterior predominance and relative sparing of the cortex and subcortical white matter. The globus pallidi may be involved. Restricted diffusion is noted in the acute phase of the disease. Diffusion-weighted images may reveal hyperintense signal without corresponding ADC drop in the subacute stages.Hypoxic ischemic encephalopathy may have similar imaging features. However there may be associated mild cortical signal, a finding not present in the patients with toxic leukoencephalopathy and periventricular white matter reduced diffusion(3). Involvement of the cerebellum and the posterior limb of the internal capsule, with sparing of the anterior limb helps distinguish it from reversible posterior leukoencephalopathy (4,5). The MRI findings are considered pathognomonic, making MRI important for diagnosis. This is especially true in busy urban emergency departments where a variety of patients may present obtunded, unable or unwilling to provide a useful history(2). In the case of chasing toxicity, prompt initiation of coenzyme Q treatments may limit the extent of disease(6).

KEYWORDS: Leukoencephalopathy
Fat Embolism to the Brain after Traumatic Injury, a case report.

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Purpose

Fat embolism is an uncommon, yet important clinical entity with unique imaging findings. We describe the clinical and imaging findings of a patient with cerebral fat embolism after trauma.

Materials and Methods

The patient is a 17-year-old previously healthy male who was transferred to the emergency department after motorcycle collision. He suffered multiple long bone fractures including bilateral femoral shaft, right distal humeral and bilateral medial malleolar fractures. Upon his arrival, he had a GCS of 15 and stable vital signs. Noncontrast computed tomography (CT) scan of the head at the time of arrival did not show any abnormal findings. Approximately two hours later, while attempting to put him on traction for his femoral shaft fractures, his GCS suddenly dropped to 12. He got unresponsive to verbal stimuli and developed multiple apneic hypoxic episodes for which he was intubated. The patient then was transferred to ICU and remained intubated for seven days. Brain MR imaging (MRI) performed one day after ICU admission revealed bilateral multiple foci of restricted diffusion involving the centrum semiovale, corona radiata, and basal ganglia. Innumerable foci of susceptibility were identified in both supra and infratentorial components on susceptibility-weighted images. After relatively uncomplicated ICU course, he was returned to normal neurologic baseline with a GCS of 15 and subsequently followed by neurology team on an outpatient basis.

Results

Diffusion-weighted image (left) shows multiple foci of restricted diffusion along corona radiata and periventricular white matter. Susceptibility-weighted image (right) reveals numerous punctate foci of blooming artifact due to fat microemboli.

Conclusions

The differential considerations according to history of trauma and brain MRI findings include diffuse axonal injury or fat embolism. However given our patient's normal GCS on arrival and sudden decrease in GCS after attempting to put him on traction and return of the GCS to the baseline after a period of time, fat emboli was the final diagnosis. This case signifies the importance of understanding and interpretation of susceptibility imaging in the trauma setting. Fat droplets like blood products can be dark on susceptibility-weighted imaging and therefore fat embolism should be considered in the proper clinical setting when this finding is present.

KEYWORDS: Fat Emboli, Susceptibility-Weighted Imaging
FDG-PET Findings in Symptomatic Developmental Venous Anomaly: A Potential Pitfall for Malignancy?

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Purpose
To the best of our knowledge FDG-PET imaging findings associated with DVAs have not been reported previously. We report two cases of positron emission tomography (PET) demonstrating increased fluoro-deoxy-glucose (FDG) uptake associated with symptomatic developmental venous anomaly (DVA) on magnetic resonance imaging (MRI).
Materials and Methods
Two separate patients with histories of remote extracranial malignancy developed acute neurologic symptoms and signs suggestive of stroke. Brain MRI and PET imaging of the brain was obtained in close temporal relation. One MRI included a perfusion study. PET imaging was performed to investigate potential metastatic disease.

Results
Both MRI studies demonstrated areas of increased signal on FLAIR and DWI adjacent to a DVA. On subsequent PET, areas of increased scintigraphic activity were identified corresponding to the areas of MR signal abnormality. In case one, perfusion MRI showed increased relative cerebral blood volume (CBV) in the areas of abnormal signal. However, follow-up MR imaging demonstrated distinct volume loss and resolving FLAIR signal abnormality. It was interpreted as resolving ischemic changes rather than tumor. In case two, the DVA drained an area of arterial infarction.

Conclusions
Developmental venous anomalies are the most common intracranial vascular anomaly and are generally benign. Occasionally, symptomatic DVAs with either hemorrhagic or nonhemorrhagic infarction can be seen. A number of mechanisms for clinically symptomatic DVAs have been proposed including diminished venous outflow across the brain parenchyma drained by the DVA, draining vein stenosis, or venous tributary tortuosity. In a number of reported cases, DVAs have been associated with increased regional cerebral blood volume on MR perfusion imaging. However, to the best of our knowledge FDG-PET findings are lacking in the literature. Our findings of apparent hypermetabolism on PET imaging appear paradoxical. In acute ischemia, regions of hypometabolism are expected. However, paradoxical hypermetabolism has been reported in hypoxic-ischemic injury in young children, attributed to glutamatergic excitotoxic injury. Paradoxical hypermetabolism also have been reported in areas of cortical malformations or heterotopia. It is possible that regions of ischemic changes in association with DVAs, as seen in our cases, can have a blood pool effect with concentration of the radiotracer or the regions demonstrate a true paradoxical hypermetabolism (areas of congenitally abnormal brain tissue). This potential association of DVAs and apparent focal brain hypermetabolism represents a previously unrecognized, but potentially important imaging pitfall in the work up of patients with probable malignant disease; warranting further investigation.

KEYWORDS: Developmental Venous Anomalies, MR Imaging Brain, PET
Florbetapir PET Imaging in Cerebral Amyloid Angiopathy

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Purpose
We describe the imaging findings of a patient with a new diagnosis of cerebral amyloid angiopathy, to include F-18 florbetapir PET imaging (Amyvid). We review the pathologic and clinical presentation of cerebral amyloid angiopathy.

Materials and Methods
A 61-year-old presented after a "spell" of vague neurologic symptoms. During this spell he had nearly hit his mailbox making a left turn into his driveway, and subsequently had a minor automobile accident in which he hit a brick pillar in his garage at low speed. Afterwards, he describes several hours of mild confusion. Neurologic examination and electroencephalogram were normal. Lumbar puncture was performed, which showed two nucleated cells and no red blood cells per microliter. CSF protein was 39 mg/dL, and CSF glucose was 48 mg/dL. IgG levels were normal without oligoclonal bands.
Results

(A) Axial gradient recalled echo (GRE) image of the brain shows multiple punctate foci of cortical susceptibility artifact in the right parietal lobe. Hyperintense white matter signal abnormality also is seen in the right parietal lobe, which corresponded to hyperintense signal on T2 and FLAIR sequences (not shown). (B) Axial F-18 Florbetapir (Amyvid) PET image through the brain shows diffuse cortical radiotrace uptake in the frontal and parietal lobes with loss of the normal gray-white matter contrast. Cerebellar reference showed normal uptake with preservation of the gray-white contrast (not shown).

Conclusions

Cerebral amyloid angiopathy (CAA) is characterized by beta-amyloid deposition within the walls of cortical and leptomeningeal cerebral vessels. This beta-amyloid is structurally similar to the amyloid within neuritic plaques of Alzheimer dementia. A less common variant of this condition is cerebral amyloid angiopathy-related inflammation (CAA-RI). These patients typically present with cognitive decline, seizures, and headaches. Unlike patients with noninflammatory CAA, patients with the CAA-RI usually have a significantly improved clinical response to immunosuppressive therapy. The typical MR imaging findings of CAA are cortical and subcortical microhemorrhages and hemosiderin deposition detected by T2* hypointense foci on gradient recalled echo (GRE) or susceptibility-weighted imaging (SWI) sequences. These commonly develop within clusters, and usually predominate in posterior regions of the cerebrum. CAA-RI additionally shows white matter edema signal changes, which also shows a posterior predilection, and may show partial or complete response to immunosuppression. Nuclear medicine PET imaging agents also may be used to demonstrate cerebral beta-amyloid. Florbetapir (Amyvid) is a Fluorine-18-based agent that recently was approved by the U.S. Food and Drug Administration for evaluation of beta-amyloid neuritic plaque density in patients with cognitive decline. Carbon-11 Pittsburg Compound B (C-11-PiB) has been used previously to demonstrate beta-amyloid deposition for both Alzheimer dementia and CAA. F-18 Florbetapir has been shown to be highly correlated with C-11 PiB imaging in patients with Alzheimer dementia. Although it does not have FDA approval in cerebral amyloid angiopathy, Florbetapir and future F-18-based amyloid agents may be helpful in confirming the diagnosis of amyloid angiopathy as well as characterizing the extent of amyloid deposition.

KEYWORDS: Cerebral Amyloid Angiopathy, PET
Hemorrhage occurring within an arachnoid cyst is a rare phenomenon that may be associated with the onset of new symptoms. However, the long term evolution of intracyst hemorrhage has not been well described. Furthermore, the hemorrhage may lead to alterations in the morphology of the cyst. We describe a case of hemorrhage within an arachnoid cyst in patient with epilepsy and the resulting structural evolution of the cyst over time.
Materials and Methods
We report the case of a 35-year-old man with a history of left temporal lobe epilepsy and a left middle cranial fossa arachnoid cyst, measuring 4.0 x 5.0 x 5.0 cm (Figure 1A), who acutely developed headaches after participation in contact sports. His initial neurological examination was unremarkable.

Results
A brain MR imaging (MRI) performed six weeks after the onset of symptoms revealed new intrinsic T1 shortening, consistent with the presence of proteinaceous material, such as hemorrhage, in the arachnoid cyst and a new 1.9cm subdural hematoma along the left cerebral hemisphere. There were differences between the T2 FLAIR signal characteristics of the cyst and the subdural collection, possibly reflecting that the hemorrhages were of different ages (Figure 1B). Furthermore, multiple new septations were observed within the arachnoid cyst. An MRI performed five months later revealed similar findings with continued asynchronous evolution of the blood products within the cyst and the subdural collection. Furthermore, the cyst had decreased in size compared to the baseline scan and now measured 3.5 x 3.9 x 4.4 cm. The size of the subdural collection had also decreased to 1.4 cm.

Conclusions
In our patient, the arachnoid cyst decreased in size following the hemorrhage. Prior reports of posthemorrhagic resolution of arachnoid cysts have been explained by formation of a communication between the cyst and extra-axial spaces leading to drainage of the cyst contents into surrounding spaces. However, in our case, there was no evidence of such a communication. Furthermore, if there were rupture of the cyst into the surrounding extra-axial spaces, one would expect a rapid decrease in the size of the cyst. Rather, serial imaging revealed gradual contraction of the arachnoid cyst, which was not noted until several months after the initial hemorrhage. One also would expect the signal characteristics of the fluid to be identical within the cyst and the adjacent extra-axial fluid collection. In our case, these diverged with time. Another possible explanation is the development of intracyst adhesions as a consequence of evolution and organization of the hematoma. As the hematoma itself contracted, the cyst walls tethered to it were pulled inward as well. This hypothesis is supported by the fact that septations were noted within the shrinking cyst. In this report, the subdural component displayed higher T2 FLAIR signal than the cyst. This may be explained by the possibility that the hemorrhages were asynchronous events. Alternatively, the differences in evolution of the hemorrhages may depend on differences in the chemical compositions of intracyst fluid and the subdural collection. Ultimately, the evolution of hemorrhage within arachnoid cysts likely depends on a multitude of factors, including both the mechanism of hemorrhage and the composition of the cyst. Further investigation of the structure and physiology of arachnoid cysts may elucidate the etiology of intracyst hemorrhages and their sequelae. This knowledge may allow for anticipation of complications associated with intracyst hemorrhages and provide an avenue for potential prophylactic intervention.

KEYWORDS: Arachnoid Cyst, Hemorrhage
Hemorrhagic Venous Infarction in a Patient with an Enlarged Developmental Venous Anomaly and New Apparent Stenosis of the Distal Outflow Vein.

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Purpose
Stenosis of the outflow vein of a developmental venous anomaly (DVA) has been proposed as a mechanism whereby isolated DVAs cause hemorrhagic venous infarction. We describe the imaging of a patient who presented with an acute hemorrhagic venous infarction in the setting of apparent new outflow stenosis of a known DVA. We then discuss other relevant current concepts of DVAs. Additionally, our patient had multiple sclerosis (MS), and initial clinical presentation and imaging mimicked MS flare; we discuss imaging features that help distinguish the two entities.

Materials and Methods
A 34-year-old female with rapidly progressive MS and a known DVA was admitted after experiencing right arm paralysis and right leg weakness for one day, unable to ambulate.
Intravenous steroids and plasmapheresis were initiated for a presumed MS flare. Subsequent MR imaging (MRI) revealed a venous infarction and new apparent stenosis of the outflow vein of the DVA. The patient was treated with heparin and transitioned to warfarin and improved over several days. She regained near full-strength of her right lower extremity and was able to ambulate with assistance. She was transferred to an acute rehabilitation facility in stable condition.

Results
MR imaging three months prior to admission demonstrated an uncomplicated left frontoparietal DVA draining into the left lateral thalamostriate vein. The DVA was uniform in caliber throughout its course. MR imaging after admission showed new heterogeneous T2 hyperintense signal along the course of the DVA with surrounding vasogenic edema. On sagittal FLAIR images, ovoid high signal was oriented perpendicular to the lateral ventricle. There was no peripheral leading edge of enhancement. The DVA (Figure 1A arrow) was increased in size proximally compared to the prior study. New multifocal ill-defined, serpentine parenchymal enhancement along the course of the DVA (Figure 1A arrowheads) was compatible with venous congestion. Same day follow-up MRI was performed to include susceptibility-weighted imaging (SWI) and MRV. Low signal on SWI was consistent with petechial hemorrhage. MRV images demonstrated a new apparent distal stenosis of the draining vein (Figure 1B arrow). Together, findings were interpreted as hemorrhagic venous infarction possibly caused by a new stenosis of the draining vein of the DVA.

Conclusions
Our case supports the concept that outflow vein stenosis is a mechanism whereby DVAs cause hemorrhagic venous infarction. We illustrate a DVA with a new apparent stenosis of the outflow vein with associated venous infarction, with no stenosis or venous infarction on imaging three months prior. Absence of a leading edge of enhancement and presence of petechial hemorrhage supported venous infarction rather than tumefactive MS. The patient improved after thrombolytic therapy.

KEYWORDS: Developmental Venous Anomalies, Multiple Sclerosis, Venous Infarction
High-Grade Dural Arteriovenous Fistula Causing Subarachnoid Hemorrhage with Direct Visualization of the Rupture Site on CT Angiography.

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Purpose
We describe the CT angiographic (CTA) detection of a subarachnoid venous rupture site downstream to a high grade dural arteriovenous fistula (dAVF). CT angiography has replaced conventional digital subtraction angiography (DSA) as the first line angiographic work up of acute subarachnoid hemorrhage in most centers but lacks hemodynamic information compared to MR angiography (MRA) and DSA. This case also illustrates the risk of developing multiple separate dAVFs subsequent to a dural sinus thrombosis.

Materials and Methods
Case Presentation: A 52-year-old right-handed female presented with sudden onset thunderclap
headache, mild drowsiness. Her past medical history was significant for superior sagittal sinus and left transverse sinus venous thrombosis diagnosed in 2008 with repeat sinus venous thrombosis after discontinuing warfarin. Routine coagulopathy screening was negative and she was placed on lifelong warfarin for a presumed coagulopathy. At this presentation, her International Normalized Ratio (INR) was 3.6, which was rapidly reversed. Noncontrast CT brain demonstrated left sylvian subarachnoid hemorrhage and adjacent small discrete left temporal parenchymal hemorrhage. Subsequent CTA showed “arterialized” opacification of an ectatic left superficial middle cerebral vein harboring a prominent saccular outpouching, with a narrow neck favoring pseudoaneurysm over varix. Conventional angiography confirmed a Cognard 2b dAVF centered on the wall of a previously thrombosed and isolated left transverse sinus (TS) segment and draining via the left vein of Labbé and the sylvian vein with a patent pseudo aneurysm. The main arterial supply was from the left middle meningeal artery (MMA) but with contributions also from the left occipital artery, contra lateral MMA and occipital arteries as well as posterior and falx cerebelli meningeal supply arising from the left vertebral artery. A Marathon Micro Catheter (EV3 Irvine, CA) was advanced via the left MMA close to the fistulous network on the dural surface and a total of 4 ml of Onyx-34 (EV3, Irvine CA) was injected with complete penetration of the fistulous network and filling of the isolated fistulized segment of the left TS. A follow-up angiogram two months later showed no recurrent fistula. She subsequently underwent elective embolization and obliteration of the unruptured right orbitofrontal fistula. She will continue surveillance with time-resolved MR angiography (MRA) and time-of-flight (TOF) MRA.

Results

Figure 1: Presenting noncontrast CT head (A) shows subarachnoid hemorrhage in the left sylvian fissure with a more discrete clot over the temporal lobe (arrow) and an axial CTA slice (B) demonstrates a corresponding saccular out pouching (arrow) arising from the left sylvian vein, with size and configuration more consistent with venous pseudo aneurysm than varix.

Conclusions

CT angiography is widely available and provides a rapid, noninvasive assessment in acute intracranial hemorrhage. In the setting of a ruptured dAVF, a discrete pseudo aneurysm should indicate the site of rupture and for a target for treatment. As we demonstrated, the principle goal of treatment is to relieve the ruptured vein of the arterial pressure resulting from the fistula and does not require embolic occlusion of the rupture site itself. Venous pseudonaeurysms should not be confused with the so-called "spot sign", a small (1-2 mm) focus of enhancement on CTA within parenchymal hematomas and extra-axial lesions such as subdural hematomas, which essentially represents a discrete microvascular extravasation without containment as in a pseudoaneurysm. In the setting of DAVF and SAH, careful analysis of the emergent CTA may reveal the exact rupture site as represented by a pseudoaneurysm arising from an arterialized vein. The treatment goal should be to disconnect the arterialization of the ruptured vein, with penetration to the venous side to reduce recurrences, but does not require casting of the rupture site itself.

KEYWORDS: Arteriovenous Fistulas, CT Angiogram
Imaging findings in a patient with PML-IRIS after the discontinuation of Tysabri for the treatment of multiple sclerosis.

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Purpose
Progressive multifocal leukoencephalopathy (PML) is a known complication of patients on Tysabri (natalizumab) for the treatment of relapsing and remitting multiple sclerosis. Withdrawal of this drug subsequently can result in immune reconstitution inflammatory syndrome (IRIS), similar to that seen in HIV patients who recently have started HAART therapy. The purpose of this exhibit is to create awareness of the entity so that a prompt diagnosis can be made and the appropriate treatment be started.

Materials and Methods
A 61-year-old female with a long history of relapsing and remitting multiple sclerosis on treatment with Tysabri (natalizumab). The patient presented with worsening fluctuating symptoms of right hand weakness and loss of coordination with a contrast-enhanced MR imaging (MRI) of the brain at that time demonstrating relative stability in the patient's size and
number of demyelinating plaques, as compared to the prior examination. There was no MR evidence of progressive multifocal leukoencephalopathy (PML) on the initial exam. A lumbar puncture performed at the time of presentation was positive for JC-virus. A diagnosis of PML subsequently was made and the Tysabri was discontinued. The patient presented again six weeks later with worsening neurologic symptoms. Contrast-enhanced MRI of the brain at that time demonstrated new areas of nodular and curvilinear enhancement, as well as worsening FLAIR signal hyperintensity in the white matter. The imaging findings in conjunction with the patient's clinical symptoms were most suggestive of progressive multifocal leukoencephalopathy-immune reconstitution inflammatory syndrome. Corticosteroid therapy subsequently was started and the patient's symptoms have since markedly improved.

Results

MR imaging findings in the first set of images (Figure A) demonstrate patchy areas of flair signal hyperintensity in the white matter compatible with the patient's history of multiple sclerosis. No associated enhancement was seen. MR imaging performed six weeks later (Figure B) after the discontinuation of Tysabri demonstrated new nodular and curvilinear areas of enhancement with worsening FLAIR signal hyperintensity in the white matter, as well as subtle mass effect, compatible with IRIS. Cerebrospinal fluid (CSF) analysis was positive for JC virus at the time imaging was performed.

Conclusions

Tysabri is a monoclonal antibody that prevents binding of leukocytes to the endothelium of brain vasculature and their subsequent migration and attack on the central nervous system. Progressive multifocal leukoencephalopathy secondary to JC virus is a known complication of patient's on Tyasbri (natalizumab) from immunosupression. After discontinuation of therapy, there is improved cellular immunity with a resultant response to a pre-existing infection, which if flagrant, will cause an immune reconstitution inflammatory syndrome (IRIS). This entity should not be confused with relapse or worsening of the already existing infection. On imaging, new nodular and curvilinear areas of enhancement and worsening FLAIR signal hyperintensity in the white matter, as well as subtle mass effect, are highly suggestive of IRIS in a patient with recent discontinuation of Tysabri. These patients often will present with paradoxical worsening of neurological symptoms, and prompt treatment with corticosteroids may aid in clinical recovery.

KEYWORDS: Immune Reconstitution Inflammatory, Multiple Sclerosis, PML
Intracranial Extraskeletal Chondrosarcoma Mimicking A Meningioma.

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Purpose
To describe the clinical presentation and imaging findings of an unusual primary intracranial extraskeletal chondrosarcoma, which mimicked a meningioma on pre-operative MR imaging (MRI).

Materials and Methods
The patient is a 41-year-old female who presented to the emergency room with an acute TIA-like spell, including scintillating scotomas, numbness involving the bilateral fingertips, and word-finding difficulties. The episode spontaneously resolved. An MRI was performed for further evaluation, and revealed an extra-axial dural-based mass along the tentorium, with the working diagnosis of meningioma. Surgery confirmed origin of the mass along the superior aspect of the left tentorium cerebelli. The intra-operative appearance of the tumor was noted to be unusual and gross total excision was obtained; intra-operative histology confirmed a tumor of cartilaginous origin. A metastatic work up of the rest of the body demonstrated no abnormality. Final pathologic diagnosis was a low grade primary intracranial extraskeletal chondrosarcoma.

Results
MR imaging of the head demonstrated a low T1 and heterogenous T2 signal extra-axial, enhancing lesion along the left tentorium, with no edema in the adjacent parenchyma. No foci of low signal were seen on susceptibility-weighted images to suggest calcification, and there were no areas of restricted diffusion.

Conclusions
Primary intracranial chondrosarcoma is a rare neoplasm. Chondrosarcomas can arise from bone, cartilage, or mesenchymal soft tissue. Due to its close association with the dura and similar MRI characteristics, the imaging findings can lead to the misdiagnosis of meningioma. Correct diagnosis is important because of treatment/management differences; chondrosarcoma is relatively insensitive to radiation treatment, has a propensity for dissemination at the time of surgery, and has a greater rate of local recurrence.

KEYWORDS: Chondrosarcoma, Dural, Meningioma
Intracranial Hemorrhage Following Spinal Surgery-Related CSF Leak, an Important Mimiker of PRES.

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Purpose
We present two cases of intracranial hemorrhage (ICH) following spinal surgery in which large dural cerebrospinal fluid (CSF) leaks were present, an uncommon but known complication. These cases show intriguing intracranial imaging findings as a result of extreme, acute intracranial hypotension (IH) in which signal abnormalities mimic posterior reversible encephalopathy syndrome (PRES) and may help support a venous pathophysiologic cause of vasogenic edema and remote cerebellar hemorrhage (RCH).
Materials and Methods
Case 1. A 64-year-old woman underwent resection of recurrent sacral chordoma. Postoperative day three (POD#3), there was high lumbar surgical drain output and the patient experienced altered mental status and seizure activity. MR imaging (MRI) of the brain showed intracranial hemorrhage. Myelography confirmed a large pseudomeningocele, at the site of recurrence resection. The pseudomeningocele was repaired and the intracranial hemorrhage was managed medically. Case 2. A 58-year-old woman with prior L4-S1 posterior spinal fusion (PSF) underwent elective, uncomplicated removal of the L4-S1 PSF hardware with decompression and PSF of L3-L4 for recurrent back pain. POD#3 the patient had nausea and vomiting with positional headache and large volume lumbar surgical drain output. MR imaging of the brain showed intracranial hemorrhage. An MRI of the lumbar spine showed a dorsal dural defect. The defect was repaired and the intracranial hemorrhage managed medically.

Results
Case 1. Brain MRI, GRE showed bifrontal, parietal, temporal, putamen and cerebellar hemorrhage. T2 and FLAIR images demonstrated cortical and subcortical hyperintensity, separate from the areas of hemorrhage, in all cerebral hemispheres, with thick pachymeningeal enhancement. Of note, there was a relative lack of brain stem slumping and no subdural hemorrhage. Lumbar spine MRI showed a large CSF intensity fluid collection in the subcutaneous tissues at the operative site in the lumbar spine. This filled with contrast at myelography, confirming a connection with the thecal sac. Case 2. Brain MRI, GRE showed cerebellar and putamen/globus pallidus hemorrhage, and patchy T2/FLAIR hyperintensity in the cortical and subcortical hemispheric white matter, the bilateral caudate heads, and thalami. There were small bilateral subdural hemorrhages, diffuse pachymeningeal enhancement, and crowding of the perimesencephalic and prepontine cisterns. Lumbar spine MRI demonstrated a dorsal dural defect with an associated CSF intensity collection containing neural elements dorsal to the lumbar spine at the site of PSF.

Conclusions
Each of these cases show marked vasogenic edema in a pattern commonly associated with PRES, however, in the clinical setting of intracranial hemorrhage with large CSF leaks following spinal surgery. There is presumed profound intracranial hypotension and there are imaging findings to support that etiology. To our knowledge, this is the first report of PRES-like imaging features in this clinical scenario. There are case reports of central brain structure vasogenic edema in IH as well as one case report of more classic PRES-like findings in the setting of IH. A case of cerebellar hemorrhage with IH was reported, and PRES with ICH and IH in a post partum patient has been reported. There is a postulated venous congestion theory with respect to IH rooted in the Monro-Kelli hypothesis; however, most patients with IH present with chronic, compensated physiology. Decreased subcortical FLAIR signal intensity due to parenchymal deoxyhemoglobin has been shown in IH. In our cases, the rapid pressure changes with acute CSF loss and venous hypervolemia likely resulted in venous congestion, vasogenic edema and hemorrhage. These findings also help to support a venous cause etiology of the PRES-like appearance and RCH post spinal surgery with dural CSF leak. Practitioners should be aware of imaging findings in the setting of RCH and IH that mimic PRES, and if the clinical scenario warrants, search for CSF leak.

KEYWORDS: Hemorrhage, Intracranial Hypotension, Posterior Reversible Encephalopathy
Intraosseous Hemangioma of the Middle Turbinate: Case Report of a Rare Entity and Review of the Literature

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Purpose
Hemangiomas are ubiquitous benign vascular tumors or malformations commonly seen within the head and neck region. Lesions arising within the nasal cavity and paranasal sinuses are uncommon, and intraosseous hemangiomas arising from the nasal turbinate are exceedingly rare with only a few reported cases in the literature. We present a case of an intraosseous hemangioma of the middle turbinate with both computed tomography (CT) and MR imaging (MRI), and histologic correlation. While the nasal turbinate is a rarely reported site of occurrence, the characteristic imaging appearance of this intraosseous hemangioma allowed the correct diagnosis to be proposed prospectively by the interpreting neuroradiologist which had direct clinical and surgical implications. We believe the neuroradiology community would benefit from our experience through this case report presentation.

Materials and Methods
A 61-year-old male was referred to our otorhinolaryngology department for intermittent right epistaxis for approximately two - three years. Sinonasal endoscopy revealed a right nasal cavity mucosal ulceration, likely responsible for the epistaxis. On the left, edematous intact nasal mucosa was noted between the left middle turbinate and nasal septum. Subsequent sinus CT and MRI demonstrated an expansile left nasal cavity mass. Imaging features (as described below) suggested a benign lesion, and intraosseous hemangioma was included within the differential diagnosis on the basis of internal bony trabecular network seen at CT. The patient underwent uncomplicated, complete endoscopic resection of the mass which was confirmed to represent an intraosseous cavernous hemangioma of the middle turbinate pathologically. Patient did well postoperatively without recurrent symptoms at follow up.

Results
Sinus CT demonstrated a 3.6 cm expansile left nasal cavity mass with internal honeycomb bony trabeculations causing secondary remodeling of the left maxillary antrum, medial orbital wall, and rightward deviation of the nasal septum. The mass obstructed the left frontal sinus outflow
tract. Subsequent MRI, performed for assessment of lesion vascularity and operative planning, demonstrated the mass to be T2 hyperintense and T1 hypointense. The mass avidly enhanced postcontrast but lacked internal "flow-voids," allaying concerns of hypervascularity and obviating the need for pre-operative embolization. The CT and MR appearance was suggestive of an intraosseous nasal cavity hemangioma, confirmed to be arising from the middle turbinate both intraoperatively and histologically. Representative sagittal bone window CT image and coronal T1-weighted postgadolinium MRI image are shown below.

Conclusions
Hemangiomas are uncommon within the nasal cavity and paranasal sinuses, making up less than 20% of benign nasal cavity lesions. Nasal cavity and paranasal sinus hemangiomas most frequently originate from the mucosa, and are rarely intraosseous with few cases arising from the nasal turbinate previously reported. Despite this unusual location, the characteristic CT and MR appearance suggested this diagnosis and was in keeping with intraosseous hemangiomas found elsewhere in the musculoskeletal system. Additional diagnostic considerations for a nasal cavity mass with internal calcifications would include squamous cell carcinoma, sinonasal undifferentiated carcinoma, inverted papilloma, ossifying fibroma, esthesioneuroblastoma, and chondrosarcoma. While a differential diagnosis typically is required when encountering a nasal cavity mass, the internal honeycomb trabecular network present in our case allowed for confident diagnosis of intraosseous hemangioma, thereby avoiding unnecessarily aggressive treatment for this benign lesion.

KEYWORDS: Hemangioma, Intraosseous, Nasal Mass
Intravascular B cell lymphoma: A diagnostic challenge

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Purpose
To demonstrate the diagnostic difficulties in a case of intravascular B cell lymphoma presenting with a progressive multifocal neurological syndrome and multifocal radiological lesions.

Materials and Methods
A 66-year-old male retired mail worker of Indian origin presented to the neurology clinic with progressive diplopia, ataxia, muscle wasting and lower limb weakness. Examination revealed right internuclear ophthalmoplegia, limb wasting, fasciculations, proximal leg weakness, ataxia and impaired sensation to the knees. The patient had emigrated to the UK in his 20s and had recently travelled to rural India and Kenya. Past history included diabetes, Crohn's disease and cervical lymph node tuberculosis. He was taking regular Azathioprine. Viral, immunological and inflammatory markers were unremarkable. Tests for TB were negative. Nerve conduction studies were consistent with a polyneuropathy with demyelinating features. MR imaging (MRI) brain revealed multiple infra- and supratentorial lesions with mild enhancement of some of the lesions. Spine MRI spine showed abnormal high T2 signal in the conus medullaris and enhancement of the left cauda equina, unusual rounded lesions in the left L2 and L3 transverse processes, and paraspinal soft tissue edema. Differential diagnosis included neoplasia including lymphoma, infection including TB, and inflammatory conditions such as neurosarcoidosis. Skin and bone biopsy and CT body were negative. The patient was started on Prednisolone which improved his symptoms and radiological findings. Three months later, he was admitted to hospital after a fall. Examination revealed flaccid paraparesis and marked apathy. This coincided with a reduction in dose of Prednisolone from 60 mg od to 40 mg od. During admission, the patient declined rapidly and required ICU admission. He developed 'pin-pong gaze', indicative of bilateral hemispheric damage. The patient continued to decline and died eight weeks later. Post-mortem examination revealed intravascular B cell lymphoma.

Results
Noncontrast CT brain was normal. STIR sequences demonstrated left paraspinal soft tissue edema at L2-L3 level (not shown). Axial and sagittal T1+C sequences showed unusual rounded left L2 (left image) and L3 transverse process lesions and asymmetric left cauda equina nerve root enhancement. T1+C sequences of the brain postcontrast demonstrated a subtly enhancing left corpus callosum lesion (right image) and further multifocal subtly enhancing infra- and supratentorial lesions (not shown).

Conclusions
This case demonstrates diagnostic difficulties which may be encountered in intravascular B cell lymphoma. Radiologists should include intravascular B cell lymphoma in the differential diagnosis in patients with a multifocal neurological syndrome and multifocal lesions of the neuraxis.
Intraventricular Obstructive Hydrocephalus and Subependymal Nodules; a Case of Anaplastic Astrocytoma with Subependymal Spread.

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Purpose
Subependymal lesions have a variety of etiologies including inflammatory, congenital and
neoplastic causes. We present an unusual case of anaplastic astrocytoma presenting with intraventricular obstructive hydrocephalus and multiple subependymal masses.

Materials and Methods
A 66-year-old female with past medical history of sarcoidosis and diabetes presented to the emergency department with headache, gait imbalance, visual disturbance and difficulty concentrating. Neurological physical examination showed no abnormality. A noncontrast computed tomography (CT) of the head was obtained in the ER and based on the results, an MR imaging (MRI) of the brain with contrast subsequently was performed. The patient underwent additional work up in the outpatient setting, although her condition continued to deteriorate. She was admitted to the hospital a few weeks later with altered mental status and underwent ventriculostomy placement. This was followed by endoscopic third ventriculostomy with biopsy of the third ventricular mass and left lateral ventricular subependymal lesion. Histopathology of the biopsy specimens revealed both lesions to be consistent with anaplastic astrocytoma WHO grade 3. The patient underwent treatment with radiation and concurrent Temodar.

Results
The initial noncontrast CT examination of the brain demonstrates enlargement of the lateral and third ventricles with periventricular low attenuation consistent with transependymal cerebrospinal fluid (CSF) flow. An ill-defined hyperdense lesion is seen in the posterior third ventricle. Additionally, four hyperdense subependymal nodules are seen in the lateral ventricles ranging in size from 6 mm to 15 mm. MR imaging examination of the brain with contrast confirms obstructive hydrocephalus with transependymal CSF flow on FLAIR imaging. An ill-defined nonenhancing lesion is seen in the posterior third ventricle with isointense T1 and mildly increased T2 and FLAIR signal. The MRI also confirmed multiple subependymal nodules in the lateral ventricles show patchy enhancement and are isointense on T1 and T2.

Conclusions
The differential diagnosis of multiple subependymal nodules includes neoplastic, congenital and inflammatory conditions. We present an unusual case of anaplastic astrocytoma presenting with a third ventricular mass causing acute obstructive hydrocephalus and multiple subependymal nodules.

KEYWORDS: Anaplastic Astrocytoma, Obstructive Hydrocephalus, Subependymal
Intraventricular Pilomyxoid Astrocytoma: Unusual Presentation of Rare Tumor.

S Thota

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**Purpose**

**Case Report**

**Materials and Methods**

A 11-year-old female presented to the emergency room with uncontrollable nausea and vomiting. In the ER, she became very lethargic and later developed seizure with generalized tonic movements. Her neurological exam demonstrated dilated pupil on the right side. Stat computed tomography (CT) of her head showed a large right intraventricular lesion with acute hydrocephalus. Significant midline shift and uncal herniation was noted. An emergent external ventriculostomy was placed in the ER and she was taken urgently to the operating room for resection of the intraventricular lesion. Patient underwent right parietotemporal craniotomy.
Brain appeared very tense after the flap was elevated and the dura irrigated. Blood clot and tumor were identified upon entering the right lateral ventricle in the region of trigone. The tumor was resected in small pieces using suction and bipolar dissection. The tumor was followed into the temporal horn. The tumor was resected until the ependymal liming was seen. Intra-operative ultrasound was used to confirm that there is no gross residual tumor present. As the brain was pulsatile after the tumor was resected and did not seem to be under pressure, bone flap was placed back.

Results
Emergent noncontrast CT head demonstrated 6.0 x 3.4 x 2.0 cm lobulated heterogenous, predominantly hyperdense intraventricular mass with intraventricular hemorrhage. The lesion is centered around the trigone of the right lateral ventricle with extension into the body and temporal horn of the lateral ventricle. Hyperdense material also was identified within the third ventricle which may represent hemorrhagic tumor or hemorrhage. Associated vasogenic edema was noted in the peritrigonal white matter. Four mm leftward midline shift was noted.

Conclusions
Pilomyxoid astrocytomas were described fairly recently as biological relatives of the more common pilocytic astrocytoma with which it shares many histopathological features. Pilomyxoid astrocytomas however, are notable for their abundant myxoid matrix and the tendency of their cellular constituents to arrange themselves agiocentrically forming pseudosarette. PMAs are known to perform less favorably than pilocytic astrocytomas, with higher rate of recurrence and leptomeningeal dissemination. Accordingly, they have been designated as grade 2 in the most recent WHO classification scheme.

KEYWORDS: Astrocytoma

EE-04

Intraventricular Schwannoma: A Rare Cause of Ventricular Entrapment.

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Purpose
We present a rare case of an intraventricular schwannoma in a 20-year-old male.

Materials and Methods
A 20-year-old male presented with a two-year history of intermittent blurry vision and a burning sensation involving the top of his head, which had increased in frequency and intensity over the past several months. Physical exam did not reveal any physical abnormalities or neurologic deficits. Initial evaluation with MR imaging (MRI) demonstrated an enhancing right-sided intraventricular mass. The patient underwent complete tumor resection through a right-sided transparietal approach with a right parietal craniotomy. A light pink, well-encapsulated mass, adherent to the medial ventricular wall, was removed. Pathologic analysis revealed a S100-positive tumor which was rich in reticulin and type IV collagen, consistent with a schwannoma.

Results
Contrast-enhanced brain MRI revealed a 2.6 x 2.1 x 1.9 cm T1 and T2 hypointense mass centered within the atrium of the right lateral ventricle. There was a large amount of T2-FLAIR
signal within the adjacent white matter of the right parietal and temporal lobes, consistent with edema. Dilatation of the temporal horn of the right lateral ventricle was consistent with ventricular entrapment. Susceptibility artifact was suggestive of calcification. After administration of gadolinium, the mass demonstrated homogeneous enhancement.

Conclusions

Schwannomas associated with peripheral nerves account for 8% of all intracranial neoplasms. Intraventricular schwannomas are rare neoplasms with only 23 cases previously reported. These lesions most often are found in the lateral ventricles (70%) but also can be located in the fourth (26%) and third (4%) ventricles and most often are seen in males (65%). Intraventricular schwannomas have been found in a wide range of age groups, 7 to 78 years of age, with a median age of 31. The most common presenting symptom is headache with or without nausea and vomiting, although lesions may be asymptomatic (detected due to papilledema seen on ocular exam). They also may present with visual changes, neurological deficits, or seizures. These lesions are most often benign, with only two malignant cases being reported. Although a definite etiology has not been determined, theories include neoplastic transformation of pluripotent mesenchymal cells into Schwann cells, neoplastic transformation of ectopic neural crest cells from disorganized embryogenesis, or hyperplastic transformation of Schwann cells from the peripheral nerve fibers located within the choroid plexus. Inclusion of schwannoma in the differential diagnosis for intraventricular lesions is important as these lesions may lead to life-threatening complications such as hydrocephalus, but often can be treated successfully with total surgical resection.

KEYWORDS: Neoplasm, Schwannoma, Ventricles
Isolated Intra-Axial Langerhans Cell Histiocytosis: An Unusual Presentation of an Uncommon Disorder

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Purpose
Langerhans cell histiocytosis (LCH) is a rare disease, which can present with a broad range of clinical and radiologic manifestations. Although involvement of the central nervous system (CNS) is not uncommon, lesions are typically extra-axial with secondary involvement of the cerebral parenchyma. This excerpt describes an unusual presentation of LCH as an isolated intra-axial lesion.

Materials and Methods
We present a case of a 31-year-old male presenting with a recent history of frontal headaches and new onset partial-complex seizures. The patient was otherwise neurologically intact without
evidence of focal neurologic deficit. Following imaging evaluation, the patient underwent a right pterional temporal osteoplastic craniotomy with microsurgical debulking and subtotal resection of the intraparenchymal lesion. No lesion was seen to originate from the meninges of the middle cranial fossa. Pathology demonstrated a nodular infiltrate of atypical epithelioid histiocytes. Within the histiocytic nodules were occasional multinucleated giant cells, many polymorphonuclear neutrophilic granulocytes and abundant eosinophils. Immunohistochemical staining was strongly and diffusely positive for CD1a and S100 protein. Findings were consistent with LCH. Following surgery, the patient reported improvement in headaches without seizure recurrence.

**Results**

Head computed tomography (CT) demonstrates a large area of vasogenic edema within the right temporal lobe with an intact adjacent calvarium. Contrast-enhanced MR of the brain demonstrates a T2 heterogeneous, avidly enhancing and infiltrative lesion within the right temporal lobe with marked surrounding vasogenic edema.

**Conclusions**

Langerhans cell histiocytosis is a rare disease, which can present with a broad range of clinical and radiologic manifestations. The disease process, which is of unknown cause, is a dendritic cell-related disorder characterized by tumor and tumor-like masses composed of histiocytes. Manifestations of LCH in the central nervous system (CNS) can have a variety of imaging presentations, including involvement of the hypothalamic-pituitary axis, which is the most commonly involved intracranial site. Other imaging patterns include neurodegenerative gray-matter changes in the cerebellum, leukoencephalopathy-like pattern changes in the white matter, meningeal lesions and choroid plexus lesions. Isolated intra-axial LCH lesions without extracranial involvement are rare; however, the diagnosis should be considered in young patients presenting with isolated intra-axial lesions demonstrating marked vasogenic edema.

**KEYWORDS:** Intraaxial, Langherans Cell Histiocytosis

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Isolated Involvement of the Substantia Nigra in West Nile Virus Encephalitis

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Purpose
West Nile virus (WNV) is a well known cause of encephalitis, and demonstrates variable findings on brain imaging. We report a case of West Nile virus encephalitis with an MR imaging (MRI) of the brain showing isolated involvement of the bilateral substantia nigra. Although involvement of the substantia nigra in conjunction with other sites has been reported previously in patients with WNV encephalitis, isolated involvement has not. We also review the clinical presentation and imaging findings of West Nile virus encephalitis as well as the differential diagnosis for the imaging findings seen in this case.

Materials and Methods
A 55-year-old man with multiple comorbidities was admitted to the hospital with a four-day history of abdominal pain, fever, and altered mentation. Laboratory analysis showed marked leukocytosis with 80% lymphocytes. Bone marrow biopsy revealed chronic lymphocytic leukemia, a new diagnosis. Evaluation for infection and broad-spectrum antibiotic coverage were initiated. Over the first several days, the patient progressively deteriorated neurologically. Computed tomography (CT) of the head with and without intravenous contrast was negative. The patient continued to have intermittent fever despite broad-spectrum antibiotic coverage. No clear source of infection was discovered. Results of HIV testing were negative. On hospital day seven, lumbar puncture was performed, showing results suspicious for viral meningitis. The patient's mental status continued to wax and wane. On hospital day 13, the infectious disease service was consulted because of persistent fever and abnormal findings on repeat LP. Brain MRI showed abnormally increased signal in the substantia nigra on T2-weighted and FLAIR images. On hospital day 15, West Nile virus serology was positive in both the cerebrospinal fluid and serum. The patient was given supportive therapy for West Nile virus encephalitis, and was discharged 4.5 weeks later neurologically intact.

Results
Computed tomography of the head with and without intravenous contrast performed on hospital day five was negative. MR imaging of the brain with and without intravenous contrast performed on hospital day 14, showed increased signal in the substantia nigra bilaterally on FLAIR and T2-weighted sequences, and no other abnormalities.

Conclusions
We report a case of West Nile virus encephalitis with isolated involvement of the substantia nigra on MRI. Imaging findings of West Nile virus encephalitis are nonspecific, but include abnormally increased signal in the deep gray nuclei, brainstem, and cerebral white matter on T2-weighted images. Hyperintensity in the substantia nigra on T2-weighted images should suggest the possibility of WNV encephalitis or other flavivirus encephalitis.

KEYWORDS: Encephalitis, Substantia Nigra
Low Grade Tumor Arising in Focal Cortical Dysplasia: Understanding the Spectrum of Pathology Through Examples of a New Subtype (IIIb)

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Purpose
To present two cases of low grade tumor arising in focal cortical dysplasia (FCD) in adult patients, and review the new International League Against Epilepsy (ILAE) classification system of FCDs.

Materials and Methods
Case 1. A 38-year-old man had an MR imaging (MRI) to evaluate tension headaches that discovered an abnormality in the left superior parietal lobule read as "nonenhancing infiltrating glioma." His headaches never returned, and the patient remained asymptomatic during MRI monitoring for one year. Due to concern for tumor, the lesion was resected. Case 2. A 50-year-old woman with history of migraines presented with visual changes, left hand paresthesias, nausea, and imbalance. Her MRI revealed a left parietal lobe lesion, which was subsequently resected. In both cases, surgical pathology demonstrated low grade neoplasm arising in focal cortical dysplasia. Histologic evaluation revealed cortical dyslamination, dysmorphic neurons, and ectopic neurons (arrowheads) in the white matter with abundant balloon cells (arrows) in both gray and white matter, consistent with FCD. Additionally, the parenchyma was hypercellular due to an atypical, neoplastic astrocytic population (circles), consistent with a low grade tumor (Figure 1a).
Results
In both cases, a 1 to 2 cm nonenhancing left parietal T2/FLAIR hyperintense lesion with blurring of the gray-white junction was identified. Gyral expansion suggested a low grade tumor. T2/FLAIR hyperintensity in the subcortical white matter tapering towards the ventricle suggested FCD (Figure 1b).

Conclusions
The imaging, surgical and pathological features of two cases of FCD type IIIb lesions are presented. Focal cortical dysplasia is the most common neuropathological finding in surgical specimens from drug-resistant epilepsy patients. Focal cortical dysplasia is uncommon in older and nonepileptic patients. Low grade tumor arising in FCD in adults is particularly rare. MRI imaging is excellent for detection of these lesions. However, distinguishing a low grade primary neoplasm, FCD, and/or their combination is challenging for radiologists and pathologists. To allow for accurate diagnosis, radiologists must include FCD type IIIb in the imaging differential diagnosis to inform surgeons and pathologists when there is a possibility of multiple abnormal cell lines in the pathological sample. Incorrect/incomplete diagnosis risks inappropriate management. The new 2011 ILAE classification system of FCDs is reviewed to explain why the two cases presented herein are classified as FCD IIIb and how older terminology was incorporated into the new schema. Radiologists should be familiar with these lesions and their classification.

KEYWORDS: Classification, Focal Cortical Dysplasia, Glioma
Metastases to the Pituitary Gland from Parotid Gland Carcinoma.

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Purpose
Metastases to the pituitary gland are rare with an incidence of 1-3.6%. The most common malignancy to metastasize to the pituitary is breast, followed by lung cancer. Herein, we report a case of a primary parotid gland cancer metastasizing to the pituitary gland.

Materials and Methods
A 51-year-old man presenting with a recent onset of progressive fatigue was investigated with an endocrine panel and found to have hyperprolactinemia, hypocortisolemia, and hypothyroidism. His past history was significant for carcinoma ex-pleomorphic of the parotid gland treated 5 years ago with resection and radiation therapy.

Results
Magnetic resonance imaging (MRI) of the brain demonstrated a homogeneously enhancing mass within the sella with suprasellar extension, approximating the optic nerve and chiasm, inseparable from the cavernous internal carotid arteries bilaterally (Figure 1). The primary imaging diagnostic consideration was a pituitary macroadenoma. During endoscopic surgery, the tumor extending anteriorly into the sphenoid sinus was biopsied. On visual inspection, the mass was vascular and more firm than a pituitary adenoma. Frozen section diagnosis was that of a carcinoma, and not a primary pituitary neoplasm. The surgery was terminated. The final histopathology was consistent with myoepithelial carcinoma with squamous differentiation, the same as the primary salivary gland tumor.

Conclusions
Metastases to the pituitary gland are unusual and most often originate from primary cancer of the breast, followed by the lung. They are predominantly clinically silent and occur mostly in the posterior pituitary. Rarely lymphomas, leukemia, plasmacytoma, renal cell carcinoma, thyroid cancer and gastrointestinal primary tumours can metastasize to the sella. The metastases are usually invasive and can be heterogeneous in appearance. We present a primary parotid gland carcinoma metastasizing to the pituitary gland mimicking a pituitary adenoma on imaging, five years following treatment of the primary and without any evidence of recurrent disease in the neck. Our report highlights the fact that although metastases to the pituitary gland are atypical, they should be considered in the differential diagnosis in patients with a prior history of malignancy exhibiting new pituitary dysfunction and enlargement.

KEYWORDS: Metastases, Parotid Gland, Pituitary Gland
MRI findings of acute crossed cerebellar diaschisis in the setting of status epilepticus

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Purpose
To highlight the MR imaging (MRI) findings in prolonged status epilepticus with secondary crossed cerebellar diaschisis.

Materials and Methods
An 82-year-old female with past medical history of hypertension and left parietal infarct approximately nine months prior was found unresponsive in her home after last seen in her normal state of health two days prior. The EMS team that brought the patient to the hospital reported possible seizure activity at the scene. The patient had a GCS of 3 at the hospital and was urgently intubated. A head CT was performed followed by a brain MRI. Following the brain
MRI findings, continuous EEG monitoring was initiated which demonstrated findings suggestive of status epilepticus.

Results
Noncontrast head CT showed no acute findings. Noncontrast brain MRI demonstrated diffuse gyriform reduced diffusion throughout the left cerebral hemisphere with associated T2 hyperintensity and gyral swelling. There was also reduced diffusion in the right cerebellar hemisphere with associated T2 hyperintensity. A region of encephalomalacia secondary to a left parietal infarct also was seen, probably representing the seizure nidus.

Conclusions
It is important for the radiologist to be aware of MRI findings in crossed cerebellar diaschisis, as it can be an indicator that active seizures are occurring in an altered or unresponsive patient. These findings must be differentiated from other causes of gyral edema and reduced diffusion including acute ischemia and infection. The radiologic findings then can be correlated with clinical findings as well as EEG monitoring to help the clinician come to a definitive diagnosis.

KEYWORDS: Crossed Cerebellar Diaschisis
Purpose
Multisystem atrophy is a sporadic neurodegenerative disorder of unknown etiology which occurs secondary to degeneration of the basal ganglia and the olivopontocerebellar system. The disease is not uncommon but may be underrecognized on MR imaging (MRI) as the imaging findings may be subtle. We present a case report and two companion cases with MR imaging demonstrating the unique findings of MSA-C and MSA-P, the two main subtypes of the disease. The third type, MSA-A is the autonomic variant which has no specific imaging findings. Recognizing the findings of MSA will lead to prompt diagnosis for the patient and may prevent unnecessary interventional procedures.

Materials and Methods
(Case 1) A 56-year-old female presented with postural hypotension and dizziness. Her blood pressure fluctuated significantly in the emergency department and on physical exam she was found to have slow speech, generalized severe hypotonia, and significant cogwheel rigidity involving all four extremities, left greater than right. Her past medical history included chronic dysautonomic symptoms and associated complications. (Case 2) A 58-year-old male with chronic dizziness and gait ataxia presented after sustaining a fall secondary to poor balance. The patient had a history of falls with increasing frequency recently. (Case 3) A 64-year-old female was referred for brain MRI secondary to progressive gait ataxia. The patient previously had undergone anterior cervical diskectomy because her symptoms had been misattributed to cervical spondylosis. Her spinal surgery resulted in no improvement in her symptoms.

Results
(Case 1) Axial T2*-weighted gradient echo sequence demonstrates bilateral decreased signal in the putamina. (Case 2) An axial T2-weighted MR demonstrates linear increased T2 signal intersecting in the pons, the so-called "hot cross bun" sign. (Case 3, not shown) Sagittal T1-weighted MR image demonstrates significant interval atrophy of the olivopontocerebellar structures compared to a study performed four years previously.

Conclusions
Following the review of this exhibit, the reader will be familiar with the types of MSA, the clinical presentation and unique neuroimaging findings. We present three patients diagnosed with MSA with the hallmark MR imaging findings of this disorder. Multisystem atrophy is a sporadic, progressive neurodegenerative disorder which shares many clinical features of other disease processes such as Parkinson's disease, progressive supranuclear palsy, and spinocerebellar ataxia. Correct identification of MSA as the diagnosis will likely aid in treatment planning as well as prognosis. Therefore, the radiologist plays an integral role in the diagnosis of this often obscure and debilitating disease.
Not all that's white is blood! – Leukemia mimicking acute subarachnoid hemorrhage

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Purpose
To present an educational case where continued misdiagnosis of acute subarachnoid hemorrhage (SAH) on computed tomography (CT) delayed further work up and treatment of a meningeal leukemia. A short review of patterns and imaging evolution of SAH and a brief illustrated review of SAH mimics also is presented.

Materials and Methods
A 21-year-old previously healthy male presented to a secondary care hospital with a three-week history of progressively worsening headaches. A head CT was performed and the diagnosis of diffuse acute SAH was made. He was admitted for observation and sequential imaging studies were performed; however the headaches increasingly worsened and he developed bilateral
amaurosis, deafness, right proptosis and progressive weight loss. Six weeks after admission the patient was transferred to our institution for further investigation. Additional imaging studies were performed. Despite all efforts the patient continued to deteriorate and died three days later. Autopsy results and histopathological findings were consistent with diffuse leukemic infiltration of the meninges.

Results
Serial CT scans showed diffuse hyperdensity of the subarachnoid spaces, with progressive and irregular erosion of the skull vault and base. Computed tomography on admission to our institution showed identical findings, plus herniation of the frontal lobe through the skull base into the right orbit, causing exophthalmos. Magnetic resonance imaging demonstrated the same filling of all cerebrospinal fluid (CSF) spaces by a T1-hypointense, T2-hyperintense component with restricted diffusion and strong enhancement after IV gadolinium. Additionally a pineal mass with the same characteristics was identified. Secondary encephaloceles were clearly visible protruding into the right orbit and through the middle cerebral fossa on the left.

Conclusions
We present a case of a 21-year-old man misdiagnosed with acute SAH in order to illustrate a rare case of aggressive meningeal leukemic dissemination, and present a brief differential diagnosis of SAH mimics. Subarachnoid hemorrhage patterns and mimics should be familiar to the neuroradiologist, in order to direct clinicians towards the right investigation and diagnosis.

KEYWORDS: Differential Diagnosis, Leukemia, SAH

EE-36

Post Carotid Endarterectomy Cerebral Hyperperfusion Syndrome Mimicking Stroke

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Purpose
Review a case of cerebral hyperperfusion syndrome status postcarotid endarterectomy highlighting findings of CT perfusion.

Materials and Methods
A 69-year-old gentleman with history of multiple punctate left cerebral infarcts and ipsilateral high grade carotid stenosis underwent uncomplicated left carotid endarterectomy (CEA). On postoperative day two the patient developed headache and right hemiplegia. Noncontrast computed tomography (CT) and MR imaging (MRI) of the brain demonstrated no stroke. Computed tomography angiography (CTA) of the neck showed expected postoperative changes related to CEA with no evidence of dissection or thrombosis. Computed tomography perfusion performed at that time revealed increased left cerebral blood flow and decreased mean transit times. Findings were considered diagnostic of cerebral hyperperfusion. By postoperative day six the patient had recovered completely without persistent deficit.

Results
MR imaging/MRA of the brain demonstrated multiple punctate left cerebral infarcts involving the left middle and posterior cerebral artery territories with a fetal configuration of the left posterior cerebral artery. Computed tomography angiography (CTA) of the neck revealed greater
than 70% stenosis of the proximal left internal carotid artery. Postoperatively, there was no acute hemorrhage or infarction on CT or MRI of the brain. Computed tomography angiography of the neck revealed expected changes related to recent CEA with no dissection or thrombosis. Increased cerebral blood flow and decreased mean transit times were noted in the left cerebrum with CT perfusion imaging.

Conclusions
Cerebral hyperperfusion syndrome (CHPS) is a known complication status postcarotid endarterectomy. It is characterized clinically by headache, seizure, and cortical neurologic deficit occurring with reperfusion in the absence of cerebral ischemia. Early identification is critical, with aggressive blood pressure control necessary to prevent intracranial hemorrhage. The majority of neurologic complications following carotid endarterectomy are ischemic in etiology with clinical features that are often indistinguishable from those of CHPS. In the setting of postoperative hemiplegia, the diagnosis traditionally has been one of exclusion primarily utilizing routine MRI and CT to rule out infarction. However, cerebral CT perfusion imaging provides the opportunity to proactively suggest the diagnosis in this clinical dilemma.

KEYWORDS: Cerebral Blood Flow, CT Brain Perfusion, Stroke

EE-17

Primary Trigeminal Nerve Germinoma: Case Report

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Purpose
To describe neuroradiologic findings in a rare case of primary intracranial trigeminal nerve germinoma.

Materials and Methods
A 19-year-old male presented to the emergency room with a three-month history of headache. He described numbness of his entire left face. He also complained of double vision and inability to open his left eye completely. Physical exam revealed a left fifth and third cranial nerve palsy. Computed tomography (CT) and MR imaging (MRI) demonstrated a left cavernous sinus/sella mass extending into the left middle cranial fossa. Subsequent surgical resection demonstrated an extraaxial mass of the middle cranial fossa with infiltration of the left trigeminal nerve, CN5, including cisternal segment and divisions V2 and V3. Oculomotor nerve, CN3, was severely compressed, but not infiltrated. Pathology revealed high grade germinoma.

Results
Computed tomography brain revealed a large homogenous enhancing mass of the left cavernous sinus/sella region with left middle cranial fossa extension. There was enlargement of left foramen ovale. MR imaging also demonstrated the mass, but with inhomogenous enhancement. There was enlargement of left trigeminal nerve, CN5, cisternal segment and divisions V2 and V3. The mass showed restricted diffusion. Cerebral catheter DSA with selective left internal carotid artery injection demonstrated an enlarged inferolateral branch supplying the mass and prolonged vascular "stain" of the mass. Selective left external carotid artery injection did not show enlargement of arterial branches or a prolonged vascular "stain". MR imaging of entire
neuraxis demonstrated two enhancing nodular masses of the lumbar subarachnoid space compatible with cerebrospinal fluid (CSF) disseminated metastases. Computed tomography chest, abdomen, pelvis and testicular ultrasound examinations were normal.

Conclusions
Germinomas make up about 0.5% to 3% of primary intracranial tumors. They occur in children and young adults. Most germinomas involve the pineal and suprasellar regions, and uncommonly the thalamus and basal ganglia. Our germinoma occurred in a young adult originating in a rare location, the trigeminal nerve. The skull base and trigeminal origin of germinoma has been reported only rarely. Although rare, germinoma should be considered in the differential diagnosis in children and young adults when a cavernous sinus/sella mass with trigeminal perineural extension is found.

KEYWORDS: Germinoma, Primary Central Nervous, Skull Base Neoplams
Retrograde Cerebral Venous Air Embolism

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Purpose
To report the imaging findings of cerebral venous air embolism after removal of central venous catheterization.

Materials and Methods
A 63-year-old male with right lung cancer was admitted to the hospital for surgery. His postop course in ICU was stable. Before transferring to general ward, the patient had his central venous catheter removed. Immediately after the catheter removal, the patient was found to be unconscious. Brain CT showed air collection in bilateral cavernous sinuses, straight sinus and bilateral cerebral cortical veins, suggesting cerebral venous air embolism. MR imaging (MRI) obtained 10 hours later showed no residual air in the venosinus system, but subtle cortical swelling in the bilateral high frontal and left parietal lobe. Follow-up MRI of brain done 12 days later revealed bilateral subacute infarctions with pseudolaminar cortical necrosis. He received supportive treatment with gradual return of consciousness despite remained to be paralysis.

Results
Noncontrast-enhanced CT of brain revealed air bubbles in the bilateral cavernous sinus, straight sinus and cerebral veins in bilateral high frontal and left parietal sulci. Axial T2-weighted MR image obtained 10 hour after to the CT scan show no residual air in the bilateral cerebral veins. Axial T1-weighted MR image with gadolinium enhancement obtained 12 day later demonstrated gyral enhancement in the bilateral high frontal and left parietal cortex suggesting subacute infarctions with pseudolaminar cortical necrosis. Diffusion-weighted image showed diffusion restriction in the affected cortex.

Conclusions
In conclusion, cerebral venous air embolism is an extremely rare complication after removal of central venous catheter. Radiologists should be aware of the imaging findings of this potentially serious complication.

KEYWORDS: Venous Infarction
Rotational Vertebral Artery Stenosis Secondary to Transverse Mega-Apophysis: an Uncommon Finding

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Purpose
We describe one case of rotational vertebral artery severe stenosis associated with a transverse mega-apophysis at C6.

Materials and Methods
A 59-year-old female was admitted with vertigo. MR imaging (MRI) and MR angiography (MRA) showed a small vertebrobasilar thromboembolic stroke without intracranial occlusion. She was discharged without symptoms. One week later, she was readmitted with similar symptoms; MRI and MRA showed an acute left PICA stroke, without intracranial occlusion. Neck CT and CTA revealed a dissection of left V2 and a bone condensation. A functional occlusion of the left vertebral due to extrinsic compression was suspected. Digital subtraction angiography (DSA) was performed, with dynamic angiograms that revealed a dissection of left V2 and a subocclusive stenosis in the left head rotation.

Results
Catheter angiography of the affected vertebral artery was performed in AP and lateral views, with dynamic angiograms (right head rotation, neutral and left head rotation). Angiograms in neutral and right head rotation revealed a dissection of left V2 segment, at the level L5-L6, that induced a 60% stenosis. Angiograms in left head rotation showed a subocclusive stenosis with hemodynamic effects. Three-dimensional images acquired with rotational angiography revealed a transverse C6 left mega-apophysis at the level of the dissection.

Conclusions
Rotational vertebral artery occlusion is a rare syndrome that can be revealed by vertigo, nystagmus and syncope during head rotation. Multiple etiologies have been described in the literature. We report a case of cervical mega-apophysis, with emphasis on angiographic findings.

KEYWORDS: Vertebral Artery Dissection, Vertigo
Purpose
To report an unusual case of multiple small adjacent venous angiomas with venous shunting mimicking arteriovenous malformation.

Materials and Methods
A 21-year-old presenting with acute onset of headache and left-sided weakness in an outside hospital. Patient then was transferred to our institution. MR imaging (MRI) was performed followed by catheter cerebral angiography to rule out arteriovenous vascular malformation. Patient showed progressive improvement during short hospital observation.

Results
MR imaging showed right thalamic remote hemorrhage. There also was typical appearance of
Multiple adjacent venous angiomas in the bilateral anterior and right posterior thalami with a large peri-thalamic draining vein constituting a large venous angioma. Typical "caput medusa" or "spider" appearances were present. Catheter angiography confirmed the venous angiomas but with additional finding of arteriovenous shunting on both right internal carotid and right vertebral artery selective injections. No AVM nidus identified.

Conclusions
Venous angiomas with arteriovenous shunting is a rare occurrence. This has been termed as "Arterialized Venous Angiomas". There are few reported cases in the literature. Our case is distinguished by virtues of multiple small venous angiomas draining into the same vein with separate anterior and posterior arterial feeding in the anterior and posterior thalamus, respectively. Also, associated hemorrhage further helped the case to masquerade as AVM. The treatment is generally conservative.

KEYWORDS: Arteriovenous Malformation, Venous Malformations

Thrombosis of a Drainage Vein in Developmental Venous Anomaly (DVA) Leading to Venous Infarction:

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Purpose
Developmental venous anomaly (DVAs) are fairly common and generally benign congenital
vascular abnormalities, present in approximately 2.6% of the general population. Thrombosis of a DVA is extremely rare, and most symptomatic complications arise from DVAs that are arterialized or associated with other vascular malformations, like cavernomas or arteriovenous malformations. In this exhibit, we report imaging findings in a case of DVA with a thrombosed drainage vein in the left cerebellar hemisphere along with a review of the relevant literature.

Materials and Methods
A 61-year-old man presented to an emergency room with sudden loss of consciousness and syncope. He had experienced a headache, progressive dizziness, and nausea persisting for two weeks. He denied previous seizure and had no cardiovascular risk factors. Laboratory values, including coagulation tests, were within normal limits. Cranial computed tomography (CT) scan revealed a large tubular hyperdense structure in the left cerebellar hemisphere converging toward the left transverse sinus (Figure 1). Additionally, mild left-sided cerebellar edema was present. Magnetic resonance imaging (MRI) performed subsequently revealed areas of hyperintense subcortical venous infarction on T2-weighted images in the left cerebellar hemisphere (Figure 1). Unenhanced T1-weighted images demonstrated a hyperintense tubular structure in the left cerebellum. Gadolinium-enhanced T1-weighted images showed the nonenhanced thrombosed drainage and enhanced medullary veins with caput medusa appearance confirming the diagnosis of DVA. Four-vessel cerebral angiography during the venous phase demonstrated lack of opacification in the territory of the thrombosed DVA. The patient's neurological status improved gradually with anticoagulation therapy over a period of 10 days with residual mild left-sided ataxia and he was discharged on coumadin and antihypertensive medication. Follow-up MRI after seven months showed recanalization of the thrombosed vein and resolution of cerebellar edema. No underlying cavernoma or AVM was identified in the region.

Results
Head computed tomography (CT) scan revealed a large tubular hyperdense structure in the left cerebellar hemisphere converging toward the left transverse sinus (Figure 1a). Additionally, mild left-sided cerebellar edema was present. Magnetic resonance imaging performed subsequently revealed areas of hyperintense subcortical venous infarction on T2-weighted images in the left cerebellar hemisphere (Figure 1b). Unenhanced T1-weighted images demonstrated a hyperintense tubular structure in the left cerebellum. Gadolinium-enhanced T1-weighted images showed the nonenhanced thrombosed drainage and enhanced medullary veins with caput medusa appearance confirming the diagnosis of DVA.

Conclusions
In summary, DVAs occasionally give rise to significant symptoms due to thrombosis of the draining vein. We evaluated comprehensive imaging findings in a challenging case of DVA associated with nonhemorrhagic infarction. The familiarity with imaging findings of complicated DVAs is essential for accurate diagnosis and appropriate management.

KEYWORDS: Developmental Venous Anomalies, Thrombosis
Unusual Necrotic Cerebral Prostate Metastasis

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Purpose
To present an unusual case of necrotic prostate cancer metastasis to brain parenchyma mimicking a high grade glioma, in the absence of other hematological metastases; and to review the spectrum of intracranial findings of prostate cancer metastasis.

Materials and Methods
A 62-year-old man with a history of prostate cancer treated with prostatectomy and radiotherapy had no close follow up for the ensuing nine years. He then presented in 2011 with cystitis, hematuria and an elevated prostate specific antigen (PSA). However, subsequent bone scan and abdominopelvic computed tomography (CT) were negative. He was started on leuprolide and his PSA normalized. In late 2012, he developed progressive fatigue, vague cognitive changes, and left foot drop. Subsequent brain MR imaging (MRI) showed a right-sided cerebral mass, which was resected with pathology showing poorly differentiated prostate adenocarcinoma.

Results
Brain MRI depicted a large right necrotic temporal lobe mass with a heterogeneous avidly enhancing peripheral rim with no restricted diffusion, which resulted in marked mass effect including uncal and subfalcine herniation. The enhancing rim showed patchy T1 shortening and T2* dephasing on susceptibility-weighted imaging, suggestive of intratumoral hemorrhage. Spread of tumor around the trapped right lateral ventricular temporal horn (arrow) and possibly into it also was suggested, given the layering of intraventricular blood products. Dynamic susceptibility contrast perfusion imaging depicted elevated tumoral blood volume with a mean
percentage signal recovery of 69%, compatible with a high grade glioma. A subcentimeter enhancing left frontal lesion also was present, possibly representing a second focus of tumor versus subacute enhancing infarction. No abnormal pachymeningeal or osseous enhancement was present. Overall findings were deemed suspicious for a high grade glioma with periventricular spread, versus less likely, an atypical metastasis. However, an abdominopelvic CT scan demonstrated retroperitoneal and iliac partially necrotic presumed lymphatic metastases, despite normal PSA. No imaging studies ever demonstrated hematogenous bone, liver or lung metastases.

Conclusions
This unusual case of a large prostate adenocarcinoma brain metastasis mimicking a high grade glioma provides the opportunity to review the pathophysiology and neuroradiological manifestations of prostate cancer metastases, which are more typically dural or osseous. This case is particularly unusual given its primarily cystic/necrotic appearance as well as the lack of hematogenous metastases elsewhere in the body and a normal PSA, which had lowered the index of suspicion for metastasis. Ultimately, the neuroradiologist should remain aware of the different presentations of metastatic tumors to the brain, including atypical ones.

KEYWORDS: Brain, Metastases, Prostate
A Case of Refractory Trigeminal Neuralgia: Relevant MR Techniques and Anatomy

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Purpose
Trigeminal neuralgia is a debilitating disorder which affects approximately 4.5/100,000 people per year. We will review anatomy of the trigeminal nerve focusing on the imaging findings of vascular compression causing trigeminal neuralgia. The MR techniques that best depict the trigeminal nerve and arteries to evaluate for neurovascular compression are reviewed. We present a case of trigeminal neuralgia caused by vascular compression at the root entry zone to illustrate the critical role imaging plays in identifying the culprit vessel and guiding surgical management.

Materials and Methods
A 72-year-old male presented with a 20-year history of left facial pain (sharp and electric) that worsened over the last two months leading to decreased oral intake and a 50-pound weight loss. Until recently the patient was managed with narcotics. On the most recent admission, the patient initially was successfully medically managed, but developed an allergy to the medication (carbamazepine) and failed subsequent attempts at medical management. After microvascular decompression of the left trigeminal nerve the patient reported complete resolution of symptoms.

Results
Initial routine brain MR did not elucidate a cause for facial pain. Follow-up MR protocled to include thin section multiplanar steady-state free precession (FIESTA) MR images revealed the left superior cerebellar artery contacting and deforming the left trigeminal nerve at the superior margin of the root entry zone (approximately 4 mm anterior to the pons). The more vulnerable segment of the trigeminal nerve is the centrally myelinated posterior portion when compared to the more resistant peripherally myelinated anterior portion. An imaging approximation is used to measure the cisternal segment of the trigeminal nerve from the pons to the porous trigeminus. The posterior 50% of the nerve roughly corresponds to the centrally myelinated portion and the anterior 50% roughly corresponds to the peripherally myelinated portion.

Conclusions
In this presentation, we report a case of medically recalcitrant trigeminal neuralgia caused by compression of the root entry zone of the nerve by the superior cerebellar artery successfully treated with microvascular decompression. Knowledge of the anatomy and more susceptible portion of the nerve as well as utilization of tailored MR protocols is necessary to correctly diagnose these patients.
Anomalous origins of bilateral anterior cerebral arteries (ACA) from the cavernous internal carotid arteries (ICA) with associated anomalies of the circle of Willis: MRA and CTA demonstration.

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Purpose
The purpose of our presentation is to describe a rare case of anomalous origins of the bilateral anterior cerebral arteries (ACAs) from the cavernous internal carotid arteries (ICAs) and associated anomalies of the circle of Willis demonstrated by CT angiography (CTA) and MR angiography (MRA) and review the clinical implications and embryologic reasons for such anomalies.

Materials and Methods
The ACA conventionally is a branch of the supraclinoid ICA emanating as one of the two terminal branches of the ICA. Very rarely, the ACA arises from the ICA at the level of the ophthalmic artery as the ‘infraoptic course of the ACA’. Bilateral anomalous origins are unusual and we present a case of anomalous origins of bilateral ACAs from the bilateral cavernous ICAs well below the origins of the ophthalmic arteries. This is a case report of anomalous origins of bilateral ACAs from the cavernous ICAs in a 68-year-old female being investigated for the cause of a subarachnoid hemorrhage. These anomalies were incidental and have nothing to do with the subarachnoid hemorrhage. The subarachnoid hemorrhage was due to a right vertebral artery aneurysm. Other associated anomalies include fenestration of the right A1, fenestration of an accessory A2, direct origin of the left PCA from the supraclinoid left ICA or MCA and conjoint origins of the left superior cerebellar artery and the hypoplastic left P1. We discuss possible clinical implications and embryologic origins of these anomalies.

Results
Initial noncontrast CT revealed a predominantly basal subarachnoid hemorrhage with mild intraventricular hemorrhage and hydrocephalus. CTA angiography at the same time revealed a right vertebral artery pear shaped aneurysm measuring 5.4 x 4.3 mm just distal to the origin of the PICA with attenuation of the terminal right vertebral artery. In addition, the bilateral anterior cerebral arteries originated from the distal cavernous ICA proximal to the origins of the ophthalmic arteries. The distal right A1 was fenestrated. An accessory A2 also showed a fenestration. The left posterior cerebral artery emanated from the left supraclinoid ICA (technically the left MCA since the ACA already originated more proximally than usual). There was a common origin of the left hypoplastic P1 and the left superior cerebellar artery. Digital subtraction angiography (DSA) confirmed the CTA findings. Follow-up MRA following treatment of the aneurysm confirmed the infraoptic course of the bilateral ACAs, the fenestrations on the right A1 and the accessory A2 as well as the left PCA anomalies (Figure).

Conclusions
This is a case of a 68-year-old patient with subarachnoid hemorrhage. During the course of the
investigation for the hemorrhage, it was discovered that she had a combination of rare anomalies that included infra-optic course of the bilateral ACA, fenestrations of the anterior cerebral arteries, direct origin of the left PCA from the left MCA and conjoint origin of the left hypoplastic P1 and the left superior cerebellar artery. The discussion centers around the clinical implications of these anomalies and embryologic origins of such anomalies.

KEYWORDS: Cerebral Arteries, Intracranial Aneurysms, Intracranial Artery

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EE-52

Atypical Cortical Restricted Diffusion in Tacrolimus-Associated Neurotoxicity: A Report of Two Cases

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Purpose
Tacrolimus (FK-506) is an immunosuppressant drug discovered in 1984 by Fujisawa Pharmaceutical Co., Ltd. This drug belongs to the group of calcineurin inhibitors, which has been proven highly effective in preventing acute rejection after transplantation of solid organs. However, tacrolimus-induced neurotoxicity is a rare, yet documented, complication. The findings on MR imaging (MRI) are similar to those in cyclosporin A (CsA) toxicity and typically present in a pattern of posterior reversible encephalopathy syndrome (PRES). To the best of our knowledge, tacrolimus-induced neurotoxicity causing cortical restricted diffusion is an extremely rare imaging presentation. We report two cases thereof.

Materials and Methods
(Case 1) A 13-year-old female with aplastic anemia status post-bone marrow transplant in 2011, cryptogenic cirrhosis complicated by portal hypertension, thrombocytopenia and
hepatopulmonary syndrome was admitted for living donor liver transplant. She was started on FK-506 on postoperative day number one at a dosage of 2.5 mg twice daily. On postoperative day number four, her FK-506 level was supratherapeutic at 28.6 ng/mL. On postoperative day number five, she developed acute bilateral upper extremity shaking and eye deviation to the left. An MRI of her brain showed abnormal gyriform restricted diffusion involving the cortices of the bilateral frontal, parietal and posterior temporal lobes. The differential diagnosis was cortical ischemia, meningoencephalitis or medication-induced toxicity. Her Tacrolimus was held for three days, with a repeat level of 6.9 ng/mL. A repeat MRI of the brain done on postoperative day number 16 showed complete resolution of the gyriform cortical restricted diffusion. She was discharged on postoperative day number 30. (Case 2) A 70-year-old female with a history of hepatitis-C, cirrhosis and hepatocellular carcinoma status postliver transplant in 2001 with recurrence and repeat transplant in 2005 was admitted for increased confusion and weakness resulting in multiple falls. Her initial lab testing including basic metabolic panel, complete blood count and urinalysis were unremarkable. Her FK-506 level was measured to be 6.0 ng/mL. A noncontrast CT of the head showed no acute process. An MRI of the brain showed gyriform-restricted diffusion involving the cortices of the bilateral parietal, occipital lobes and the right temporal lobe.

Results
(Case 1) Axial diffusion-weighted sequence shows gyriform-restricted diffusion involving the cortices of the bilateral frontal, parietal and posterior temporal lobes in a symmetric distribution. (Case 2) Axial diffusion-weighted sequence shows gyriform-restricted diffusion involving the cortices of the bilateral parietal, occipital lobes and the right temporal lobe.

Conclusions
Tacrolimus-induced neurotoxicity after solid organ transplantation is a rare but known complication with an incidence of approximately 0.4 – 0.5%. It usually can be diagnosed on the basis of a characteristic clinical and radiographic pattern. Prior reports have described neurotoxicity with the development of a posterior reversible encephalopathy syndrome (PRES) imaging pattern. However, to our knowledge, cortical restricted diffusion is not a typical presentation of Tacrolimus-associated PRES. Many studies have shown that the neurotoxicity associated with tacrolimus may occur at therapeutic levels. In prior cases of tacrolimus-induced neurotoxicity, medication withdrawal often results in alleviation of toxicity, which was the case in one of the patients presented here. We present these cases in an effort to educate the neuroradiology community on the rare but varied patterns of tacrolimus-induced toxicity.

KEYWORDS: Medication, Restricted Diffusion
Fatal Outcome of Tissue Plasminogen Activator Administration in a Stroke-like Syndrome

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Purpose
To illustrate the potential insensitivity of computed tomography (CT) in detecting subacute subarachnoid hemorrhage (SAH), the importance of considering vasospasm as a possible cause for neurologic deficits, and the risk of tissue plasminogen activator (tPA) administration in the misdiagnosis of thrombotic stroke.

Materials and Methods
A 47-year-old Hispanic woman arrived to the emergency room with slurred speech and confusion that began two hours earlier. Her husband mentioned that she had been complaining of a headache for the last eight days. A noncontrast head CT obtained for "aphasia and headache"
revealed effacement of the left sylvian fissure and questionable left temporal lobe hypodensity without visible intracranial hemorrhage. The treating neurologist administered tPA and within 15 minutes the patient developed worsening headache, extreme hypertension, and subsequently became unresponsive and apneic. After intubation, a CT angiogram revealed SAH, diffuse cerebral edema, and lack of intracranial arterial perfusion. Autopsy revealed SAH concentrated near a 3mm aneurysm at the left internal carotid artery bifurcation.

Results
Noncontrast head CT images revealed subtle low attenuation of the left temporal lobe, effacement of the left sylvian fissure, and no convincing evidence of hemorrhage. Computed tomography angiography performed two hours later demonstrates diffuse subarachnoid hemorrhage with an asymmetric larger amount of blood in the left paraclinoid region. No intracranial vascular enhancement was present above the cavernous ICAs.

Conclusions
A large prospective study revealed that the sensitivity of a noncontrast CT for detecting SAH drops from nearly 100% within the first six hours of headache onset to 85.7% after six hours. (1) Cerebral vasospasm is most likely to occur four to 12 days after onset of SAH, and 35% of those with aneurysmal SAH experience neurologic symptoms associated with brain ischemia secondary to vasospasm. (2) We suspect that our patient's onset of headache eight days prior to her presentation was due to a sentinel aneurysmal bleed, that the patient's aphasia was secondary to vasospasm, and that subsequent tPA administration resulted in catastrophic aneurysmal rebleed. This case demonstrates the importance of considering an aneurysmal hemorrhage in a stroke-like syndrome with a negative CT. If radiologists are provided with a history of several days of headache, it may be prudent to inform clinicians of the decreased sensitivity of a CT head to detect nonacute SAH.

KEYWORDS: Aneurysm, Stroke, Vasospasm
Imaging Beyond Common Neoplasms of the Sinonasal cavity.

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Purpose
To revisit two very rare entities [(1) Nasal polyps with metaplastic ossification and (2) Respiratory epithelial adenomatoid hamartoma (REAH)] involving the sinonasal cavity and their characteristic imaging findings.

Materials and Methods
Case 1: A 67-year-old female presented with rhinorrhea, nasal obstruction and headache. She is a known case of nasal polyp for the past 18 months. Case 2: A 63-year-old male presented with two-year history of anosmia and posterior rhinorrhea, not relieved by antibiotic treatment.

Results
Case 1: Multiplanar computed tomography (CT) scan of the sinuses with bone and soft tissue
window reveal a mucosal mass with central linear calcification in the posterior aspect of the right nasal cavity. The lesion extended through the posterior choana into the nasopharynx, associated with obstruction of drainage of the right posterior ethmoid air cells. The CT findings were consistent with a nasal polyp with metaplastic ossification. Case 2: Multiplanar CT scan of the sinuses with bone and soft tissue window reveal widening of the left nasal vault by the presence of a soft tissue lesion, which extends posteriorly into the left sphenoid sinus through the sphenoethmoidal recess. The lesion fills the olfactory recess, obstructs the left cribriform plate, also displaces the septum towards the contralateral side with obstruction of the right cribriform plate accounting for the patient's anosmia.

Conclusions
1) Although rare, metaplastic ossification can occur within nasal polyps and possibility should be raised when one visualizes benign-looking sinonasal mass with centrally located radiodensity on CT scans. 2) REAH though rare, should be included in the differential diagnosis of a symptomatic sinonasal mass to prevent unnecessary aggressive surgical intervention of this benign lesion. 3) Finally the radiologist should be familiar with the imaging findings of these two rare entities involving the sinonasal cavity.

KEYWORDS: Nasal Mass, Sinonasal Disease
Imaging of Supraclavicular Nerve Perineural Spread with Operative Correlation.

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Purpose
To describe a novel case of perineural spread (PNS) along the intermediate branch of the supraclavicular nerve, correlated with operative findings. Relevant anatomy of this branch of the cervical plexus is reviewed.

Materials and Methods
A 61-year-old man who had prior excision of skin cancer on the upper anterior chest, noticed growth of a painless left lower anterior neck mass over three months. Biopsy revealed poorly differentiated carcinoma. Perineural spread was proven by surgical excision and histopathologic examination.

Results
Left, contrast-enhanced axial CT scan of the neck showed an irregularly marginated subcutaneous tumor implant (asterisk) lateral to the left sternocleidomastoid muscle and external jugular vein. A curvilinear, cord-like structure (arrow) extended medially from the tumor implant, traversing the posterior triangle of the neck and coursing towards the left C3-C4 neural foramen. The cord-like structure corresponded anatomically to the abnormally thickened intermediate branch of the supraclavicular nerve. Right, hematoxylin and eosin section at 70x shows normal wavy nerve fibers and their spindled nuclei (between arrows) interspersed with perineural invasion by poorly differentiated carcinoma cells that have large round nuclei (arrowheads). The asterisk shows surrounding desmoplastic reaction.

Conclusions
Anatomy Review: The cervical plexus is formed from C1-C4 nerve roots. The ventral rami of C3-C4 contribute to the supraclavicular nerve. The supraclavicular nerve emerges from beneath the posterior border of the sternocleidomastoid muscle and divides into an anterior (or medial) branch, a posterior (or lateral) branch and an intermediate branch. The intermediate branch provides sensory innervation to the skin over the clavicle, anteromedial shoulder, and proximal chest. Perineural extension is a well described mode of head and neck cancer spread, generally along branches of cranial nerves. Perinural spread along spinal nerves is uncommon, with prior reports of only the great auricular branch of the cervical plexus being involved. We report the first case of PNS along the supraclavicular nerve branch of this plexus. Recognition of this type of spread requires knowledge of the relevant neuroanatomy, as well as the typical imaging features of perineural tumor spread.

KEYWORDS: Neoplasm Recurrence, Diagnosis, Nerve Imaging, Perineural
Inadvertent MRI/MRV Imaging Following Administration of Intravenous Ferumoxytol (Superparamagnetic Iron Oxide Nanoparticles) Resulting in Profound Vascular Signal Artifacts

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Purpose
To describe the confounding brain MR imaging (MRI) findings in a patient who recently had received intravenous ferumoxytol for treatment of iron deficiency, the administration of which was unknown to the interpreting radiologist.

Materials and Methods
A 38-year-old female patient with history of total gastrectomy with esophagojejunostomy, iron deficiency, and clotting disorder underwent routine head MRI and MRV for chronic headaches and action tremor. Head imaging was essentially normal except for the gradient echo and susceptibility-weighted imaging, which were very unusual, as described below. These findings were initially a diagnostic dilemma. After discussing with the referring neurologist, who then conferred with the patient's gastroenterologist, it was realized that the patient had received IV ferumoxytol (Feraheme) for iron deficiency (plasma ferritin 7 mcg/L) two days prior to MRI. Ferumoxytol consists of superparamagnetic iron oxide nano particles and is an approved treatment for iron deficiency in individuals with chronic renal disease, but it is not yet approved
as an MRI contrast agent. The imaging findings were fully consistent with this history of recent intravenous ferumoxytol administration, which caused very exaggerated susceptibility-related signal loss in intracranial blood vessels.

Results
Standard clinical T1-weighted, T2-weighted (Figure 1A), T2-weighted FLAIR, and post-gadolinium contrast T1-weighted MRI as well as gadolinium bolus MRV of the head were performed on a 1.5 T scanner and were judged to be completely normal. However, a gradient echo T2*-weighted (GRE) sequence also was performed, which showed abnormally very prominent signal loss throughout the subarachnoid spaces reminiscent of superficial siderosis, versus in subarachnoid blood vessels, but also in small parenchymal veins. This GRE appearance was similar to that seen normally with susceptibility-weighted imaging (SWI). The GRE was repeated and was unchanged. Susceptibility-weighted imaging then was also performed (Figure 1B), and the degree of signal loss throughout the superficial and deep cerebral vasculature also was much more profound than usual. Superficial siderosis did not seem likely, as there seemed to be a diffuse vascular abnormality uniformly throughout the intracranial compartment. Findings were, however, compatible with an exaggerated loss of signal intensity on T2*- and susceptibility-weighted images from an intravascular USPIO (ultrasmall super paramagnetic iron oxide) nanoparticle such as ferumoxytol.

Conclusions
Ferumoxytol is a USPIO which is FDA-approved for the treatment of iron deficiency anemia in patients with renal failure, as it is not renal excreted (1). It also has high r1 and r2 relaxivity values of 15 and 89, respectively, and so it has been used in brain imaging as an experimental contrast agent (2, 3). It persists in the vasculature longer than gadolinium-based contrast agents, affecting MRI scans for up to three months following IV infusion for iron deficiency, though effects are maximal at 1-2 days. It only slowly traverses the disrupted blood-brain barrier, an advantage in first pass T2*-weighted dynamic susceptibility contrast (DSC) perfusion. It also is gradually taken up by inflammatory cells such as macrophages, which provides unique information on delayed T1-weighted imaging in inflammatory and neoplastic diseases. However, there has not been much description of the T2*- or susceptibility-weighted imaging appearance of intracranial ferumoxytol. Its very strong effect on transverse relaxivity creates a predictable, very exaggerated signal loss throughout the vasculature on these pulse sequences, such as in this present case. Awareness of the MRI appearance of intravenous ferumoxytol is important to avoid additional imaging or unnecessary medical intervention. Very exaggerated and diffuse intravascular paramagnetic effects on T2*- or susceptibility-weighted imaging should prompt one to consider prior iron oxide nanoparticle infusion such as for iron deficiency anemia.

KEYWORDS: Artifacts, Iron, Susceptibility-Weighted Imaging
Inflammatory Pseudotumor of the Nasopharynx: A Case Report

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Purpose
1) To describe the imaging findings of inflammatory pseudotumors (IPTs) involving the nasopharynx. 2) To differentiate IPTs from nasopharyngeal carcinoma (NPC).

Materials and Methods
A 87-year-old male presented with severe unrelenting headaches and recent onset facial numbness and facial palsy. Review of the database revealed similar stable findings on previous computed tomography (CT) scan of the brain done for trauma.

Results
Computed tomography scan of the brain and base of skull reveals nasopharyngeal soft tissue predominantly involving the left side and extending across the midline with destruction of the clivus and left carotid canal. Significant narrowing of the petrous segment of left internal carotid artery also noted. There was complete opacification of the left mastoid air cells. MR imaging (MRI) redemonstrated soft tissue mass lesion in the left posterolateral aspect of the
nasopharynx with destruction of the clivus, left petrous apex and narrowing of the petrous segment of left internal carotid artery. Important points to differentiate IPTs from NPC are: 1) Hpointense mass lesion compared to brain parenchyma while NPC are more hyperintense, 2) Internal carotid artery encasement and resultant narrowing are common features in cases of IPT but not NPC.

Conclusions
Inflammatory pseudotumor of the nasopharynx is a great mimicker of nasopharyngeal carcinoma. The clinician should be aware of this disease process and investigate patients, combining clinical presentation, imaging characteristics and possible histological evidence to arrive at a correct diagnosis.

KEYWORDS: Nasopharyngeal Carcinoma (NPC), Nasopharynx

EE-55

Magnetic Resonance Imaging Findings of Infantile Myofibromatosis

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Purpose
We describe the magnetic resonance imaging (MRI) features of infantile myofibromatosis involving the neck and paraspinal soft tissues to familiarize other radiologists with this rare condition.

Materials and Methods
A 7-week-old with expanding right lateral temporal and left posterior neck masses underwent MRI for further delineation of the abnormality. Following MRI, the lesion in the right temporal region was biopsied and the left posterior neck lesion was surgically excised. Histopathologic findings were consistent with a diagnosis of myofibromatosis.

Results
MR imaging demonstrated an expansile oval mass within the right suprazygomatic masticator space. The mass was T1 hypointense, T2 centrally hyperintense, peripherally hypointense, and peripherally enhancing on subsequent contrast-enhanced examination. It measured 2.7 x 1.5 x 2.4cm and was difficult to separate from adjacent musculature. An additional mass with similar signal characteristics was present in the left posterior cervical triangle, measuring up to 1.0cm. A lesion within the left thoracic paraspinal soft tissues had slightly different characteristics-central mild T1 hyperintensity, T2 hypointensity with peripheral T1 hypointensity, and T2 hyperintensity. This abnormality decreased in size on subsequent examination.

Conclusions
Infantile myofibromatosis is part of the spectrum of musculoskeletal fibromatoses. While some authors describe it as the most common fibrous tumor of infancy, the entity rarely is encountered in daily practice. Myofibromas may be solitary or multifocal, with well defined or infiltrative margins; they spontaneously regress in about 30% of patients. The head, neck, and trunk are common areas of involvement. Lesions may be found in multiple organ systems, including skin, bone, muscle, viscera, and, rarely, the central nervous system. Visceral involvement is a poor prognostic indicator, carrying a mortality rate of up to 75%. The overall mortality rate for
infantile myofibromatosis approximates 15%. The recognition of myofibromatosis may guide management by prompting further imaging to delineate the extent of systemic involvement, particularly of the viscera.

KEYWORDS: Fibromatosis

EE-48 6:30AM - 9:00PM

Perineural Spread of Adenoid Cystic Carcinoma Mimicking a Cavernous Sinus Meningioma

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Purpose
We present a case of intracranial perineural spread of nasopharyngeal adenoid cystic carcinoma mimicking cavernous sinus meningioma.

Materials and Methods
A 62-year-old female presented with a five-year history of left ear discomfort and discharge, thought to be secondary to Eustachian tube dysfunction and treated with repeated myringotomy and tubes. She subsequently developed numbness and tingling in the V2 distribution of her face as well as decreased sensation over the left eye while applying makeup. She reported a lack of tearing in the left eye, requiring eye drops. Brain MR imaging (MRI) at an outside facility demonstrated a mass lesion involving Meckel's cave and the cavernous sinus, and interpreted as either meningioma or schwannoma. The patient was referred to our institution for radiation therapy options for a presumed benign lesion. Physical examination revealed left nasopharyngeal soft tissue fullness and a left tympanic membrane perforation and a middle ear mass. Cranial nerve testing revealed deficits in all three branches of the trigeminal nerve. Extraocular movements and facial nerve function were normal.

Results
MR imaging obtained for treatment planning purposes confirmed a mass in the left Meckel's cave and the cavernous sinus, with retrograde extension along the main trunk of the left trigeminal nerve. Based on the concern that this was not a meningioma, further high-resolution skull base imaging was obtained and revealed abnormal enhancement in foramen ovale, and enhancing submucosal fullness in the upper masticator space and submucosa of the left nasopharynx. Additionally, from Meckel's cave, there was posterolateral perineural enhancing tumor spread along the greater superficial petrosal nerve to involve the geniculate ganglion and the labyrinthine segment of the left facial nerve. The patient underwent biopsy of the left middle ear mass revealing adenoid cystic carcinoma with cribriform and solid patterns. Given the overall extent of tumor spread, the patient was not a candidate for surgical resection. She was dispositioned to definitive chemoradiation with proton therapy and cisplatin-based chemotherapy.

Conclusions
Perineural spread of tumor, particularly adenoid cystic carcinoma, can mimic other head and neck lesions. Submucosal malignancy of the nasopharynx, specifically, may spread by this mechanism to the cavernous sinus or Meckel's cave, and be misdiagnosed as nerve sheath tumors.
or meningioma. If treatment for a benign lesion is undertaken without histologic sampling, the primary cancer may go undiagnosed with disastrous consequences, and so accurate imaging is of critical importance.

KEYWORDS: Cavernous Sinus, Meningioma, Perineural
Pterygoid Hamulus Syndrome: Imaging Findings in an Unusual Cause of Soft Palate Pain.

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Purpose
We report a rare case of an abnormally elongated pterygoid hamulus in a patient presenting with soft palate pain (pterygoid hamulus syndrome). We review this curious entity and present an imaging review of other pathologies of the soft palate with reference to the anatomy of this region.

Materials and Methods
A 63-year-old male patient presented to the Maxillofacial Surgery clinic with a seven-month history of bilateral pain in the lateral aspects of the soft palate. On examination, prominent bilateral bony structures were palpable with keratinization of the overlying mucosa. A diagnosis of pterygoid hamulus syndrome was made following CT imaging of facial bones. The patient was treated conservatively with oral anti-inflammatory drugs and local steroid injections.

Results
We performed spiral CT acquisition through facial bones with high resolution bone algorithm axial reconstruction and multiplanar reformats. This revealed bilateral enlarged hamuli of the pterygoid bones, each measuring 14mm in length (normal length 5-6mm). These hamuli were oriented towards the midline and hooked in configuration. The differential diagnoses of soft palate pain is wide. In this exhibit we demonstrate and review the computed tomography (CT) and MR imaging (MRI) appearances of peritonsilitis, malignancy, impacted teeth and trauma.

Conclusions
Pterygoid hamulus syndrome is rare with approximately 40 cases reported to date. Conservative treatment usually is sufficient, but persistent symptoms warrant surgical management which involves exposure of the hamuli by blunt dissection or resection of the hamuli. This case demonstrates the importance of recognizing abnormal anatomical structures in a region often overlooked on CT.

KEYWORDS: CT Anatomy, Oropharynx, Pain
Revisiting the Utility of the "Open-Ring" Sign in the Diagnosis of Demyelinating Disease.

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Purpose
Multiple sclerosis (MS) is the most common demyelinating disease, classically presenting as multiple ovoid periventricular white matter hyperintensities perpendicular to the corpus callosum on T2-weighted MR imaging (MRI). This characteristic appearance often locks in the diagnosis of MS. A solitary lesion in the cerebral hemisphere of a patient without a history of demyelinating disease results in a diagnostic dilemma; the differential diagnosis then includes infectious, inflammatory, and neoplastic entities. Additionally, the open-ring enhancement pattern on postgadolinium MR imaging is highly specific for the diagnoses of demyelinating lesions and extremely useful in atypical cases. We report a case of glioblastoma multiforme (GBM), with the "open-ring" pattern of enhancement, mimicking a demyelinating lesion.

Materials and Methods
A 55-year-old previously healthy male presented with a postconcussive syndrome. Initial neurologic examination revealed no focal deficits or other abnormalities. A head CT and brain MRI were obtained for further evaluation.

Results
MR imaging demonstrated a 1.5 cm lesion in the right periventricular white matter of the temporal lobe. There is minimal surrounding edema and mass effect. Postcontrast imaging demonstrated an open-ring enhancement pattern.

Conclusions
The patient's clinical status worsened; repeat imaging demonstrated marked enlargement of the lesion and closed-ring enhancement, along with multiple satellite lesions. The patient underwent biopsy and debulking of the lesion. Neuropathology revealed GBM. Although the open-ring sign is highly specific for demyelination, high-grade neoplasms may demonstrate this finding. Therefore, advanced imaging modalities such as perfusion imaging and spectroscopy should be entertained, along with follow-up imaging in these atypical cases, even when the open-ring sign is appreciated.

KEYWORDS: Glioblastoma, MR Imaging Brain, Multiple Sclerosis Plaques
Sacral nerve root neurocytoma.

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Purpose
Neurocytomas typically are well differentiated tumors of the central nervous system (CNS) and predominantly arise intracranially within the lateral ventricles. They occur in young and middle-aged adults, and have no sex predilection. Herein we report the first case of a sacral nerve root neurocytoma and its management.

Materials and Methods
A 49-year-old man presented with a seven-month history of back pain and right S1 radiculopathy diagnosed on EMG.

Results
Magnetic resonance imaging (MRI) of the spine demonstrated an extramedullary enhancing lesion at the right S1 level with the primary imaging diagnostic consideration of a nerve sheath tumor. The patient subsequently underwent surgery with a final histopathological diagnosis of a neurocytoma of the S1 nerve root.

Conclusions
Neurocytomas in the spinal cord are extremely rare. They appear to have a propensity for the
male population and can present at ages ranging from eight to 72 years. Majority of spinal cord neurocytomas present as an intramedullary cord lesion. Its occurrence along a sacral nerve root has not been described before and on such occasions it can be mistaken for a schwannoma. The treatment of choice is surgery with adjuvant radiotherapy advocated only in cases with anaplastic features and high MIB-1 labeling index.

KEYWORDS: Neurocytoma, Spinal Nerve Root

EE-57

Spinal subdural space enlargement with subdural enhancement in adults after craniocervical surgery.

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Purpose
Spinal subdural space enlargement and enhancement after suboccipital craniotomy is a known observation in the pediatric neuroradiology literature. This benign postoperative MR imaging (MRI) finding also can be seen in adults who have undergone intrathecal surgery at the cranio-cervical junction. The aim of this exhibit is to discuss the proposed physiologic mechanism responsible and acquaint radiologist of this finding to prevent misdiagnosis.

Materials and Methods
Case Report: We present two cases of patients who underwent intrathecal surgery at craniocervical junction and upper cervical spine and were noted to have an enlarged enhancing subdural space throughout the cervical and thoracic spine on immediate postoperative MRI. The findings resolved within 10 days in both the cases. Case 1: A 58-year-old male patient who presented with neck stiff and shoulder pain underwent an MRI of the C-spine, which revealed a 2cm enhancing lesion in the lower half of the 4th ventricle. An ependymoma was in the differential. The immediate postsurgical MRI for extent of resection evaluation revealed an enlarged subdural space with diffuse enhancement throughout the spinal canal. There was no T1 hyperintensity. The patient was asymptomatic and there was no signal abnormality in the cord. A postsurgical subdural hematoma was included in the provisional diagnosis. A follow-up scan on day eight demonstrated complete resolution of the findings. Case 2: A 40-year-old male patient with a history of NF-1 presented with gradually progressing weakness in all four extremities. Postcontrast MRI of the cervical spine revealed a 3.5cm neurofibroma at C3-4 causing significant mass effect on the cord with intramedullary T2 hyperintensity. An emergent cervical decompression with neurofibroma resection was performed. The immediate postsurgical MRI revealed subdural space enlargement and enhancement throughout the lower cervical and thoracic spinal canal. Even though there was no T1 hyperintensity on noncontrast imaging, a postsurgical subdural hematoma was considered. A repeat postcontrast MRI on day six after surgery demonstrated resolution of the findings.

Results
Immediate postsurgical postcontrast Sag and Axial T1 images of the cervical and thoracic spine demonstrate enlargement of the subdural space with diffuse uniform enhancement. There is mild
to moderate narrowing of the spinal subarachnoid cerebrospinal fluid (CSF) space. On the follow-up scan (not uploaded at this time), there is complete resolution of the findings.

Conclusions
Enlargement with diffuse enhancement of the spinal subdural space on immediate postoperative scans after suboccipital craniotomy is a described finding in the literature (1). Posterior fossa neoplasms are common in children and radiologists working with pediatric scans are aware of this finding. This finding may be obscure to radiologist working mainly with adult patient imaging and this may result in misdiagnosis and unnecessary further evaluation with a potential of unrequired surgery. Educating radiologist of this benign finding will result in appropriate patient management.

KEYWORDS: Spinal Imaging, Subdural

(Filename: TCT_EE-57_Picture1.jpg)

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Excerpta - Head and Neck
EE-64
A Rare Case of a Retromandibular Varix Presenting as a Parotid Mass

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Purpose
To describe a rare case of a retromandibular varix presenting as a parotid mass in a patient with locally advanced supraglottic carcinoma.

Materials and Methods
An 88-year-old male with a history of supraglottic squamous cell carcinoma presented with an enlarging and asymmetric left parotid mass concerning for metastatic spread of disease. The patient underwent a contrast-enhanced computed tomography (CT) of the soft tissue neck as well as a subsequent sonogram of the mass with Doppler to complete the work up of the suspicious mass. Upon confirming the diagnosis of a retromandibular varix, the patient completed his outpatient treatment without the need for tissue sampling of his parotid mass.

Results
A contrast-enhanced CT of the soft tissues of the neck through the level of the parotid glands demonstrates a 4.2cm tubular low attenuating mass in the deep left parotid gland. There is an enhancing and dilated left retromandibular vein contiguous with the posteromedial aspect of the mass. Subsequent color Doppler images of the palpable left parotid mass demonstrate a dilated vessel that corresponds to the mass seen on the prior CT and therefore represents a varix of the left retromandibular vein. A follow-up PET/CT two weeks later as part of the patient's routine cancer work up confirmed the nonhypermetabolic nature of the left retromandibular varix.

Conclusions
A varix of the retromandibular vein (posterior facial vein) presenting as a parotid mass is a very rare entity that to our knowledge has been reported only once in the otolaryngology literature. Varices of the cervical and facial regions are particularly rare given the low pressure system and are seen more typically in patients with thoracic outlet syndrome or following trauma. Identifying a suspicious parotid mass as a vascular structure is an important diagnosis in order to prevent potentially disastrous complications upon biopsy. Slow flow through the varix can hinder diagnosis on contrast-enhanced studies due to lack of enhancement. Therefore, implementing appropriate radiological imaging, such as a Doppler sonogram, becomes an essential component of the diagnostic work up to prevent unnecessary and potentially harmful interventions.

KEYWORDS: Parotid Gland, Ultrasonography, Venous Malformations
An Unusual Case of Cholesterol Granuloma of the Orbit

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Purpose
Orbital masses can be difficult to diagnose, as they often have overlapping clinical and imaging features. We present an unusual case of cholesterol granuloma of the orbit, a common radiographic lesion occurring in an uncommon location. Understanding the imaging
characteristics of a cholesterol granuloma will help the radiologist include it appropriately in the differential diagnosis.

Materials and Methods
An 80-year-old male was referred to Ophthalmology clinic with progressive left eye proptosis over one year. The patient had a history of blunt injury to the left eye 20 years ago, after which he has been able to see only shadows. However, during the past year he has had increasing proptosis along with pain and redness of the left eye. The patient was placed on steroid eye drops, and was told he has a tumor behind the left eye. So far he had declined surgical options, but now with worsening symptoms the patient wished to reevaluate his tumor and undergo surgery. The patient was taken to the operating room for a left ocular enucleation, anterior orbitotomy, resection of the mass, and placement of an orbital implant. The patient tolerated the procedure well. The pathology result from the surgical specimen was reported as cholesterol granuloma.

Results
Computed tomography (CT) images demonstrate a well-defined soft tissue mass arising from the superolateral postseptal left orbit, causing adjacent mass effect and proptosis as well as smooth bony remodeling of the left lateral orbital wall and orbital roof. MR images demonstrate homogeneously high T1 signal and heterogeneous T2 signal within the mass, with few areas of curvilinear low T2 signal and a well-defined low T2 rim. There is no significant enhancement within the mass. The findings are compatible with a slow-growing hemorrhagic lesion of the postseptal orbit. The differential diagnosis includes cholesterol granuloma, cavernous hemangioma, hemorrhagic mesenchymal tumor, and hemorrhagic nerve sheath tumor.

Conclusions
Cholesterol granuloma of the orbit is an uncommon cause of an orbital mass. Recognizing the features of internal hemorrhage, no enhancement, and smooth, expansile bony remodeling is important for suggesting this diagnosis, especially since the orbit is an atypical location for this lesion.

KEYWORDS: Orbits
Coexisting Papillary Thyroid Carcinoma (PTC) and Primary Thyroid Large Cell Lymphoma

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Purpose
We present an unusual case of coexisting PTC and thyroid lymphoma with lateral compartment lymphadenopathy (LAD) from both entities. The typical ultrasound (US) and computed tomography (CT) findings of these two entities are reviewed.

Materials and Methods
A 64-year-old male presented with cervical lymphadenopathy, night sweats, and 35 lb weight loss.

Results
Computed tomography showed a large left thyroid mass with tracheal deviation, and bilateral, multilevel, LAD with both cystic and solid nodes. Fine-needle aspiration (FNA) of the left thyroid mass and left neck node revealed large cell lymphoma. Following three cycles of chemotherapy, the patient self-referred to MDACC for an enlarging right neck mass. Positron emission tomography (PET)-CT demonstrated resolution of the left thyroid mass and improved lymphadenopathy, without residual FDG avid disease. However, a cystic right neck node had increased in size. Fine-needle aspiration and core biopsy of the cystic node were both nondiagnostic. Thyroid ultrasound demonstrated hypoechoic masses in both lobes. Repeat FNA of the right cystic neck node for assessment of the FNA cyst fluid for thyroglobulin (Tg) level (Result Tg=152590) also demonstrated PTC on this repeat cytology. Patient underwent total thyroidectomy and bilateral neck dissection, demonstrating multifocal PTC with multiple metastatic lymph nodes.

Conclusions
Coexisting thyroid lymphoma and papillary thyroid carcinoma (PTC) is very rare. Cystic nodes and microcalcification within nodes are not associated with lymphoma, and raise the concern for coexisting PTC. While preferred in cases of lymphoma, core biopsy can be nondiagnostic when dealing with cystic nodes from PTC. Fine-needle aspiration can be acellular with cystic nodes, and Tg assay is essential to establishing a diagnosis of metastatic PTC.

KEYWORDS: Biopsies, Lymphoma, Thyroid
Cutaneous Angiosarcoma Presenting With Dermal and Parotid Invasion.

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¹University of Michigan Health System, Ann Arbor, MI
Purpose
To highlight an unusual imaging and clinical presentation of a facial angiosarcoma, a rare neoplasm of the head and neck.

Materials and Methods
A 54-year-old man presented to the ER room with a nonhealing facial lesion and acute right-sided facial swelling. The lesion appeared four months prior as a "sore" in the middle of his forehead. Approximately a week before the ER visit, he began to have swelling in his right jaw, which progressed significantly to prompt him to seek immediate medical assistance. On clinical evaluation the patient showed a swelling along the right face from the pre-auricular region to the submandibular area. A purpuric vascular midline lesion with central ulceration and erythema was noted on the forehead. Ill-defined erythema was present surrounding this lesion and extending along the right face to the submandibular region. A soft subcutaneous mass was palpable in the latter location. A punch biopsy of the ulcer and computed tomography (CT) of the head and maxillofacial region was performed. Biopsy from the ulcerated portion of lesion showed a high grade angiosarcoma.

Results
The CT studies showed contiguous soft tissue edema, fat stranding, and streak-like linear densities limited to the superficial portion of the right parotid gland and surrounding subcutaneous tissues extending to the forehead. Focal soft tissue stranding with excavation at the site of the forehead ulcer was observed. A presumptive diagnosis of dermal and parotid gland involvement was made.

Conclusions
The CT studies showed contiguous soft tissue edema, fat stranding, and streak-like linear densities limited to the superficial portion of the right parotid gland and surrounding subcutaneous tissues extending to the forehead. Focal soft tissue stranding with excavation at the site of the forehead ulcer was observed. A presumptive diagnosis of dermal and parotid gland involvement was made.

KEYWORDS: Face, Metastases, Neoplasm
Cutaneous head and neck angiosarcoma mimics hematoma after neck mass biopsy

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Purpose
To illustrate an unusual and previously unreported manifestation of head and neck angiosarcoma mimicking soft tissue hematoma following biopsy of a presumed venolymphatic malformation (VLM).

Materials and Methods
A 61 year old African American female presented with a painless, 1 cm right neck mass. Past history was significant for 40-pack-year tobacco use. CT demonstrated an ill-defined fluid collection, which following biopsy revealed benign lymphocytes without evidence of malignancy. Clinical, radiologic, and histopathologic features at presentation and follow up were favored to represent a VLM. Three weeks following biopsy, the mass had dramatically enlarged, extending beyond the right ear and towards the eye. CECT was favored to represent an enlarging periprocedural hematoma. Despite non-healing, multidisciplinary ENT, dermatologic, vascular surgical, and infectious disease consultation again supported the diagnosis, and the patient was discharged with a presumptive diagnosis of procedural hematoma following VLM biopsy. Two weeks later, the mass had grown and became increasingly purpuric and hemorrhagic, and the right eye was increasingly edematous. Repeat CECT suggested cellulitis, myositis and fasciitis.
MRI followed, and findings were compatible with an evolving chylous collection. Repeat biopsy revealed marked atypical, ecstatic vascular channels diffusely infiltrating tissue consistent with angiosarcoma. Unfortunately, the patient was not a candidate for surgical resection and began palliative doxorubicin/ifosfamide. She passed away one month after diagnosis due to a large pulmonary embolism.

Results
CECT at presentation (Fig. 1) demonstrated a discrete fluid collection abutting the thyroid and enveloping the cervical vessels. Vague adjacent edema extended towards the supraclavicular soft tissues. Follow up CT showed multiple ill-defined pockets of fluid and soft tissue stranding extending from the right supraclavicular region to the right facial soft tissues and scalp. No aggressive osseous findings were present at the calvarial interface. A rim enhancing fluid collection in the deep cervical fascia was believed to represent VLM, possibly with superimposed infection. Findings were overall favored to represent a hematoma secondary to VLM biopsy. Fat-suppressed T2-weighted MRI (Fig. 2) exhibited a transpatial, multi-cystic fluid intensity tracking along the posterior right neck fascial planes into the face. Foci of signal loss were believed to reflect venous channel rather than flow voids. No definite fluid-fluid levels. Imaging features were felt to be compatible with presumptive mixed malformation. Post-contrast T1-weighted images showed vague areas of enhancement, which were more confluent overlying the upper cervical and scalp soft tissues. While greater than expected for VLM, superimposed reactive or inflammatory enhancement was favored.

Conclusions
Head and neck angiosarcoma is a rare and highly aggressive vascular proliferative neoplasm. Most cases occur in geriatric Caucasian patients with only 4% of cases in African-Americans. Angiosarcomas are often diagnosed late; prognosis is poor. Typical imaging features are characterized as an enhancing mass with hypervascular flow voids. Hemorrhage following biopsy is well-described, and clinical and imaging features generally indicate aggressiveness. The rare manifestation reported within this case mimicked the presence of a far less sinister process, suggesting VLM at presentation, with presumed periprocedural hematoma on multiple subsequent examinations. The confounding features in this case, including the paucity of distinct flow voids, and absence of a discrete mass or aggressive features, in the setting of recent biopsy, resulted in misdiagnosis over four hospital admissions and delayed treatment. The findings in this case emphasize the need for careful inspection and surveillance of atypical or slow-healing head and neck lesions, and illustrate a potential diagnostic pitfall in clinical ENT imaging.

KEYWORDS: Diagnostic Accuracy, Neck Masses, Neoplasm
Ecchordosis Physaliphora Meningocele with CSF leak

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Purpose
Few cases of meningocele and cerebrospinal fluid (CSF) leak related to the notochordal remnant ecchordosis physaliphora (EP) have been described (1-3). MR imaging characteristics of EP have been described previously in the neuroradiological literature (4). A description of MRI findings of CSF leak related to EP in the neuroradiological literature however, is useful to reinforce this differential consideration in a patient with CSF leak emanating from a defect in the sphenoid sinus.

Materials and Methods
A 47-year-old female presented with several month history of profuse clear rhinorrhea. She denied a history of trauma and showed no meningeal signs. Computed tomography scan showed a defect in the posterior wall of the right sphenoid sinus with suggestion of a bony stalk and a fluid filled sinus. MR imaging showed a lobulated gelatinous lesion protruding through the sinus wall defect with CSF communicating between the intracranial compartment and sinus. The patient was taken for endoscopic repair where a meningocele was found at the site of defect and reduced back into the intracranial compartment. Unfortunately, no tissue sampling was performed. Dural graft with overlying mucosal graft was used to cover the defect and the patient has since had no recurrence of rhinorrhea.

Results
Sagittal T2 sequence shows a lobulated T2 hyperintense lesion extending from the posterior aspect of the clivus through the sphenoid sinus wall defect. Cerebrospinal fluid communicates freely between the intracranial compartment and sinus.

Conclusions
Cerebrospinal fluid leak related to EP and associated meningocele is reported rarely. Although no histologic confirmation was obtained in this case, the imaging findings are consistent with
those reported in similar cases in the neurosurgical and otolaryngological literature. Imaging features presented in the neuroradiological literature hopefully will be a ready aid for the practicing radiologist in forming a differential diagnosis in a patient presenting with CSF leak emanating from the sphenoid sinus.

KEYWORDS: CSF Leak, Ecchordosis Physaliphora, Meningocele

EE-65

Ectopic External Auditory Canal and Ossicular Formation in Goldenhar Syndrome

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Purpose
To demonstrate previously unreported finding of ectopic external auditory canal and rudimentary ossicular formation in a case of Goldenhar syndrome.

Materials and Methods
A 4-year-old girl with a diagnosis of Goldenhar syndrome, presents with right hemifacial and auricular microsomia, associated with hearing deficit. She also exhibited congenital progressive scoliosis with multiple vertebral segmental anomalies as well as radial hypoplasia and
underdeveloped thumbs. A CT of the temporal bone without contrast was performed to evaluate for potential reconstruction of the right ear with hearing aid placement.

Results
CT temporal bone demonstrated ectopic location of a small, malformed right pinna and external auditory canal, terminating in a hypoplastic temporomandibular joint. Rudimentary ossicle formation is noted within the hypoplastic temporomandibular joint. At the expected location of the middle ear cavity, there is a hypoplastic aerated cavity without visualization of typical mesotympanic structures, including the ossicles. The right inner ear and internal auditory canal are within normal limits. In addition, there is hypoplasia of the right zygomatic arch, mandible and mandibular condyle, consistent with hemifacial microsomia. Figures: Coronal CT of the temporal bone demonstrates a hypoplastic right temporal mandibular joint articulating with a hypoplastic condyle and zygomatic arch. A medial rudimentary ossicle (white arrow) can be seen within the joint. Axial oblique reformats show the rudimentary ossicle (white arrow) with a small focal aeration (black arrow) connected to a severely atretic and ectopic external auditory canal with malformed pinna (black arrows). The expected posterior location of the left middle ear cavity is hypoplastic.

Conclusions
Goldenhar syndrome (aka oculoauricolovertebral dysplasia) is a rare condition, presenting at birth and has a wide range of clinical manifestation involving the eye, ear and spine. The characteristic facial phenotype defined as hemifacial microsomia, occur due to abnormal development of the first and second pharyngeal arch derivatives. Goldenhar disease may also affect the heart, lungs, kidneys, and central nervous system. The underlying cause of the condition remains unknown. A wide variety of ear/temporal bone deformities can be seen in Goldenhar as a spectrum from mild to severe from isolated preauricular appendages, fistulae, to abnormal formation of the external auditory canal with malformation of the middle and inner ear cavities. A review of embryological development of the ear will be discussed to help understand the wide spectrum of ear deformities in Goldenhar syndrome. However, all reported cases in the literature report typical location of the hypoplastic external auditory canal. This is the first report to our knowledge of Goldenhar syndrome with ectopic location of the ear pinna, external auditory canal and rudimentary ossicular formation associated with the temporomandibular joint.

KEYWORDS: Congenital Anomalies, ENT, Hearing Loss
Extraspinal Meningioma Presenting as a Neck Mass

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Purpose
We present a case of extraspinal meningioma presenting as a neck mass.

Materials and Methods
A 59-year-old man presented with vague right-sided neck and jaw discomfort. The patient denied any weakness or symptoms suggestive of radiculopathy. Computed tomography (CT) and MR imaging (MRI) of the cervical spine revealed a right paraspinal mass.

Results
Contrast-enhanced CT demonstrated a heterogeneously enhancing lobulated 3.5 cm right-sided paraspinal mass extending from the C1 to C3 levels without internal hemorrhage or calcification. The mass abutted the adjacent C1-2 and C2-3 neural foramina, without apparent intraforaminal extension or osseous destruction. On MRI, the lesion was T1 isointense with heterogenous
enhancement. Ultrasound-guided core biopsy was performed with histology revealing meningioma. 

Conclusions 
Extrapinal meningioma is a rare entity that may be confused with other paraspinal soft tissue masses, such as sarcoma, neurofibroma or metastases in the appropriate clinical setting. It has been postulated that these lesions may arise from meningocytes or dural fibroblasts that accompany exiting nerve roots or from developmental cell rests. Although our patient's lesion demonstrated no obvious extension into the adjacent neural foramina by imaging, Ibrahim et al reported attachment to the nerve root sleeve on microscopic examination following resection of extrapinal extradural meningioma (1). One reported case by Christopherson, et al demonstrated purely extraspinal meningioma without attachment to the dura or nerve root sleeve on microscopy (2). Additional paraspinal sites mimicking neck mass include parapharyngeal location reported by Taori et al and Possanzini et al (3, 4). Correct diagnosis and tissue sampling is essential for treatment planning.

KEYWORDS: Extradural, Meningioma
Iatrogenic Masticator Space Abscess: an Infrequent but Important Cause of Pain and Trismus Following Inferior Alveolar Nerve Block for Routine Dental Procedures.

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Purpose
Persistent postprocedural pain and trismus are among the most common complications of inferior alveolar nerve block for elective dental procedures. This is thought to be secondary to multiple or forceful injections, injury to muscles, or hematoma formation (1). Uncommonly, iatrogenic infection can occur at the site of injection presenting as pain and trismus 2-3 days following the procedure and should not be confused with benign post procedural pain (2). Clinical evaluation of these patients reinforced by contrast enhanced CT is important in correctly guiding clinical management (3-5).

Materials and Methods
We report 2 cases of iatrogenic deep masticator space abscesses following routine elective dental procedures. Patient 1, a 14 year old male, presented to a pediatric emergency department with trismus and pain 4 days following filling placement. The patient was found to have an abscess in the infratemporal fossa anterior and superior to the lingula of the mandible. This patient was treated with antibiotics and recovered well. Patient 2, a 48 year old male presented to the emergency department 5 days following left central incisor extraction with trismus and pain. He reported the dentist having had difficulty in obtaining anesthesia during the procedure, requiring multiple injections. A masticator space abscess was found centered at the left mandibular foramen (Figure 1). Needle aspiration was performed returning purulent material positive for Streptococcal infection. The patient was treated with incision and drainage and antibiotics, subsequently recovering well.

Results
Classic CT imaging findings of a masticator space abscess were demonstrated, however without an odontogenic source. Conventional masticator abscess formation is described on imaging as periodontal disease leading to infection of the mandible and dehiscence or direct spread into the masticator space (6). These conventional findings were not seen in these patients. The abscesses were centered in the masticator space demonstrating central soft tissue or fluid density with peripheral enhancement. Enlargement and edema within the adjacent muscles was seen in addition to stranding and obliteration of adjacent fat plains.

Conclusions
Iatrogenic masticator space abscesses are an uncommon but important consideration in a patient with late presenting postprocedural pain and trismus following inferior alveolar nerve block. Patients with this history are best evaluated with contrast enhanced CT for appropriate guidance of clinical management. Imaging findings are that of classic masticator space abscess, however without apparent odontogenic source.

KEYWORDS: Abscess, Deep Space, Iatrogenic
Maxillary Mass with Loss of the Maxillary and Mandibular Cortical Lamina Dura: A Diagnostic Clue

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Purpose
We describe a case of an expansile mass of the maxilla with an additional finding of diffuse loss of the cortical lamina dura of the maxillary and mandibular teeth. The significance of loss of the lamina dura is discussed, and how this finding can be used to suggest the diagnosis of the maxillary mass.

Materials and Methods
A 59-year-old female was referred for maxillofacial computed tomography (CT) for evaluation of a right maxillary mass that had been enlarging over the course of the previous three months. On clinical examination, there were areas of ulceration of the mucosa maxillary gingival mucosa. Biopsy of the overlying oral mucosa showed ulceration with underlying proliferation of osteoclasts. She then underwent right maxillectomy with fibular free flap reconstruction. Pathology findings were consistent with a giant cell granuloma, without evidence of malignancy. During postoperative inpatient admission, she had steadily increasing serum calcium levels up to 12.5 mg/dL, and parathyroid hormone level of 725 pg/mL. On follow-up examination, an ultrasound of the neck was performed, and a mass deep to the right lobe of the thyroid gland was visualized. Patient was later taken for parathyroidectomy, and pathologic evaluation of the specimens demonstrated a right superior parathyroid adenoma. Serum parathyroid hormone and serum calcium levels subsequently normalized.
Results
Axial CT image through the maxilla in soft tissue algorithm shows a lucent expansile mass in the right paramedian alveolar ridge of the maxilla with erosion of the anterior cortex, and an associated soft tissue mass. Axial CT image in bone window shows loss of the cortical lamina dura of the maxillary teeth. There was also diffuse loss of the lamina dura involving the mandibular teeth (not pictured here).

Conclusions
The differential diagnosis of lucent mass lesions of the maxilla involving the alveolar ridge include both odontogenic and nonodontogenic lesions. Odontogenic neoplastic lesions include ameloblastoma, odontogenic myxoma, and rarely odontogenic carcinomas. Odontogenic cystic lesions include radicular cysts, dentigerous cysts, and odontogenic keratocysts. Nonodontogenic lesions include benign etiologies such as osteitis fibrosis cystica (brown tumor), aneurysmal bone cysts, and fibrous dysplasia. Malignant nonodontogenic osseous lesions may manifest in the maxilla or mandible, including plasmacytoma or metastatic disease. Osteitis fibrosa cystica is a diffuse process of bone resorption in response to hyperparathyroidism (primary or secondary). With long-standing hyperparathyroid states, focal non-neoplastic proliferations of multinucleated giant cells and fibrovascular tissue can develop within a bone. This is known as a "brown tumor," due to hemosiderin staining that results from its tendency to hemorrhage. On imaging, brown tumor usually presents as a lucent or cystic expansile mass. It may occur within any bone, including the mandible and maxilla. Brown tumors may be monostotic or polyostotic. Other radiographic findings associated with hyperparathyroidism include phalangeal subperiosteal bone resorption, osteolysis of the distal clavicle, and "salt and pepper" appearance of the calvarium. Loss of the cortical lamina dura is another established radiographic finding in hyperparathyroidism that was described on dental radiographs prior to the introduction of computed tomography. On modern CT imaging, loss of the lamina dura also can be seen with multidetector CT (MDCT) or cone-beam CT (CBCT), although CBCT has been shown to be more sensitive in evaluation of the lamina dura. In this patient, the anatomical location of the focal osseous lesion within the maxilla allowed simultaneous visualization of this finding and provided an important diagnostic clue.

KEYWORDS: Bone, Hyperparathyroidism
Ocular Hemorrhage in a Patient with Ruptured Cerebral Aneurysm (Terson's syndrome)

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Purpose
Terson's syndrome (vitreous hemorrhage) and other ocular hemorrhages (retinal hemorrhages) have been reported to occur in up to 40% of patients with ruptured cerebral aneurysms. The mechanism of Terson's syndrome is controversial. The vitreous hemorrhage may be caused by a large amount of blood, originally formed by Terson's syndrome, entering the subarachnoid space around the optic nerve and from there infiltrating the intraocular space through the perivascular space around the central retinal vessels within the optic nerve. Here we report magnetic resonance imaging (MRI) findings of Terson's syndrome in a patient with ruptured aneurysm who developed acute unilateral vision loss.

Materials and Methods
A 51-year-old man had acute onset of severe headache, weakness, and depressed consciousness and was admitted to the hospital. He had no significant past medical or ocular problems and was not taking any medication. The preoperative computed tomography (CT) scan clearly depicted extensive subarachnoid hemorrhage in the basal cisterns and mild ventricular dilatation. Lumbar puncture confirmed a subarachnoid hemorrhage. Cerebral angiography demonstrated an aneurysm arising from the origin of the right anterior choroidal artery. The patient underwent emergency external ventriculostomy and later endovascular coil treatment of the aneurysm. Patient developed acute onset of vision loss in the left eye within three hours of endovascular treatment. Patient underwent a MRI and MR angiogram of the brain to rule out infarcts or findings of vasospasm. MR imaging study revealed diffuse subarachnoid hemorrhage, seen as bright signal within the sulci and cisterns. The scan also revealed increased T1 signal in the left globe with loss of signal suppression on the FLAIR images. Fundoscopic exam done subsequently revealed extensive viterous hemorrhage. Patient underwent emergency vitrectomy. His condition improved with medical and surgical therapy and his vision returned to normal with absorption of the blood. This patient had Terson syndrome, intraocular hemorrhage due to acutely elevated intracranial pressure usually associated with subarachnoid hemorrhage or severe head trauma. To our knowledge, neuroimaging of ocular hemorrhage in Terson's syndrome has not been reported previously.

Results
The preoperative CT scan clearly depicted extensive subarachnoid hemorrhage in the basal cisterns and mild ventricular dilatation. Lumbar puncture confirmed a subarachnoid hemorrhage. Cerebral angiography demonstrated an aneurysm arising from the origin of the right anterior choroidal artery. The patient underwent emergency external ventriculostomy and later endovascular coil treatment of the aneurysm. Patient developed acute onset of vision loss in the left eye within three hours of endovascular treatment. Patient underwent a MRI and MR angiogram of the brain to rule out infarcts or findings of vasospasm. MR study revealed diffuse subarachnoid hemorrhage, seen as bright signal within the sulci and cisterns. The scan also
revealed increased T1 signal in the left globe with loss of signal suppression on the FLAIR images (Figure 1). Bright signal also was noted in the dilated optic nerve sheaths on both sides.

Conclusions

Ophthalmological screening of patients with histories of transient or prolonged comas after ruptured cerebral aneurysms very sensitively identifies patients with ocular hemorrhages, which are relatively common in patients with subarachnoid hemorrhage treated in an academic neurosurgical practice. The present case depicts the imaging findings of Terson's syndrome in a patient who presented with acute onset vision loss within hours of endovascular treatment of aneurysm. Vitrectomy for patients who do not exhibit spontaneous improvement in vision results in a dramatic reversal of blindness.

KEYWORDS: Aneurysm, SAH

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EE-69

Osseous Metaplasia of the Laryngeal Cartilage Mimicking Tumor Invasion

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Purpose

To illustrate the imaging findings of metaplasia of the laryngeal cartilage mimicking tumor invasion. Our purpose is to raise awareness of the neuroradiology community concerning this rare entity so that unnecessary extensive surgery may be avoided.

Materials and Methods

A 50-year-old white male presented with a one-month history of hoarseness. He was treated by his PCP for an upper respiratory infection, which did not resolve the hoarseness. He was referred to an ENT, who performed a laryngoscopy, which revealed a left vocal cord mass. A biopsy was obtained which revealed squamous cell carcinoma with a probable invasive component. He was
referred to our institution for further treatment. Laryngoscopy showed normal vocal fold mobility, epiglottis rotated to the right, left vocal fold with hyperkeratotic lesion at anterior commissure, erythematous lesion extending to left posterior cord, and not involving the arytenoids. Patient underwent a total laryngectomy based on the imaging findings described below, which appears to show extensive tumor that goes far beyond that which is suspected clinically. Gross specimen of total laryngectomy showed a tumor (1.3 x 0.6 x 0.3 cm), grossly limited to the left true vocal cord without crossing the midline. On serial sectioning the tumor does not appear to involve cartilage or extend into the prelaryngeal soft tissue. The right true vocal cord shows an area of edema with submucosal hemorrhage. The underlying soft tissues are soft without discrete lesions. The thyroid and cricoid cartilages are partially ossified without fibrosis. There is marked osseous metaplasia of the cartilages with hematopoiesis. Gram stain and GMS to evaluate the inflammation in the anterior soft tissues are negative for microorganisms.

Results
With respect to the larynx, the patient has a most unusual appearance. The left aryepiglottic fold appears somewhat hypoplastic. The left arytenoid and normal vocal cord are not seen. Rather the inferior aspect of the anterior thyroid cartilage appears to be involved with tumor and largely replaced. This finding extends more inferiorly where the cartilage appears to be heavily consumed and replaced by tumor. There is a question that tumor is extending posteriorly in the location lateral to the left side of the cricoid and medial to the left thyroid lobe. Base on imaging, there is far more than a relatively low-grade or early stage tumor that is the clinical impression and rather one that has replaced many of the normal structures including much of the thyroid cartilage.

Conclusions
Osseous or chondroid metaplasias are uncommonly found adjacent to laryngeal squamous cell carcinoma (SCC) and may resemble an osteosarcoma (1). This particular case has extensive osseous metaplasia of the laryngeal cartilage adjacent to the real SCC, mimicking cartilage invasion on imaging, and therefore possibly contributing to a total laryngectomy for T4 disease that may not have been. To our knowledge, this has yet to receive attention in the neuroradiology literature. Although relatively rare, neuroradiologists should be aware of this entity and consider it in the differential diagnosis when the characteristic features are encountered, possibly avoiding unnecessary extensive surgery.

KEYWORDS: Cancer, Head And Neck, Larynx
Papillary Thyroid Carcinoma in a Thyroglossal Duct Cyst: A Rare Occurrence

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Purpose
To present a case of papillary thyroid cancer in a thyroglossal duct cyst and to allow the reader to consider thyroid carcinoma in the differential of a calcified midline neck mass.

Materials and Methods
A 56-year-old male presented with a midline anterior neck mass as noted by his primary care physician. The patient reported a history of gout and denied any significant family history of cancer. Imaging demonstrated a partially calcified mass anterior to the thyroid cartilage, suspicious for a thyroid carcinoma in a thyroglossal duct cyst. The patient went on to fine needle aspiration of the mass, which yielded malignant cells. The patient subsequently proceeded to surgery with resection of the mass as well as thyroidectomy. The surgical biopsy results came back as papillary thyroid carcinoma.

Results
Axial computed tomography (CT) image through the level of the neck shows a midline partially calcified mass along the anterior margin of the thyroid gland.
Conclusions
Thyroglossal duct cysts are formed after failure of the thyroglossal tract to involute during embryologic development and occur in approximately seven percent of the population. Malignant changes within a thyroglossal duct cyst are very rare with the incidence of malignancy occurring in less than one percent of cases. Papillary thyroid carcinoma is the most common type of cancer occurring in a thyroglossal duct cyst; however there have been reports of squamous cell carcinoma and anaplastic thyroid carcinoma. Thyroid carcinoma in a thyroglossal duct cyst may be clinically indistinguishable from a benign thyroglossal duct cyst. Therefore, it is important to include thyroid carcinoma in the differential diagnosis of midline neck lesions with suspicious CT findings. Other differential considerations for a calcified midline neck mass include a calcified anterior cervical node, dermoid cyst, tophaceous gout, and tuberculosis. The preoperative diagnosis of thyroid carcinoma in a thyroglossal duct cyst can greatly affect surgical planning and further management.

KEYWORDS: Cancer, Neck Masses, Thyroid
Post-traumatic sinus pneumocele formation relating to long-term intracranial hypotension.

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Purpose
Skull pneumoceles are extremely uncommon. Though they are associated with prior head trauma, it is not known why or how this complication occurs. Here we illustrate this rare and important entity and suggest a possible mechanism by which it occurs.

Materials and Methods
A 29-year-old man with a history of prior severe traumatic brain injury relating to a motor vehicle accident was treated during his initial injury for severe hydrocephalus requiring placement of a ventricular shunt catheter. Noncontrast head CT and brain MR were performed five years later after a fall and showed bilateral complex sinus pneumoceles. A decision was made to surgically excise the lesions due to potential risk of obstruction and infection with extremely thin bone separating the intracranial compartment from the sinuses. The patient underwent a bifrontal craniectomy, and exenteration of the frontal sinuses with resection of complex sinus pneumoceles and placement of pericranial grafts. The patient clinically did well.

Results
Noncontrast head CT performed shortly after the traumatic injury confirms the presence of moderate to severe hydrocephalus and placement of a right frontal ventricular catheter. In addition, areas of prior contusional injury are present in the frontal lobes bilaterally. A follow-up noncontrast head CT performed during the patient's most recent admission redemonstrated the ventricular catheter with marked decrease in ventricular size compared with the prior study. There were new bilateral, bubbly, loculated and septated air-filled osseous spaces communicating with the paranasal sinuses projecting intracranially. These demonstrated mass effect on the frontal lobes and had extremely rarefied bone surrounding them, consistent with complex pneumoceles (Figure 1). MR imaging (MRI) performed at the same time also showed findings compatible with intracranial hypotension including diffuse, smooth pachymeningeal thickening and enhancement, dilated superior sagittal sinus, inferior displacement of the midbrain, and a prominent pituitary gland. In addition, CT confirmed thickening of the inner table of the calvarium in keeping with intracranial hypotension.

Conclusions
We present a dramatic case of acquired sinus pneumoceles occurring years after significant head trauma. There are concomitant findings of cerebrospinal fluid (CSF) overshunting leading to chronic intracranial hypotension. Prior trauma previously has been cited as a risk factor for pneumocele formation, though the mechanism by which this occurs is unknown. We suggest here a possible mechanism related to intracranial hypotension for the development of sinus pneumoceles after head injury.

KEYWORDS: Intracranial Hypotension, Sinonasal Disease, Skull
Pott's Puffy Tumor: Imaging Findings from Ultrasonography to Magnetic Resonance Imaging

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Purpose
Pott's Puffy tumor is a complication of acute sinusitis and occasionally trauma. It is an uncommon presentation of acute sinusitis in pediatric population (1). It's characterized by subperiosteal abscess and osteomyelitis of frontal bone. Clinical findings are fluctuant swelling of scalp, headache, periorbital edema. We aimed to present imaging findings (ultrasound (US),
computed tomography (CT), magnetic resonans imaging (MRI)) of a 14 year old boy with Pott's Puffy tumor.

Materials and Methods
14 year old boy applied for 2 months history of headache and 1 week history of swelling of his forehead. His forehead swelling was tender, warm and erythematous. His laboratory values were no suspicious of infection. For diagnosis, CT (64 slices, multi-detector CT), MRI(1.5 T,Siemens, Erlangen, Germany) and then after US was performed.

Results
First US was applied to understand the nature of swelling. Transverse sonogram of the frontal swelling demonstrates the subperiosteal abscess and discontinuity of frontal bone (figure 1a). CT was performed to reveal sinusitis, to confirm the bone defect and abscess. Contrast enhanced CT revealed pansinusitis, epidural abscess in frontal area, frontal bone osteomyelitis, abscesses in diploe and subgaleal spaces. To see clearly if there was any brain parenchyma involvement which could be overlooked by CT, patient underwent contrast enhanced MRI. There was erosion and destruction of frontal bone (osteomyelitis) on the right, soft tissue and epidural abscesses with their rim enhancements (figure 1b) and no parenchymal involvement. With those imaging and clinical findings, the diagnose was Pott's Puffy tumor, a rare complication of acute sinusitis today, thanks to broad-spectrum antimicrobial coverage. The patient was recommended surgery for abscesses. Patient was underwent surgery by otolaringology and neurosurgery at the same time. Right frontal bone and sinus anterior wall destruction were seen. Abscesses were drained from frontal sinus. Then neurosurgery team attended the operation. Craniotomy was performed to left frontal side and epidural abscess was drained. At the end of the operation, frontal sinus was obliterated with the fat from the left groin. Microbyologic results were negative under the antibiotic supression. Pathology result was active chronic inflammation.

Conclusions
Pott's Puffy tumor is a surgical emergency. Imaging methods have an important role in the diagnosis of it(2). Nowadays we have forgotten this entity under the broad spectrum antibiotic therapis for sinusitis. In the literature US findings of Pott's Puffy tumor was rarely adverted. In this presentation we also mentioned sonographic images addition to CT and MRI findings. US is helpful in diagnosis of osteomyelitis (3).

KEYWORDS: MR Imaging, Sinonasal Disease, Ultrasonography
Silent cranium syndrome: A rare and unique imaging and clinical entity

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Purpose
Describe the clinical and imaging characteristics of silent cranium syndrome. Two cases are presented with discussion of their clinical concerns and CT findings.

Materials and Methods
Two female patients presented to the Orbital Surgery service with severe bilateral enophthalmos. Both patients had longstanding histories of hydrocephalus requiring ventriculoperitoneal (VP) shunting. A 53-year-old female was referred with a history of ocular irritation and left eye discharge. This patient had a remote history of VP shunting for late onset hydrocephalus at the age of 13 years, with shunt revision at the age of 24 years. Clinical examination revealed marked enophthalmos with lack of lid corneal contact, left inferior corneal scar and erosions, and upper lid entropy with lagophthalmos. Her visual acuity was 20/40 (right eye) and 20/70 (left eye). A 55-year-old female was referred with a history of chronic headache, persistent eye irritation and discharge. At the age of three months, she was diagnosed with obstructive hydrocephalus and had VP shunt surgery followed by shunt revision at the age 22 years. She developed progressive enophthalmos at the age of 39 years with a right corneal ulcer identified seven years later. Computed tomography (CT) scan of the orbits was reviewed for each patient, and bony orbital, orbital soft tissue, and orbital fat volumes were calculated for each orbit. These were compared with a single normal case control.

Results
Computed tomography orbits of both patients showed marked superior bowing of the orbital roof into the anterior cranial fossa with severe enophthalmos, lack of appropriate contact between the eye lids and globes and resultant air entrapment as illustrated in the provided CT image. We found an increase in these patients' calculated total orbital volumes (47 cm³, patient 1; 38 cm³, patient 2) compared with control (30 cm³). There also was a decrease in their orbital fat volumes (22.4 cm³, patient 1; 17 cm³, patient 2) compared with control (24 cm³).

Conclusions
Silent cranium syndrome refers to bilateral severe progressive enophthalmos developing in the setting of longstanding VP shunting. This syndrome has been recognized recently in some patients who had history of hydrocephalus early in life requiring VP shunt. This longstanding shunting results in bony remodeling of the thin orbital roof, with characteristic clinical and radiologic appearance. Silent cranium syndrome represents a previously undescribed unique clinical and radiologic entity.

KEYWORDS: Shunt
Small Cell Neuroendocrine Tumor of the Paranasal Sinuses

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Purpose
Primary small cell neuroendocrine carcinoma (SNEC) of the paranasal sinuses are extremely rare neoplasms. Similar to SNEC of the lung, SNEC of the paranasal sinus demonstrates aggressive clinical behavior and poor prognosis. The tumor exhibits early local recurrence, widespread dissemination and paraneoplastic syndromes. Primary SNEC of the paranasal sinus has not demonstrated a strong linkage with smoking as opposed to its pulmonary counterpart. Clinical symptoms are nonspecific and generally attributed to involvement of the adjacent cranial nerves, nasal and orbital cavities. Common symptoms include epistaxis, diplopia, proptosis, pain, nasal obstruction and paraneoplastic syndromes. We report a case of paranasal sinus small cell neuroendocrine carcinoma in a 78 year old male.

Materials and Methods
78 year old male presented to the Emergency Department with a painful hard mass in the right cheek which he first noticed 2 weeks prior. He described pain radiating to the right eye accompanied by swelling and increased lacrimation. Over the prior 2 days he noticed decreased hearing and vision on the right. He also reported difficulty chewing on the right: with 3-4 daily episodes of intermittent bleeding from the mouth. Over the prior 2 weeks he lost approximately 8 pounds. Laboratory results were significant for hyponatriemia, (Na:119).

Results
CT of the Orbits demonstrated a large destructive soft tissue mass within the right maxillary sinus that eroding adjacent bony structures. The mass extended through the floor of the right orbit causing proptosis and encasing the inferior rectus muscle. Involvement of the pterygoid plate with expansion of the pterygopalatine fossa was noted. The mass extended laterally into the buccal and masticator spaces with involvement of the right premalar soft tissues. No intracranial extension was present.

Conclusions
Surgical biopsy of the right maxillary sinus was positive for primary small cell neuroendocrine
carcinoma. Nephrology concluded that the patient's hyponatremia was a result of SIADH from the sinonasal neoplasm. Primary small cell neuroendocrine tumor of the paranasal sinuses is an uncommon, extremely aggressive neoplasm that carries a poor prognosis. Clinical symptoms are nonspecific pain, epistaxis, diplopia, proptosis and nasal obstruction. Patients may experience paraneoplastic syndromes which are a unique feature of these neuroendocrine tumors, and when present in conjunction with a sinonasal mass should raise suspicion for a primary SNEC.

KEYWORDS: Paranasal, Paraneoplastic, Sinonasal Disease

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EE-77

Sudden onset hearing loss in the setting of a Chronic Myelogenous Leukemia Blast Crisis: Inner Ear Leukemic Infiltrate

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Purpose
To review the imaging findings of leukemic inner ear infiltrate/hemorrhagic labryrinthitis, a rare cause of sudden-onset sensorineural hearing loss.

Materials and Methods
A 36-year-old male with a past medical history of chronic myelogenous leukemia (CML) presented with sudden-onset left greater than right sensorinerral hearing loss, dizziness, and vertigo. The patient was treated initially for presumptive otitis media without improvement. Three weeks after initial presentation the patient was admitted for CML blast crisis (WBC >700,000), at which time persistent vertigo and hearing loss prompted an MR imaging (MRI) examination of the cranial nerves.

Results
MR imaging of the internal auditory canals demonstrates T1 hyperintense fluid within the bilateral inner ear structures, more pronounced on the left. Findings are consistent with subacute
hemorrhage, leukemic infiltrate and proteinaceous material. Asymmetric prominence on the left is concordant with the patient's symptoms of left greater than right sensorineural hearing loss. 

Conclusions

Labryrinthine hemorrhage has been described previously in association with anticoagulant therapy, sickle cell disease, and chronic myelogenous leukemia among others. It is a rare cause of sudden onset sensorineural hearing loss. Careful attention to the labyrinth on T1-weighted images may reveal vestibulocochlear high signal, which can be differentiated from intralabyrinthine lipoma with fat saturation sequences. The detection of labyrinthine hemorrhage has important clinical and prognostic implications.

KEYWORDS: Labyrinthine Hemorrhage, Leukemia, Neoplasm

(Filename: TCT_EE-77_Picture1.jpg)

EE-76

6:30AM - 3:00PM

The Enlarging Neck Mass: A Rare Case of Metastatic Papillary Thyroid Cancer

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Purpose

We describe a rare case of metatastatic papillary thyroid carcinoma presenting as a slowly enlarging, multicystic neck mass. Papillary thyroid cancer should be recognized as a possible differential diagnosis in the setting of a multicystic neck mass, especially when specific imaging characteristics are present.

Materials and Methods

41-year-old man without significant past medical history presented to an outside institution with an enlarging left neck mass. His symptoms included dysphonia with an increased raspiness to his voice and globus sensation upon swallowing. Cervical physical examination revealed a large, firm mass just above the left clavicle and adjacent to a normal-feeling thyroid gland. Flexible fiber-optic laryngoscopy showed normal vocal cord mobility. Fine needle aspiration returned a diagnosis of metastatic papillary thyroid cancer. A total thyroidectomy revealed the primary cancer to be in the thyroid isthmus.
Results
MRI showed an 8.3 cm multiloculated cystic mass in the left neck extending from the level of C3 inferiorly to the clavicular head. The mass was located posteromedial to the left sternocleidomastoid muscle and was noted to abut the left common carotid artery without displacement of the carotid or parapharyngeal spaces. The mass included cystic components (T1 hypointense, T2 hyperintense) and more complex material (T1 iso- to hyperintense and T2 hyperintense). There was no associated enhancement. In addition, an 8-mm intrinsically T1 hyperintense nodule was seen immediately medial to the left common carotid artery. By imaging, the thyroid gland appeared unremarkable.

Conclusions
Multicystic neck masses carry a wide differential diagnosis, which can be divided into congenital and acquired categories. Congenital neck masses include branchial cleft cysts and venolymphatic malformations. Acquired neck masses include complex lymph nodes and multicystic peripheral nerve sheath tumors. The age of the patient and clinical presentation of a slowly enlarging neck mass suggests an acquired etiology. The presence of T1 and T2 hyperintense components in both the enlarging multicystic neck mass and the adjacent T1 hyperintense nodule suggests increased thyroglobulin content. With the appropriate clinical scenario and imaging characteristics, metastatic papillary thyroid cancer should be suspected as a possible cause of a slowly enlarging neck mass.

KEYWORDS: Cystic Lymph Node, Cystic Neck Mass, Thyroid
Purpose
Occlusive carotid dissections occur in around 30% of cases of carotid dissection. If revascularization is considered, most cases are treated with stent and balloon angioplasty. In this young stroke population, the use of a stent implies life-long antiplatelet medication. Our purpose is to describe a technical use of a balloon guide catheter in the revascularization of occlusive internal carotid artery (ICA) dissection.

Materials and Methods
Three patients were admitted in our stroke unit for acute ischemic stroke of the carotid circulation. All three patients were eligible for endovascular thrombectomy. In two patients, spontaneous proximal carotid occlusion with the characteristic signs of dissection was documented, both in noninvasive studies and in conventional angiography. In one patient, iatrogenic dissection while manipulating the intermediate catheter for thrombectomy caused an ICA occlusion.

Results
A balloon guide catheter was advanced into the common carotid artery. A 0.014” microguidewire and a microcatheter were advanced through the guide catheter, and across the proximal ICA occlusion, until the cavernous segment of the ICA was reached. Multiple contrast injections were done through the microcatheter, confirming its position inside the true lumen of the vessel. The balloon guide catheter then was advanced over the microcatheter and positioned distally to the dissection. The balloon was inflated to its nominal pressure, and the guide catheter then was pulled proximally, until the common carotid was reached, keeping the balloon inflated. The inflated balloon, while crossing the true lumen, collapsed the false lumen, and re-established patency of the vessel. In all three cases, the occlusion resolved, and anterograde flow was achieved. No stent was needed in any of the cases. There were no embolic Complications of the procedure.

Conclusions
A new technique for revascularization of occlusive ICA dissections is described, where a balloon guide catheter can be used, in the setting of thrombectomy, to re-establish the patency of the true lumen of the ICA.

KEYWORDS: Carotid Dissection, Thrombectomy
Differential Considerations for Vascular Preauricular Lesion in a Young Wrestler

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Purpose
The term 'Vascular Malformation' is routinely employed to describe varying manifestations of vascular pathology. There can be confusion in distinguishing malformation types, especially in the pediatric population. Multispecialty vascular teams composed of clinicians, surgeons, radiologists, and pathologists often are needed to sort through complex differentials. The following case exemplifies how such a team allows for streamlined healthcare delivery to these patients.

Materials and Methods
A 17-year-old high-school wrestler presented with a progressively worsening aching soft tissue abnormality overlying the right pre-auricular region during the course of a year. Physical exam demonstrated a warm, partially compressible 2 cm pink-green lesion with palpable thrill and audible bruit. No associated neurological deficits or additional lesions were noted. Computed tomography angiography (CTA) and MR angiography (MRA) exams confirmed the lesion's vascular etiology, having opacified on arterial phase and rapidly washed out on venous phase. Differential considerations at the time included AV Fistula, pseudoaneurysm, or AV Malformation.

Results
Cerebral angiogram performed two weeks later demonstrated no readily filling aneurysm, arteriovenous shunting, significant stenosis, or occlusion of internal/external carotid systems. Hypervascularity of both pinnae and preauricular regions was noted. Ultrasound of the lesion was performed following cerebral angiography. A 20 mm hypoechoic nodule corresponding to the patient's palpable abnormality was noted. Color Doppler revealed trace peripheral flow at its cephalad aspect, and a focal triangularly shaped area color flow at its caudal aspect related to a feeding native vessel. Findings were most consistent with a progressively thrombosed pseudoaneurysm, with only minimal thrombosis at time of initial noninvasive imaging. Residual neck of pseudoaneurysm was treated via ultrasound-guided thrombin injection in order to minimize bleeding during planned resection. Resection confirmed thrombosed pseudoaneurysm arising from the anterior division of the superficial temporal artery.

Conclusions
Vascular malformations encompass a wide range of manifestations. Classification consists of either developmental (high flow AVM, slow-flow venous, congenital mixed syndromes, vascular tumors, lymphatic) or acquired (pseudoaneurysm, traumatic AVF). The anterior division of the superficial temporal artery is prone to injury, with pseudoaneurysm typically seen in young males with history of acute/repetitive facial trauma. In our case, the patient's history of high-school wrestling and hyperemic pinnae complement this presentation. Associated physical symptoms include ear pain, headache, or rarely facial nerve palsy. In summary, a combined physician approach aided in proper diagnosis and treatment of this superficial temporal artery pseudoaneurysm. Such multidisciplinary clinics are a great resource for providing quality
healthcare, and could potentially become the standard of healthcare delivery in the treatment of vascular malformations.

KEYWORDS: Aneursym, Superficial Temporal Artery, Thrombosis

SUCCESSFUL USE OF THE AMPLATZER VASCULAR PLUG II IN THE SETTING OF ACUTE SIMULTANEOUS TRANSECTION OF THE CERVICAL INTERNAL CAROTID AND VERTEBRAL ARTERIES.

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Purpose
The Amplatzer Vascular Plug II, a self-expanding Nitinol mesh occlusion device, provided safe, rapid, and complete parent artery occlusion in an exceptional case of simultaneous traumatic transection of the right cervical internal carotid and vertebral arteries.

Materials and Methods
A 49-year-old male presented with penetrating trauma to the midface and right neck by a wooden board after rotary saw accident. Transection of the cervical segments of the right ICA and right VA was suspected and confirmed by CT imaging. Neuroangiography was performed with subsequent embolization of the right ICA and right VA above and below the level of transection. The Amplatzer plug II was utilized proximally, having the advantage of prompt deployment and total occlusion in potentially high-flow lesions. Microcoils were deployed distally. The patient underwent surgical removal of the wooden board. Follow-up MR imaging (MRI) demonstrated no evidence of ischemia, infarct, or intracranial hemorrhage. At three month follow up, the patient demonstrated no neurologic sequelae as a consequence of this near fatal injury.
Results
Computed tomography (CT) head without contrast and CT angiogram of the head and neck: A wooden board with accompanying streak-like artifact extended dorsally along the right lateral mass of C1 with transection of the right vertebral and right internal carotid arteries at the C1 level. There were no findings of acute intracranial hemorrhage or ischemia. Digital subtraction angiography (DSA) and endovascular therapy: Right VA injection demonstrated patency to the C1-C2 level transection. Subsequently an Amplatzer plug measuring 8mm in diameter was placed in the right vertebral artery at the C4 level. Right CCA injection demonstrated patency of the distal right CCA with a patent right carotid bifurcation, with complete occlusion approximately 1.5cm past right ICA origin. Subsequently a 12mm Amplatzer plug was placed in the right ICA extending to the right CCA. Left ICA injection demonstrated patency of the left intracranial arterial vasculature, robust filling of the right ACA and the right MCA across a patent anterior communicating artery, and filling of the right ICA terminus. Left VA injection demonstrated wide patency of the intracranial left VA, basilar artery, and bilateral PCAs. Retrograde filling of the right vertebral artery supplied the right PICA. A microcatheter was advanced over a microwire across the vertebrobasilar junction and into the right VA just above the transection where multiple microcoils were packed. Next, the microcatheter was advanced from the left VA, through the basilar artery and right posterior communicating artery, into the cervical right ICA above the transection. Similarly, microcoils were packed into the right ICA cervical segment. MR imaging of the brain without contrast (post-embolization): No evidence of acute ischemia, infarct, or acute intracranial hemorrhage.

Conclusions
The Amplatzer Vascular Plug II is a self-expanding Nitinol mesh occlusion device shown to provide safe, rapid, and complete parent artery occlusion in the peripheral vasculature. In this unique case of complete simultaneous transection of the right cervical internal carotid and vertebral arteries, successful endovascular embolization was attained.

KEYWORDS: Endovascular Embolization, Endovascular Management
Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Excerpta - Pediatrics
EE-84

A case of ADEM with multiple reversible foci on T1-weighted images without hemorrhage on T2*-weighted images.

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Purpose
Acute disseminated encephalomyelitis (ADEM) is an inflammatory demyelinating disorder of the central nervous system that usually occurs in children after viral infection or vaccination. Clinical prognosis of ADEM is usually good. Common imaging finding of ADEM is multiple subcortical and deep white matter lesions with hyper intensity on T2-weighted images and hypo intensity on T1-weighted images of MRI. ADEM with hyper intense areas on T1-weighted images is rare. Hyper intensity areas on T1-weighted images, which reflect hemorrhagic necrosis, are reported in acute hemorrhagic encephalomyelitis (AHEM), which is severe acute variant of ADEM with poor prognosis. We herein report an unusual case of ADEM with multiple reversible foci on T1-weighted images without hemorrhage on T2*-weighted images.
Materials and Methods
A Japanese two-year and 8-month old boy presented with one-week history of low fever with headache and vomiting, one month after vaccination of polio. He was mildly mentally disabled although was developmentally normal before onset. The blood test and the examination for cerebrospinal fluid were normal. T2-weighted images and FLAIR images of brain magnetic resonance imaging (MRI) demonstrated multiple high signal foci in subcortical white matter and basal ganglia. Under the diagnoses of ADEM, he underwent high-dose intravenous steroid therapy. On MRI of 14 days after admission, lesions with hyper intensity on T2-weighted and FLAIR images were reduced, but multiple hyper intense lesions on T1-weighted images with contrast enhancement appeared in subcortical white matter and basal ganglia. None of these lesions showed low intensity on T2*-weighted images. Hyper intense lesions on T1-weighted images increased on MRI of one month after admission, but gradually decreased in one-year follow up. The patient recovered with mild developmental delay.

Results
MR imaging on admission showed multiple hyper intense lesions in subcortical white matter and basal ganglia on T2-weighted images and FLAIR images of MRI. On MRI of 14 days after admission, lesions with hyper intensity on T2-weighted and FLAIR images were reduced, but multiple hyper intense lesions on T1-weighted images with contrast enhancement appeared in subcortical white matter and basal ganglia. Hyper intense lesions on T1-weighted images increased on MRI of one month after admission, but gradually decreased in one-year follow up.

Conclusions
Hyper intense lesions in subcortical white matter and basal ganglia on T1-weighted image without hemorrhage may appear on clinical course of ADEM. These lesions may disappear in follow-up images. Because its clinical prognosis may be good, this state should be distinguished from AHEL.

KEYWORDS: Acute Disseminated Encephalomyelitis, Demyelination, Hemorrhage
A Flower in Her Head: A Rare Case of Rosette Forming Glioneuronal Tumor of the Posterior Fossa

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Purpose
Is to present a case of a posterior fossa Rosette forming glioneuronal tumor, and review the spectrum of it's imaging appearance in cross-sectional imaging.

Materials and Methods
A 17-years-old girl was referred to our clinic complaining of persistent headache for six months, along with repeated attacks of nonprojectile vomiting since three months. There was no history of ataxia, vertigo, or blurred vision. She had several trips to the emergency department in the
past, in which she was given symptomatic treatment for her symptoms. On examination, she was vitally stable. Systemic and neurological examinations were negative. There were no neurologic deficits. Her initial lab works were negative. A computed tomography (CT) scan of the brain was obtained initially and showed a posterior fossa mass with supra tentorial hydrocephalus. The patient was immediately admitted and undergone an emergency shunt insertion. The MR imaging (MRI) was obtained later and showed a large heterogeneous mass filling the aqueduct and the fourth ventricle. A few days later the patient had a suboccipital craniotomy for tumor resection. The diagnosis of Rosette forming glioneuronal tumor was made by the pathologist. The patient did well after the operation and only suffered mild nystagmus. One year follow-up studies showed no evidence of recurrence.

**Results**

The initial MRI showed a large partially defined heterogeneously enhancing mass, with combined solid and cystic components. The lesion was centered in the fourth ventricle and extended superiorly to fill and expand the aqueduct. There was no edema of extension into the brain stem. No fluid level, calcification or leptomeningeal enhancement. The mass had a heterogeneous high signal in both T1- and T2-weighted images. Areas of blooming were noted on gradient echo images consistent with hemorrhage. There were no obvious areas of flow voids within the lesion. Although the initial imaging differential diagnosis of the lesion included ependymoma, medulloblastoma and cerebellar pilocytic astrocytoma, the lesion lacked the classic imaging appearance of any of the above lesions. The diagnosis of RGNT was made by pathology.

**Conclusions**

Rosette forming glioneuronal tumor is a rare posterior fossa tumor, that may present in adolescents and young adults, with a wide range of imaging features. Knowledge of this entity and its appearance on imaging studies is essential to guide clinicians and pathologists into making the correct diagnosis.

**KEYWORDS:** Neoplasm, Pediatric Brain Tumors, Posterior Fossa

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**EE-95**

**Active Venous Bleeding on Intraoperative (IoMRI) Brain MRI Performed During Brain Tumor Resection in a child.**

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**Purpose**

Review the imaging findings consistent with active venous bleeding on intra-operative MR imaging (IoMRI) obtained during resection of a brain tumor in a child, elaborate hypothesis to explain imaging findings and suggest MRI criteria to suspect active venous bleeding on IoMRI of brain tumors.

**Materials and Methods**

A seventeen-year-old male was diagnosed with a large extra and intra-axial mass lesion involving both of the supra and infratentorial compartments of the posterior right hemisphere whose MRI characteristics initially raised the diagnosis of meningeal hemangiopericytoma or
hypervascular meningioma. He underwent a first resection of the supratentorial component that was subtotal due to extreme large size of the lesion as well as severe peri-operative bleed with acute coagulation disorder and needs for transfusions.

Results
Intra-operative MRI showed expected findings of faintly enhancing tumor residue located superficial to the nonexpected finding of a large heterogeneous grossly round mass lesion occupying most of the surgical bed, showing heterogeneous isointense T1 signal, mixte hypo and hyperintense T2 signal, partial but avid enhancement and T2 shine-through of the hyperintense T2 component, restricted diffusion and absence of enhancement of the hypointense T2 component. Computed tomography (CT) was not performed due to stable clinical condition of the patient. On follow-up MRI obtained 15 days later, the surgical cavity had significantly increased in size, was mainly filled with T1-hyperintense bloody fluid, and was containing a large rounded clot similar in size to the enhancing rounded mass lesion seen during IoMRI; however, it was not showing any residual enhancement. The tumor residue was unchanged. The clinical context of acute peri-operative coagulation disorder and the large amount of methemoglobin content of the fluid filling the surgical cavity seen on follow-up MRI are consistent with organizing subacute bleed within the surgical cavity. In that context, the marked enlargement of the surgical cavity in between the two MRIs obtained 15 days apart raised the suspicion for slow bleeding continuing after the surgical time. In retrospect, avid enhancement of part of the mass lesion occupying the surgical bed on IoMRI is thought to represent active venous bleeding. Isointensity to the adjacent enhanced veins as well as apparent continuity with one of these veins appear the most interesting imaging criteria to suggest active venous bleeding.

Conclusions
Active venous bleeding has not been described previously on IoMRI. In the proper clinical context, it could be suspected based on at least two criteria including continuity with and isointense enhancement to enhancing adjacent vein.

KEYWORDS: Bleeding, Intraoperative Imaging, MR Imaging Brain
Demonstration of the Retrodural Space of Okada on MRI and Percutaneous Injection in a patient with Axial Low Back Pain

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Purpose
Illustration of a potentially under-recognized pattern of spread of fluid and inflammation through the retrodural space of Okada on MR imaging (MRI), which may be associated with axial low back pain or pain related to spinal canal stenosis. The retrodural space allows communication between ipsilateral facet joints, interspinous adventitial bursae, contralateral facet joints, and the posterior paraspinal musculature (1). Access to the retrodural space from a facet joint is facilitated by spondylolysis, although this communication can also be present without spondylolysis (1). Over the past decade, we have encountered a small number of cases of patients with axial low back pain with fluid and inflammation (gadolinium enhancement) present within multiple compartments of the posterior spine, communicating through the retrodural space.

Materials and Methods
We present a 52-year-old male who presented with longstanding axial low back pain with an occasional component radiating down left lower extremity. Given the imaging findings (below) and clinical findings, he was treated with serial computed tomography (CT)-guided bilateral L5 pars interarticularis injections of 6-12 mg of betamethasone over a three-year period with substantial pain relief with each injection.

Results
An MRI of the lumbar spine without gadolinium demonstrated bilateral L5 pars interarticularis defects with slight anterolisthesis of L5 on S1. Joint effusions were present in the bilateral L4/L5 facet joints, in the retrodural space of Okada, and in the L4/L5 interspinous region, all of which were contiguous. During the percutaneous treatment sessions, injection of iodinated contrast material into the bilateral L5 pars interarticularis defects demonstrated contrast opacification of the retrodural space of Okada on CT and the contiguous facet joints and interspinous bursa. This indicated that these contiguous structures in the retrodural space were amenable to percutaneous treatment via the pars interarticularis injections.

Conclusions
There are very few previously reported cases of visualization of the retrodural space of Okada on MRI (2). Recognition of this pattern of involvement can have implications for diagnosis and percutaneous treatment approach. This case demonstrates the MRI appearance of spread of signal abnormality on MRI and directly injected iodinated contrast through the retrodural space.

KEYWORDS: Spinal Imaging, Spine Injections, Spine Interventions

EE-89

Documented 8 year development of a pediatric olfactory schwannoma

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Purpose
We report a rare case of olfactory groove schwannoma in a 16-year-old female with a normal
MR imaging (MRI) evaluation eight years before the lesion diagnosis. In this report, we discuss the presentation, histopathology and controversial origin of these unusual tumors.

Materials and Methods

Olfactory groove schwannomas are rare lesions with 35 prior reported cases in the literature. Only five of these cases were of patients less than 18 years old. We report a case of a 16-year-old female with a long history of migraine headaches and seizures who presented with mental status changes. The computed tomography (CT) of the head at the time of presentation showed a large, peripherally calcified mass in the anterior cranial fossa extending into the ethmoid sinus and nasal cavity. MR imaging showed a solid, T2 heterogeneous lesion, avidly enhancing after contrast. A remote MRI of the brain performed eight years earlier was normal. The lesion was resected via bifrontal craniotomy. On pathologic examination, the tumor was a bland spindle-cell lesion with palisading nuclei (Antoni A pattern) and positivity on S100 immunohistochemistry, features characteristic of benign schwannoma. In this report, we discuss the presentation, histopathology and the controversial origin of these tumors including the enigmatic cranial nerve 0.

Results

Head CT without contrast: Large, peripherally calcified extra-axial mass in the anterior cranial fossa with extension into the frontal, sphenoid, ethmoid sinuses and nasal cavity. MR imaging brain without and with contrast: The mass is lobulated, well defined, extra-axial, T1 hypointense, T2/FLAIR iso-hyperintense and shows avid postcontrast enhancement.

Conclusions

We report a rare case of olfactory nerve schwannoma in a young patient which developed in an 8-year interval period. The clinical presentation, imaging characteristics, histopathologic analysis as well as the controversial origin of these tumors will be discussed.

KEYWORDS: Pediatric Neoplasms

(Filename: TCT_EE-89_Picture2.jpg)
Extra-skeletal Ewing’s Sarcoma of the Scalp

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Purpose
Extra-skeletal Ewing's sarcomas are rare soft tissue tumors, first described in 1975. These lesions occur predominantly in adolescents and young adults between the ages of 10 and 30 years and are indistinguishable from Ewing's sarcomas of the bone by histologic analysis. We report a two-year-old patient with extra-skeletal Ewing's sarcoma of the scalp with a complicated past medical history that include prematurity, neonatal intracranial hemorrhage with previous craniotomy for evacuation, hypoxic ischemic encephalopathy, hydrocephalus and developmental delay.

Materials and Methods
A two-year-old male presented with focal swelling of the scalp that rapidly increased in size over a three- to four-week period prior to admission. The lesion was not tender on palpation. Computed tomography (CT) scanning of the head without contrast and magnetic resonance imaging (MRI) of the brain and showed a scalp soft tissue mass over the right vertex. The patient underwent embolization before surgical resection. A small, pink to gray rubbery soft tissue mass was resected. Histopathologic analysis revealed a cellular tumor composed of polygonal cells with round nuclei and moderate amounts of cytoplasm. The cells were present in sheets within a rich network of blood vessels. Ultra-structural examination of the specimen revealed evidence of striated muscle differentiation in the neoplastic cells. Immunohistochemistry analysis demonstrated that the tumor cells were positive for vimentin. The patient was discharged home and no further work up or treatment was pursued by patient's family due to his complex medical history and poor prognosis secondary to his underlying comorbidities.

Results
Computed tomography head without contrast showed a solid, heterogeneous mass in the scalp dermal and subcutaneous tissues near the vertex. On MRI the mass was iso-hypointense on T1 and heterogeneous on T2 with minimal restricted diffusion and heterogenous enhancement. The subjacent parietal bone was thin and irregular without frank cortical disruption. The mass was supplied by the right superficial temporal artery and multiple branches on MR angiography (MRA). Cerebral angiogram confirmed vascular supply from superficial temporal artery vessels.

Conclusions
Primary scalp lesions are unusual in the pediatric population. We present a rare case of extra-skeletal Ewing's sarcoma of the scalp in an infant. The differential diagnosis for soft tissue neoplasms in the pediatric age group includes: neuroblastoma, rhabdomyosarcoma, lymphoma, neuroepithelioma, extra-skeletal Ewing's sarcoma and other round cell sarcomas. In our case, the appropriate immunohistochemical analysis was critical to rule out other diagnostic possibilities.

KEYWORDS: Pediatric Neoplasms
Familial Incidence of the Congenital Torcular Dural Arteriovenous Shunt.

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Purpose
There are several hereditary disorders that are well known to be associated with arteriovenous malformations (AVMs) involving the central nervous system including Sturge-Weber, Klippel-Trenaunay-Weber, and Parkes-Weber syndromes as well as hereditary hemorrhagic telangiectasia and hereditary neurocutaneous angiomatosis. Furthermore, familial incidence of AVMs in the absence of congenital hereditary disorders also has been reported. Herein, we describe the occurrence of the giant torcular herophili (TH) dural arteriovenous fistula (AVF) in two pediatric cousins treated with endovascular embolization.

Materials and Methods
Case 1: Five-month-old male with the chief complaint of poor head control, right head tilt, and increasing head circumference with full and pulsatile fontanelle presented and following imaging studies revealing marked venous dilation adjacent to the vein of Galen he underwent multiple sessions of embolization and radiation therapy without significant improvement. Ten months
later the patient presented to our center with significant clinical deterioration with developing seizure and apnea requiring immediate intubation. Case 2: Second case was the third-degree relative (paternal cousin) of case 1. A 20-day-old female was admitted for evaluation of failure to thrive, dysphagia, and enlarged head circumference with bulging fontanelles. Pregnancy history was remarkable for intrauterine diagnosis of an intracranial mass superior to the posterior fossa which was identified on 20-week gestation ultrasound. Amniocentesis with chromosomes and SNP array examinations were reported normal. Mother denied smoking and drinking alcohol during pregnancy and family history was negative for hematological disorders, cardiovascular events and stroke prior to age 50, stroke or frequent miscarriages.

Results
Case 1: Immediate cerebral angiography was performed and venography of the TH demonstrated the filling of the large cavity within the mostly thrombosed TH with retrograde drainage into the superior sagittal sinus (SSS) and subsequently into the deep cerebral vein via a second channel. Embolization of the TH and the distal thirds of the SSS were performed utilizing multiple hydro coils followed by pushable fiber coils and N-butyl cyanoacrylate in multiple sessions. Although complete obliteration of the shunts was achieved, the sequels of the prolonged drainage disturbance remained due to the late diagnosis. Case 2: Fetal MR imaging (MRI) revealed a midline mass in the region of the TH with signal characteristics of blood or blood products that was thought to be consistent with dural sinus thrombosis (Figure). Following presentation, cerebral angiography demonstrated a significant AV shunting from multiple meningeal vessels including bilateral occipital, middle meningeal arteries, and posterior meningeal arteries into a massively enlarged TH either directly or through intermediate dural veins. Subtle opacification of the outflow into the right sigmoid sinus and internal jugular vein and normal venous drainage from the SSS to the TH also was observed. Additionally, there was evidence of venous collateral pathways including the petrygoid venous plexuses due to the venous hypertension. Endovascular embolization was performed in multiple sessions using Onyx resulting in obliteration of the shunt with long-term favorable angiographic and clinical outcome.

Conclusions
Congenital dural sinus malformations (DSMs), as a subgroup of dural arteriovenous shunts, typically are associated with dural AVF shunting into a dilated dural sinus lake. Familial incidence of arteriovenous malformations has been reported in association with several vascular anomalies including cerebral cavernous malformations, dural intracranial arteriovenous fistulas and aneurysms. Although several case-series of DSMs have been reported, no familial incidence was reported in their cohorts. To the best of our knowledge, our case series represents the only reported familial incidence congenital DSMs involving TH in children.

KEYWORDS: Congenital, Dural Arteriovenous Fistula, Pediatric Cerebrovascular Disease
Ganglioglioma mimicking an extra-axial mass

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Purpose
Gangliogliomas are rare intracranial neoplasms of the central nervous system. Most of these lesions occur in children and young adults and classically present clinically with seizures. While many sites of the central nervous system can be affected, temporal lobe lesions are overwhelmingly most common. We report a case of ganglioglioma mimicking an extra-axial mass in the left middle cranial fossa.

Materials and Methods
A 13-year-old previously healthy female presents with one year of complex partial seizures that have increased in frequency over several weeks. Initially, seizures were reported once per week and had increased to 2-3 times per day, lasting 30 seconds at a time. Initial neurological
examination revealed no focal deficits or abnormalities. EEG evaluations were inconclusive in evaluation of seizure activity. Patient was referred for MR imaging (MRI) evaluation.

**Results**
MR imaging demonstrates a 5.8-cm well defined mass in the left middle cranial fossa, which appears to be extra-axial in location. The mass has both cystic and solid components with the solid component enhancing heterogeneously. There is mild left uncal herniation secondary to mass effect. There is mild vasogenic edema within the underlying temporal lobe. There is abnormal dural enhancement overlying the mass.

**Conclusions**
Surgical biopsy/resection revealed a dominant extra-axial mass with a thin pedicle of vascular support arising from the temporal lobe. Pathological diagnosis of ganglioglioma was made. Gangliogliomas are uncommon primary central nervous system tumors that often present clinically with seizure in children and young adults. They arise from atypical ganglion cells and astrocytes and are usually found in the temporal lobes. In the setting of a young patient with an apparent extra-axial mass in the middle cranial fossa, ganglioglioma should be considered within the differential diagnosis.

**KEYWORDS:** Epilepsy, Extra-Axial, Ganglioglioma

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EE-104

**Ganglioglioma on the run: A rare presentation with leptomeningeal spread**

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Purpose
We describe a rare case of ganglioglioma presenting with leptomeningeal and subarachnoid spread.

Materials and Methods
A 14-year-old male presented with new onset seizures, described as repetitive behaviors, blank stares and chewing movements lasting two to three minutes and followed by garbled speech. The patient had an EEG performed, which showed focal slowing in the left anterior temporal lobe. A contrast-enhanced MR imaging (MRI) brain examination demonstrated an enhancing solid and cystic lesion in the left temporal lobe with leptomeningeal enhancement. The patient underwent a left frontotemporal craniotomy and resection of the left anterior temporal lobe mass. Pathologic examination revealed low grade glioma with significant ganglion cell component and predominant subarachnoid growth, consistent with ganglioglioma, WHO Grade II.

Results
MR imaging showed a circumscribed, cystic mass with a solidly enhancing mural nodule in the left anterior temporal lobe, with surrounding leptomeningeal enhancement.

Conclusions
Gangliogliomas are well differentiated, low grade neuroepithelial tumors which appear most commonly in the temporal lobe. These are peripheral tumors that tend to occur at the cortical or corticomedullary junction. Most commonly, gangliogliomas present as a circumscribed cyst with a mural nodule. Differential diagnostic considerations include pleomorphic xanthoastrocytoma (PXA), dysembryoplastic neuroepithelial tumor (DNET), pilocytic astrocytoma and oligodendroglioma. While ganglioneuromas are typically nonaggressive, gangliogliomas with leptomeningeal spread can rarely occur, and it is important to be aware of this entity, as the imaging features may mimic more aggressive tumors or infection.

KEYWORDS: Ganglioglioma, Leptomeningeal, Pediatric Brain Tumors

(Filename: TCT_EE-104_ganglioglioma.jpg)
Imaging Findings in a Pediatric Patient With Disseminated Coccidioidomycosis Involving the Spine and Skull

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Purpose
The purpose of this presentation is to describe the imaging findings in a pediatric patient with disseminated coccidioidomycosis involving the spine and skull.

Materials and Methods
The patient was a 14-year-old African American male. He recently moved to Texas from the San Joaquin Valley, California. He complained of back pain for 1½ years, generalized weakness, and weight loss of 30 pounds. He was in no distress. Physical exam revealed right frontal scalp swelling. Laboratory showed iron deficiency anemia. There also was elevated sedimentation rate and a high C-reactive protein level. Initial chest radiograph demonstrated extensive paraspinal masses of the thoracic region. Subsequent computed tomography (CT) and MR imaging (MRI) spine imaging showed involvement of the cervical, thoracic, lumbar, and sacral spine with paraspinal masses/abscesses. Skull and scalp involvement also was seen. Paraspinal biopsy revealed coccidioidomycosis fungal infection. Patient initially was placed on iv liposomal amphotericin, and later switched to p.o. Voriconazole. The patient demonstrated progressive clinical and imaging improvement over the past year.

Results
Chest radiograph showed extensive bilateral paraspinal thoracic masses. Computed tomography of the entire spine showed extensive mixed sclerotic and lytic changes of the vertebra and noncalcified paraspinal soft tissue masses/abscesses. MR imaging of the entire spine also showed abnormal signal intensity and enhancement of the vertebra and large paraspinal enhancing soft tissue masses/abscesses. Brain MRI showed abnormal signal intensity of the right frontal bone with adjacent scalp swelling/enhancement and intracranial epidural enhancement. There was extension of the infection to involve the temporalis muscles bilaterally.

Conclusions
Our case report describes a pediatric patient with disseminated coccidioidomycosis infection involving the entire spinal neuraxis, as well as the skull and adjacent soft tissues. Coccidioidomycosis is a fungal disease caused by Coccidioides immitis. Recently, the CDC has reported a 10-fold increase in the number of cases since 1998. The infection is endemic in the southwestern United States. The infection may cause a self-limited influenza-like illness or may cause disseminated coccidioidomycosis. The disseminated form is more prevalent in some groups including those of Filipino, African, Native Americans, Hispanic, and Asian descent. Similar to our case, this infection is often misdiagnosed leading to a delay in diagnosis. Awareness of the clinical and imaging findings of coccidioidomycosis will make it possible to diagnose this infection earlier.

KEYWORDS: Fungal Disease, Skull, Spinal Imaging
Marburg’s Variant of Pediatric Multiple Sclerosis: Clinical Course, Magnetic Resonance Imaging and Histopathology

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Purpose
Acute multiple sclerosis (MS), also known as "Marburg variant of MS", is a rare but severe form of MS characterized by a fulminant monophasic disease course leading to death or severe disability within weeks to months. Most of the patients who survive develop later a relapsing form of MS. Here we present a five-year clinical and magnetic resonance imaging (MRI) follow up of a 13-year-old patient presenting with Marburg's variant (malignant form) of pediatric MS.
Materials and Methods
The patient was a 13-year-old previously healthy boy. Following an infection of the upper respiratory tract he developed somnolence, neck stiffness and a left-sided hemiparesis. The lumbar puncture displayed no evidence of intrathecal synthesis of immunoglobulins or oligoclonal bands. Despite multiple treatments, including intravenous corticosteroids, plasma exchange and mitoxantrone, we observed a rapid clinical and radiological deterioration (expanded disability status scale, EDSS, 9.5). After onset of cyclophosphamide a slow but steady improvement was noted. Cyclophosphamide was maintained for three and one-half years, followed by intramuscular interferon beta-1a. His current EDSS evaluated five years after disease onset was 5.0.

Results
Serial MRIs were performed. Initial MRI revealed a large tumefactive thalamic lesion without contrast enhancement, but with signs of neuronal dysfunction (reduced NAA peak with an increase in the choline/NAA ratio) in spectroscopy. Additional small lesions were detected in pons and the deep white matter of the cerebral hemisphere. The methionin-PET revealed a moderate increased uptake of the radiotracer within the thalamic lesion. Because these abnormalities were suggestive of a brain tumor, a brain biopsy was performed five days after clinical onset. It revealed an inflammatory demyelinating process accompanied by axonal destruction and gliosis. The MRI controls performed within five months from symptoms onset displayed a massive progression in the number and size of the demyelinating lesions, with new lesions extending in the splenium of corpus callosum, juxtacortical, periventricular and infratentorial. Some of the lesions became confluent, and/or presented with strong contrast enhancement, and/or showed diffusion restriction. The subsequent MRI scans performed afterwards did not show major further cerebral changes.

Conclusions
The imaging presentation of the course of acute multiple sclerosis in children or adolescents has not been described yet in the literature. Here we report the long term follow up of a boy presenting with an acute variant of MS at the age of thirteen. We present the clinical course, MRI findings, histopathology, treatment procedures and outcome in this patient.

KEYWORDS: Childhood, Multiple Sclerosis
EE-102

Papillary Glioneuronal Tumor

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Purpose
To illustrate the imaging findings of a case of a solid papillary glioneuronal tumor with MR spectroscopy, which to our knowledge has not been reported in the literature. Our purpose is to raise awareness of the neuroradiology community concerning this rare tumor.

Materials and Methods
Patient is an 11-year-old Asian female who was in her usual state of good health until November 2006 when she had an episode of low-grade headache with associated vomiting. She went to her pediatrician who started medication for the headache and also recommended a CT scan. A CT scan revealed a lesion in the right frontal lobe. The patient went to see a neurosurgeon who felt that this was most likely a tumor, but he recommended an angiogram. An angiogram was performed by a neuroradiologist who suggested that this might be an AV malformation or a vascular lesion potentially in association with a tumor. After this initial episode of headache she did not have any other headache or vomiting episodes until next spring. At that point, she was generally considered to be asymptomatic. She denies any motor or sensory deficits. She was doing very well in school. She was referred to our institution for consideration of surgery. The
family, however, did not want surgery at the time, and she was followed with MRIs until June 2011. Clinically she remained stable with no new symptoms other than progressive migraine-like headaches. Subtotal resection of tumor was performed on June 2011. Pathology was consistent with papillary glioneuronal tumor (PGNT). She has been followed by multiple MR scans, with no progression of residual lesion.

Results
On computed tomography (CT), there is a partially calcified lesion in the right frontal lobe, suggestive of underlying tumor. On MR imaging (MRI), there is a heterogeneously enhancing lesion in the right frontal lobe extending into the frontal horn of right lateral ventricle. There is no significant surrounding T2 FLAIR hyperintensity to suggest edema. Diffusion-weighted imaging (DWI) demonstrates no restricted diffusion within the tumor. On MR spectroscopy (MRS), the choline/creatine ratio is greater 2 with low NAA, which typically is seen in high grade tumors. No lipid is present.

Conclusions
We describe a young female with slowly progressive solid tumor in the frontal lobe. Pathology was consistent with papillary glioneuronal tumor (PGNT), which is a rare brain tumor originally reported in 1998 (1). In 2007 World Health Organization classified the PGNT as a grade I neuronal-glial tumor because of its biphasic neurocytic and glial components and indolent clinical course. Most of the reports have been in pathology literature. There was a report in radiology literature which described the tumor as predominantly cystic with enhancement (2). In our case, the tumor is solid with avid enhancement. We also present unusual MR spectroscopy findings, which to our knowledge has not been reported in the neuroradiology literature. The PGNT has a high choline/creatine ratio with low NAA, which typically is seen in high grade tumors even though it is a low grade tumor. Despite its rarity, neuroradiologists should be aware of this rare brain tumor and consider it in the differential diagnosis when the characteristic features are encountered.

KEYWORDS: MR Imaging Brain, MR Spectroscopy, Pediatric Brain Tumors
Pediatric Patient with Multiple Cerebral Cavernous Malformations and Multiple Cranial Nerve Neurofibromas: Report of a Novel Syndromic Presentation
Purpose
To the best of our knowledge, this is the first reported, pathologically proven case of a patient
with multiple cerebral cavernous malformations (CCMs) and multiple cranial nerve
neurofibromas. Independently, multiple CCMs or multiple neurofibromas can be seen in specific
syndromes (familial multiple CCM syndrome and NF1, respectively), but the combination of the
two findings may represent a novel syndromic presentation.

Materials and Methods
A four-year-old boy presented with left-sided facial weakness that had progressed since 18
months of age. Additionally, a CN VI palsy was noted at birth, for which he had undergone two
prior ocular surgeries. Past medical history and family medical history were otherwise
unremarkable. Physical examination revealed complete left-sided facial paralysis. MR imaging
(MRI) revealed abnormal enlargement and enhancement of the left abducens and facial nerves,
as well as multiple, bilateral CCMs. The patient underwent left transmastoid/middle cranial fossa
craniotomy and resection of CN VI and VII nerve sheath tumors with subsequent left facial
erve interposition graft placement. Histopathology revealed spindle cell tumors of moderate
cellularity with minimal nuclear hyperchromasia and pleomorphism. No mitoses were identified.
Surgical specimens were focally positive for S-100 protein, displayed multifocal positivity for
Collagen IV, and demonstrated axons distributed throughout the tumors on
immunohistochemical stains, compatible with neurofibromas.

Results
Postcontrast T1-weighted imaging demonstrated enlargement and enhancement of the cisternal
portion of the left abducens nerve, as well as enlargement and abnormal enhancement of the
tympanic and mastoid segments of the left facial nerve. The other cranial nerves were normal.
Additionally, numerous foci of "blooming" artifact were present within the subcortical and
periventricular white matter of the bilateral cerebral hemispheres and the left cerebral peduncle
on susceptibility-weighted imaging. Several foci of susceptibility artifact demonstrated markedly
low signal intensity on T2-weighted imaging, but no contrast enhancement.

Conclusions
Cerebral cavernous malformations are relatively common and can be either sporadic or inherited.
Inherited CCMs are much more commonly multiple, whereas sporadic CCMs are typically
solitary. Neurofibromas also can be sporadic or inherited, but to date this patient does not meet
diagnostic criteria for NF1. Review of the medical literature finds three cases of solitary CCM in
an NF1 patient: an acquired cerebellar CCM following radiotherapy for a mesencephalic glioma,
a metachronous medulloblastoma and cavernous malformation in an NF1 child, and an NF1
patient with a solitary sellar CCM. The constellation of multiple CCMs and multiple
neurofibromas has not been reported previously in the medical literature and may reflect a
previously undescribed syndrome. The patient and family have been referred to medical genetics
for further evaluation.

KEYWORDS: Cavernous Malformation, Nerve Sheath Tumor, Neurfibroma
Posterior Mediastinal Lipoblastoma with Intraspinal Epidural Extension: An Atypical Presentation of a Rare Entity

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Purpose
To describe imaging features, clinicopathologic correlation as well as surgical management of this uncommon mesenchymal tumor of embryonal fat cells.

Materials and Methods
A ten-month-old female presented with progressive dyspnea and difficulty per oral intake. Plain film of the chest at an outside hospital demonstrated opaque right hemithorax with leftward mediastinal shift. The patient was transferred to our facility for further evaluation, and CT of the chest and abdomen as well as MR imaging of the thoracic spine was performed. A gross total resection was performed, revealing a histopathologic diagnosis of lipoblastoma.

Results
Computed tomography (CT) chest with contrast demonstrated a large heterogeneous lesion within the right hemithorax with complete collapse of right lung and intraspinal epidural...
extension through the neural foramina from T6 through T10 resulting in moderate mass effect and lateral displacement of the spinal cord. In addition there was remodeling of the affected thoracic vertebral bodies and splaying of the ribs. MR imaging (MR) thoracic spine substantiated CT findings and better delineated the extent of the lesion. The large tumor showed internal T1 hyperintensity with suppression on fat saturation and demonstrated heterogeneous enhancement with contrast. The initial differential diagnosis based on MR findings included neuroblastoma, PNET, germ cell tumor such as immature teratoma or pleuropulmonary blastoma. Under image title- T1 postcontrast axial image shows large right hemithorax heterogenous signal intensity lesion extending through neural foramen into spinal canal and displacing the spinal cord to left. Conclusions

Lipoblastomas are rare benign tumors arising from embryonic adipocytes and lipoblasts. Although only 10% of all pediatric soft tissue tumors are adipose in origin, lipoblastoma or liposarcomas should be considered in the differential diagnosis of rapidly growing, large fat-containing masses in infants within the posterior medisatinum. Only three cases of lipoblastoma invading the spine have been reported previously. Imaging is paramount for presurgical planning as treatment of choice is surgical excision. After complete excision the prognosis is excellent with recurrence rate of less than 25%. Caption for image: T1 post-contrast axial image shows large right hemithorax heterogenous signal intensity lesion extending through neural foramen into spinal canal and displacing the spinal cord to left.

KEYWORDS: Epidural, Intraspinal

(Filename: TCT_EE-98_T1postcontrast.jpg)

EE-101

Recurrent Subarachnoid Hemorrhage near Occipital Craniectomy site without Angiographic or MRI Source in a Child with Sickle Cell Disease and Past History of Surgical Decompression of a Chiari I Malformation

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Purpose
1. Present an unusual case of repeated focal subarachnoid hemorrhages near the occipital craniectomy site in a child with sickle cell disease and discuss possible etiologies. 2. Display the imaging findings and review literature pertinent to this uncommon presentation.

Materials and Methods
A 10-year-old girl with history of sickle cell anemia and past uneventful Chiari I decompression (nine months earlier) presented with a second episode of headache, posterior neck pain and nausea and vomiting. Her first episode, which had occurred three months earlier, had been managed with pain medications and was presumed to be a vaso-occlusive crisis. A lumbar puncture performed at that time was bloody but presumed traumatic without xanthochromia and a head computed tomography (CT) was unremarkable except for demonstrating the postoperative site for Chiari decompression. On this second episode, a cervical spine and brain MR imaging (MRI) was performed and showed a triangular focus of hemorrhage at the posterior cervico-medullary junction. This was new from a routine postoperative brain MRI done months earlier. A CT angiogram (CTA) and a cerebral angiogram were performed given this new hemorrhage but failed to show an abnormality. A repeat MRI five days later demonstrated resolution of the hemorrhage and given clinical resolution of symptoms, the patient was discharged. Another three months later, the patient returned with a third similar episode of symptoms. An MRI and MRA of brain and neck were performed and demonstrated a recurrent similar abnormality in the posterior fossa. No aneurysm, arteriovenous malformation was seen on either MRA. An MRI of the cervical spine did not show any additional abnormality. A repeat cerebral angiogram was recommended by neurosurgery and also failed to show an abnormality. Repeat lumbar puncture was technically difficult but performed and showed hemorrhage without xanthochromia.

Results
MR imaging cervical spine (Figure 1) and brain at the second episode demonstrate a triangular (arrow) T2 hypointense and T1 isointense to spinal cord/brain stem focus just posterior to the cervico-medullary junction, consistent with an intradural (subarachnoid) hemorrhage. Follow-up MRI five days later showed resolution of abnormality. MR imaging brain and cervical spine on third episode demonstrated a similar site of hemorrhage in the low posterior fossa adjacent to the craniectomy site. Cerebral angiograms and CTA were negative.

Conclusions
Spontaneous subarachnoid hemorrhage has been described in patients with sickle cell disease both with and without associated aneurysms. In some cases it follows blood transfusions and in others no etiology is found. What is unusual with respect to this patient, is the repeated focal and isolated hemorrhage near the occipital craniectomy. Review of the neurosurgical reports indicates that the dura was thickened and resected at surgery and after resection was closed with a bovine pericardium graft and the suture line coated with duraseal. There are reports in literature of repeated hemorrhage near occipital craniectomy repair sites though most were extradural hemorrhages and were adjacent to predominantly silastic grafts. The negative angiograms and the repeated hemorrhage at the postoperative site still favor the postoperative site (whether related to the dural graft or intrinsically) as a source possibly facilitated by her medical condition of Sickle Cell disease. We believe that radiologists and clinicians involved in the care of such children should be aware of this clinical and radiological conundrum.
Reversible diffusion-restriction lesion representing Cytotoxic Intramyelinic Edema in a patient with Traumatic Brain Injury

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Purpose
We report this case to increase the awareness of magnetic resonance imaging (MRI) features of cytotoxic intramyelinic edema visualized as reversible areas of restriction diffusion in diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) maps in a patient with traumatic brain injury (TBI).

Materials and Methods
An 8-year-old girl who was hit by a truck was brought by the emergency medical services (EMS) to the emergency department. The Glasgow-Coma-Scale (GCS) was 5/15 when EMS team
attended on the scene. She suffered polytrauma with TBI resulting in intubation and ventilation for the first two days.

Results
The computed tomography (CT) scan showed depressed right parietal bone fracture with subarachnoid hemorrhage requiring neurosurgical intervention. Her GCS improved dramatically up to 15/15 on the sixth day. Eleven days later, she experienced cognitive impairment rendering MRI scan necessary. The scan revealed the known depressed fracture and subarachnoid hemorrhage with contrecoup injury as T2 high signal intensity areas in the inferoposterior portion of the left front lobe and the left temporal lobe. Scattered punctate hemorrhagic areas were seen in both cerebral hemispheres in susceptibility-weighted images (SWI). Diffusion-weighted imaging and ADC maps showed diffusion restriction involving the corpus callosum, periatral white matter and in the right centrum semiovale with no significant hemorrhagic foci in these regions. On follow-up MRI scan 13 days later, there is complete resolution of the described abnormal DWI/ADC-restriction areas. The last neurological examination seven months after the trauma showed residual cognitive impairment with neuropsychological diagnosis of attention deficit disorder.

Conclusions
This reported case revealed complete radiological resolution of the cytotoxic intramyelinic edema. This is a rare entity should be kept in mind when diffusion restricted abnormalities are present in the clinical setting of traumatic brain injury especially if there is no white matter hemorrhagic foci. The underlying pathogenesis for such phenomena is uncertain. However, disruption of the cellular mechanism caused by trauma leads to diffuse cytotoxic injury which results in diffuse intramyelinic edema. The cellular protective pathway is not functioning at this stage but has not been damaged yet, which gives a reasonable explanation for the reversibility of these lesions in the follow-up imaging.

KEYWORDS: Diffusion-Weighted Imaging, Pediatric Brain, Traumatic Brain Injury
Salivary Gland Anlage Tumor – First Report of Fetal Imaging

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Purpose
We present a case of nasopharyngeal obstruction caused by a congenital salivary gland anlage tumor detected in utero. We will discuss the main differential diagnosis that should be applied in this scenario and the implications of this diagnosis in the management of the pregnancy.

Materials and Methods
The mother was a healthy 31-year-old gravida para 3 with late prenatal care. She was referred to our institution at 36 weeks for further evaluation of severe polyhydramnios. Fetal MR imaging (MRI) demonstrated a lobulated nasopharyngeal mass obstructing the airway. The patient was extensively counseled. At 37½ weeks, the baby was delivered by EXIT (ex utero intrapartum treatment) to airway procedure due to the concern for airway compromise at birth. Neonatal contrast-enhanced CT was obtained prior to resection of the mass at four days of life. A large,
pedunculated, midline nasopharyngeal mass tethered to the posterior septum with continuity with the adenoid pad was found at surgery (3 x 2 cm). Histopathology revealed salivary gland anlage tumor.

Results
Fetal MRI demonstrated a lobulated soft tissue mass (2.6 x 1.5 x 1.9 cm) occluding the nasopharynx and posterior left nasal cavity with intact skull base and normal intracranial structures. The lesion was isointense to hypointense on T2 and hyperintense on T1-weighted imaging relative to the brain parenchyma. There were no internal flow voids. There was significant polyhydramnios and a small stomach, supporting associated pharyngeal/airway obstruction. The main differential consideration was nasopharyngeal teratoma, dermoid and salivary gland anlage tumor. Postnatal contrast-enhanced CT imaging demonstrated a mildly enhancing lobulated lesion in the nasopharynx with mild expansion of the left posterior nasal cavity and stable size. The uploaded sagittal single shot fast spin echo fetal MR image demonstrates the mass occupying the nasopharynx between the nasal cavity and the oropharyngeal airway.

Conclusions
Congenital midline nasopharyngeal masses include teratoma, dermoid, encephalocele, craniopharyngioma, glial heterotopia and salivary gland anlage tumor. Salivary gland anlage tumor is a rare but characteristic lesion presenting in the early neonatal period with nasal or pharyngeal obstruction. It is a benign salivary gland lesion and surgical resection is curative.

KEYWORDS: Fetal, Nasal Mass, Salivary Gland
Subcortical Diffusion Abnormalities Without Cortical Abnormalities After Prolonged Seizure in a Pediatric Case

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Purpose
To illustrate the possible predictive value of acute changes in diffusion-weighted imaging in a case of prolonged seizure activity with extensive subcortical restricted diffusion.

Materials and Methods
This six-year-old girl with previous chronic sinovenous thrombosis and subsequent bilateral thalamic infarcts presented in status epilepticus and slow-to-resolve right-sided Todd's paralysis. The patient has congenital microophthalmos and congenital cataracts with a likely genetic carnitine transporter deficiency. Prior to the episode of status epilepticus, while the patient demonstrated global developmental delay, her development was advancing with no regression.

Results
On the immediate post-ictal MR imaging (MRI) images obtained, there was evidence of restricted diffusion with extensive cytotoxic edema involving the subcortical white matter including the U-fibers in the frontoparietal and temporo-occipital regions. No evidence of direct cortical involvement or central white matter abnormalities. Corresponding marked decreased signal in these same regions on MRI raise concern for permanent underlying parenchymal injury. Repeat MRI two months later demonstrated interval resolution of the cytotoxic edema with marked asymmetric left-sided widespread cerebral atrophy.

Conclusions
Subcortical diffusion abnormalities without cortical involvement is very rare after a prolonged seizure. Significant restricted diffusion with marked decreased signal intensity on the corresponding apparent diffusion coefficient (ADC) map may have predictive value in determining underlying permanent parenchymal subcortical injury. It has been postulated that the increased ratio of glutamine to glutamate creates an osmotic gradient causing astrocyte swelling or edema. This case supports the theory that prolonged seizures may cause deep subcortical white matter involvement.

KEYWORDS: ADC, Diffusion-Weighted Imaging, Pediatric Epilepsy
Symptomatic Cervical Calcific Discitis with an Associated Schmorl’s Node and Abnormal Vertebral Body Signal in a Pediatric Patient

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Purpose
Demonstration of cervical calcific diskitis with an associated Schmorl's node in a pediatric patient with neck pain. Calcific diskitis is an uncommon condition which may be painful, particularly when it occurs in the cervical spine (1). Cervical disk calcification has been well described as a cause of pain in the past (2). However, reports of associated intravertebral migration (Schmorl's node) are rare (3, 4, 5) with few, if any, prior reports in the cervical spine.

Materials and Methods
We submit a case of a six-year-old female who presented with three weeks of neck pain without known injury. Physical exam revealed a degree of torticollis and marked diminished range of motion to the left. Given the initial imaging abnormalities of the C3-C4 disk space, including calcification, and a lucent lesion with abnormal signal throughout the C3 vertebral body (detailed below), she was treated with conservative management and close imaging follow up rather than a more aggressive treatment or biopsy. Follow-up imaging demonstrated resolution of the calcification, and the patient's symptoms resolved.

Results
Computed tomography (CT) of the cervical spine demonstrated calcification within the C3-4 space. MR imaging (MRI) with gadolinium revealed there was also a contiguous well circumscribed T2 hyperintense lesion in the inferior aspect of the C3 vertebral body suggestive of a Schmorl's node with edema and enhancement throughout the C3 vertebral body. Follow-up MRI at six weeks showed stability of the calcified extruded C3-4 disk, slight shrinkage of the
Schmorl's node within the inferior C3 vertebral body, and decreasing vertebral body edema and enhancement. Three-month follow up CT demonstrated near complete resorption of the calcification in the disk space with a persistent Schmorl's node consistent with calcific diskitis.

Conclusions
It is important to recognize calcific diskitis with an associated Schmorl's node to avoid misdiagnosis of another vertebral body lucent lesion or infection, and to prompt conservative treatment and imaging follow up (6). This case nicely demonstrates the follow-up imaging findings in calcific diskitis with an associated Schmorl's node and highlights the excellent prognosis.

KEYWORDS: Disk Herniation, Pediatric Spine, Spinal Imaging
Purpose
Atretic occipital cephalocele is an uncommon congenital anomaly, which usually presents as a nodular, small mass just above the external occipital protuberance. Patients with atretic occipital cephaloceles appear to have a low incidence of associated anomalies and a good prognosis for normal development. We herein present two cases of atretic occipital cephalocele with large posterior cyst and enlarged posterior fossa.

Materials and Methods
(Case 1) A male newborn baby of two days after birth was presented with a small cranial mass with bone defect. MPR and 3D images of computed tomography (CT) visualized the bone defect. Conventional and CISS image of MR imaging (MRI) visualized cephalocele of 2cm in diameter, fibrous tissue connecting cephalocele with bottom of the vermis, a large posterior cyst which communicated with the IVth ventricle, and enlarged posterior fossa and subependmal heterotopia. MR venography (MRV) visualized the highly located sinus confluence and cephalocele under the confluence. (Case 2) A one-year-old girl presented with small cranial nodular mass. Conventional and CISS image of MRI visualized small occipital mass suggested to be atretic cephalocele, sinus tract though the skull, a large posterior cyst which communicated with the IVth ventricle, and enlarged posterior fossa. The sinus confluence was highly located and nodule was under the confluence.

Results
High resolution heavy T2-weighted images visualized atretic occipital cephalocele with intracranial anomaly of large posterior cyst with enlarged posterior fossa in both cases.

Conclusions
Large posterior fossa cysts communing with the IVth ventricle in these two cases are suggested to be Blake's pouch cysts. Over distention of posterior fossa due to large Blake's pouch cyst might be the etiology of atretic occipital cephalocele in these two cases. High resolution heavy T2-weighted images of MRI is useful to visualize these anomalies.

KEYWORDS: Atretic Occipital Cephalocele, Dandy-Walker Malformation
Unusual Intracranial Metastasis from Prostatic Embryonal Rhabdomyosarcoma.

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Purpose
Rhabdomyosarcoma (RMS) is a malignancy of children and young adults in which osseous and pulmonary metastases are common. Central nervous system (CNS) metastases from rhabdomyosarcoma are uncommon. When present, intracranial metastases are preceded almost always by pulmonary metastases, and intracranial metastases are predominantly seen to arise from the meninges. This is an unusual case of an infant diagnosed with prostatic rhabdomyosarcoma who subsequently developed a large, solitary extraaxial metastasis with pial
invasion without dural involvement nearly after a year of treatment with no osseous or pulmonary metastatic disease.

Materials and Methods
A 4-month-old male patient, presented to the ER with decreased appetite and three episodes of nonbilious vomiting. On physical examination, the pediatrician noted suprapubic fullness and recommended a pelvic ultrasound which revealed a 5 x 5 cm pelvic mass. On biopsy, the pelvic mass proved to be an embryonal rhabdomyosarcoma originating from the prostate. Metastatic work up was negative at that time. Following resection of the pelvic tumor, the patient underwent 14 cycles of chemotherapy and radiation. Subsequent chest CT exams and bone scans at regular intervals, did not reveal pulmonary or osseous metastasis. At 14 months of age, nearly after a month of completion of treatment, the patient presented with weakness of the left upper extremity and facial droop. Head CT and MRI brain examinations were ordered, both revealing a large right frontal region intracranial mass. After resection of this intracranial mass, the patient was treated with 20 additional cycles of chemotherapy and photon beam therapy. Interval brain MRIs revealed stable postoperative changes. A month after completion of treatment for CNS relapse, the patient developed a seizure. Repeat brain MRI revealed extensive T2 hyperintensity with associated enhancement in the midline and parafalcine regions, right more than left, predominantly leptomeningeal in location and to a lesser extent parenchymal.

Results
Head CT revealed a mixed hypo/isodense mass without hemorrhage. Follow-up brain MRI performed for further characterization of the mass demonstrated a large mixed T2 signal intensity extra-axial mass deforming the right frontal lobe. The mass, measuring approximately 7.6 x 6.0 cm, demonstrated T2/FLAIR hyperintensity, some regions of restricted diffusion, and heterogenous enhancement. Mass effect deformed the right frontal horn, and produced 7mm of right-to-left shift of the midline stuctures with subfalcine herniation. Effacement of the right sylvian fissure and perimesencephalic cistern was additionally present.

Conclusions
Embryonal rhabdomyosarcoma, metastatic to the leptomeninges from the prostate, without prior pulmonary or osseous metastatic disease is extremely rare in infants. Rhabdomyosarcoma (RMS) is a malignancy of mesenchymal cell origin that occurs primarily in children and young adults. The most common sites for this tumor, in order of frequency are: 1) head and neck; 2) genitourinary tract and 3) biliary tract. The different pathological subtypes include embryonal, alveolar and pleomorphic. Central nervous system (CNS) metastases from embryonal rhabdomyosarcoma are uncommon, being seen in only 2/85 cases in one series. Central nervous system (CNS) metastases in primary rhabdomyosarcoma tumors are typically meningeal rather than intraparenchymal (1). They are uncommon in infancy but carry a worse prognosis when present, as compared to adults. Patients who go on to develop intracranial metastases are almost always (>90% of cases) preceded by lung metastases (1, 2). In another series based on autopsy data, 6% of embryonal rhabdomyosarcomas developed cerebral metastases, but all of the patients had pulmonary metastases prior to development of CNS metastases (3).

KEYWORDS: Metastases, Rhabdomyosarcoma
Vigabatrin Induced Central Nervous System Toxicity in a Child with Aicardi Syndrome

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Purpose
To demonstrate the MR imaging (MRI) findings of central nervous system (CNS) vigabatrin toxicity in an infant with Aicardi syndrome.

Materials and Methods
A 1-year-old female with pharmacologically refractory seizures and an established diagnosis of Aicardi syndrome underwent a noncontrast MRI of the brain prior to placement of a vagal nerve stimulator. Seizures had begun at one month of age, and were poorly controlled with anti-seizure...
therapy and a ketogenic diet. Introduction and gradual increase of Vigabatrin reduced seizure frequency.

Results
MR imaging demonstrated dysgenesis of the corpus callosum with colpocephaly and an interhemispheric cyst. A malformation of cortical development was present within the left frontal lobe, consisting of atypically located areas of thickened cortex with a microserrated contour, suggestive of polymicrogyria; a focus of gray matter heterotopia studded the margin of the left lateral ventricle. All of the aforementioned findings are consistent with the patient's history of Aicardi syndrome. New T2/FLAIR hyperintensity was noted within the anteromedial aspect of both thalami as well as portions of the dorsal pons and midbrain, with correlating diffusion restriction most impressive in the dorsal brainstem. These abnormalities of the thalami and brainstem resolved on follow-up examination.

Conclusions
The triad of callosal dysgenesis, infantile spasms, and chorioretinal lacunae is pathognomonic for Aicardi syndrome, a rare disorder likely resulting from an X-linked dominant mutation. Infantile spasms are a form of epilepsy that is unique to the developing brain, with a potential for poor neurodevelopmental outcome if the spasms are not controlled. ACTH and vigabatrin have been recognized as effective in the treatment of infantile spasms. Vigabatrin is associated with an irreversible retinopathy in adults, causing mild to moderate concentric peripheral visual field deficits. Infants are prone to developing vigabatrin CNS toxicity, manifesting as a reversible T2/FLAIR hyperintensity in the brainstem, thalami, and basal ganglia with concomitant diffusion restriction. These correlate to intramyelinic edema and microvacuolation seen on histopathological studies of animals. Infants are thought to be vulnerable on the basis of relative immaturity and ongoing myelination. The natural history of infantile spasms increases the likelihood that these patients will be treated with vigabatrin at a young age and consequently puts them at risk for the associated CNS toxicity. Here we share both the MRI features of vigabatrin toxicity as well as those of Aicardi syndrome in an effort to familiarize other radiologists with both conditions.

KEYWORDS: Congenital Brain Malformations, Drugs, Epilepsy

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Excerpta - Spine
EE-108
6:30AM - 9:00PM

A Genitourinary Sign in the Neuraxis: Spinal Cord Endometrioma with “Shading”

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Purpose
To present a case of spinal cord endometrioma with diagnostic strategy and review possible etiologies for intramedullary endometrioma.

Materials and Methods
A 28-year-old female with a history of endometriosis and dyspareunia, treated with luprolide acetate, initially presented with urinary retention. Subsequently diagnosed with a compressive lumbar hematoma, she underwent decompression, but declined resection of a presumed hemorrhagic spinal tumor. Seventeen months later, she redeveloped urinary retention with leakage, new pain radiating from the buttocks to the thighs, a burning sensation in both feet and progressive lower extremity weakness. Symptoms were cyclical monthly and improved with chemically induced menopause. Neurosurgical exploration of the lumbar cord revealed an enlarged, hypervascular conus and a cystic lesion that previously had been disrupted leaving a dark greenish-brown wall. Frozen sections of the lesion showed gliotic spinal cord with hemosiderin staining and no neoplasm identified. Final pathology showed reactive, gliotic spinal cord with fragments of endometrial epithelium, stroma, and scattered hemosiderin laden macrophages, consistent with endometriosis. At follow up, patient reported improvement in all cord-related symptoms.

Results
Pre-operative MRI: solitary, ovoid, central 2.4 cm by 1.1 cm conus medullaris lesion, expanding the adjacent central canal of the cord. The mass was homogeneously T1-shortened and not convincingly enhancing. Central and peripheral T2-shortening suggested central blood products (so-called "shading" sign) with a hemosiderin/fibrous rim/wall. The adjacent cord was normal.

Conclusions
In endometriosis, endometrial tissue is found in extra-uterine locations, most commonly within the peritoneal cavity, but sometimes distant sites. Proposed etiologies include direct spread, hematogenous dissemination, or metaplasia of embryonic rests into endometrial tissue. When intraperitoneal, symptoms include pain, dysmenorrhea, and infertility; when extra-peritoneal, symptoms vary by affected area. Diagnosis usually entails direct visualization. Treatment is medical or surgical. Endometriomas involving the spinal cord are uncommon and usually present with symptoms related to local mass effect. These symptoms are not specific to endometriosis and can mimic other causes of spinal cord pathology. Location dependent symptoms include pain, weakness, and bladder or bowel dysfunction. Symptoms can be cyclical, due to hormonal response. Lesions may hemorrhage, resulting in additional mass effect. Proposed etiologies of spine endometriosis include dissemination of endometrial tissue via Batson's plexus, development or metaplasia of embryonic rests, or occurring hematogenously after surgical interventions involving the uterus. The classic imaging finding of endometriosis in the pelvis is described as the "shading sign." "Shading" refers to a T1-shortened structure with a variable pattern of T2-shortening: focal, diffuse, complete signal loss, or a layering dependent fluid level. The mechanism is complex and appearance depends on protein and iron concentrations accumulated during repeated hemorrhages. The presence of a T1-shortened spinal cord lesion may first raise the possibility of primary CNS hemorrhagic lesions including: cavernous malformation, ependymoma, hemangioblastoma, or melanoma. The "shading" sign, most commonly used in genitourinary imaging, in a lesion in a female patient may raise the possibility of a hemorrhagic lesion, such as an endometrioma, and should prompt search for additional history, specifically cyclic symptoms.
A Novel Approach: CT Guided Epidural Blood Patch Treatment in the Absence of a Myelographic-Evident CSF Leak

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Purpose
To demonstrate a novel approach of treating spontaneous intracranial hypotension without myelographic evidence of a cerebrospinal fluid (CSF) leak by using computed tomography (CT) to deliver a transfenoral blood patch adjacent to perineural root sleeve cysts.

Materials and Methods
A 56-year-old previously healthy man presented with daily positional headaches without a history of trauma or spinal intervention. MR imaging (MRI) brain with gadolinium showed diffuse pachymeningeal enhancement consistent with spontaneous intracranial hypotension. Computed tomography myelogram demonstrated no direct evidence of a CSF leak but multiple small bilateral perineural root sleeve cysts from T6-T9 were present. The patient did not respond to multiple traditional epidural blood patches. To avoid surgical exploration, the decision was made to use CT guidance to deliver a dorsal transfenoral epidural blood patch adjacent to the most prominent perineural root sleeve cyst. A 20-gauge needle was inserted into the epidural space adjacent to the right T8-9 prominent perineural root sleeve cyst using CT guidance. Fifteen cc of the patient's blood was injected into the epidural space. The patient tolerated the procedure well and there were no complications. After the procedure, patient's headache significantly improved. This improvement was sustained over subsequent months.

Results
MR imaging brain with gadolinium shows diffuse pachymeningeal enhancement consistent with spontaneous intracranial hypotension. Image from CT myelogram demonstrates needle insertion into the epidural space adjacent to the right T8-9 perineural root sleeve cyst for blood patch placement.

Conclusions
Computed tomography-guided epidural blood patching can be used for the treatment of spontaneous intracranial hypotension in the myelographic absence of a CSF leak by targeting perineural root sleeve cysts. Computed tomography-guided epidural blood patching is a new, safe and effective alternative compared to traditional surgical exploration.

KEYWORDS: Blood Patch, Headaches, Intracranial Hypotension
Active Extravasation of Gadolinium-Based Contrast Agent On Lumbar Spine MRI Following Traumatic Lumbar Puncture

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Purpose
Introduce a case of active extravasation of gadolinium-based contrast agent in the central nervous system (CNS).

Materials and Methods
A 39-year-old male with AIDS who presented with headache. Imaging revealed brain lesions concerning for toxoplasmosis versus CNS lymphoma, for which empiric toxoplasmosis treatment was initiated. As part of the work up, the patient also underwent lumbar puncture which was performed at bedside. Shortly after the procedure, the patient developed new bilateral leg weakness, diminished sensation below T10, decreased rectal tone, and urinary retention. MR imaging of the lumbar spine demonstrated a large subdural hematoma and active extravasation of gadolinium-based contrast. Patient underwent emergent surgical decompression. Intraoperative
findings included subdural hematoma compressing the cauda equina. During evacuation, an actively bleeding vessel was identified. Surgeons noted that dissection planes oozed significantly throughout the procedure. Evaluation for coagulopathy showed decreased fibrinogen.

Results
MR imaging demonstrated a 5.6 x 1.1 cm intradural extramedullary collection at the level of L3-5 which compressed the cauda equina. The collection was isointense to CSF on T2-weighted imaging and slightly T1 hyperintense. On T2-weighted imaging, there was a peripheral rim of T2 hypointensity. On the sagittal postcontrast images, there was a curvilinear area of apparent contrast enhancement extending from the central thecal sac anteroinferiorly and contacting the posterior aspect of the right L4 vertebral body. On the axial postcontrast images which were acquired several minutes after the sagittal postcontrast images, the areas of apparent contrast enhancement had significantly increased. Therefore, it was concluded that the areas of apparent contrast enhancement in fact represented active extravasation of gadolinium-based contrast agent.

Conclusions
While active extravasation of gadolinium-based contrast in the liver has been reported, a literature review does not reveal any reports of active extravasation of gadolinium-based contrast in the CNS. In this case, a patient underwent a common diagnostic procedure and suffered an uncommon complication of lumbar subdural hematoma resulting in cauda equina syndrome. Subdural hematoma following lumbar puncture is a rare but reported complication, as noted by Gaucher (1), Guthikonda (3), and Vos (5). Contrast-enhanced MRI not only demonstrated the subdural hematoma, but also showed areas of apparent contrast enhancement. A key finding in this case was the increase in the areas of apparent contrast enhancement on the sagittal postcontrast images which were acquired several minutes after the axial postcontrast images, thereby confirming a dynamic process and leading to the diagnosis of active extravasation.

KEYWORDS: Contrast, Contrast Enhancement, Contrast Extravasation
An Unusual Primary Osseous Tumor: Desmoplastic Fibroma of the Thoracic Spine

P Hill¹, D Pastel¹

Figure 1. Sagittal and axial post-contrast fat-saturated T1W image was obtained 7 minutes after the sagittal image. Apparent enhancement within the thecal sac (curvilinear on sagittal and markedly increased by the time axial image was obtained.)
**Dartmouth Hitchcock Medical Center, Lebanon, NH**

**Purpose**
To report the extraordinarily rare case of a thoracic spine desmoplastic fibroma causing myelopathic symptoms.

**Materials and Methods**
A 46-year-old male with a five-year history of lower back pain and prior L5-S1 diskectomy presented with new onset of parasthesias, myelopathic gait and hyperreflexia. A total spine MR revealed a homogenous T1 & T2 hypointense, expansile mass involving the T3 vertebral body, spinous process and articulating processes with epidural extension causing cord compression. Computed tomography (CT) examination detected a destructive lesion with a large lytic defect in the T3 vertebra with complete replacement of the osseous matrix in the majority of the vertebral body and posterior elements with a sclerotic inferior and anterior osseous remnant. To assess the histological diagnosis, a biopsy was attempted but due to the hard density of the mass was unsuccessful. A marginal tumor resection was performed and stabilization with T1-T6 laminar hook and posterior rods. Pathologic staining and immunoreactivity confirmed a diagnosis of desmoplastic fibroma.

**Results**
Axial CT image in a bone window, through the T3 vertebral body. A sclerotic sliver of the vertebral body remains, as the destructive lesion has replaced the osseous matrix. Scattered small fragments of the posterior elements are seen at the costo-vertebral joints and adjacent to the central canal. The spinous process is seen in the center of the image completely replaced by a soft tissue density. T1 sagittal image of the thoracic spine. A fairly homogenous, hypointense, expansile mass invades the majority of the T3 vertebral body and spinous process with obvious compression of the spinal cord at this level.

**Conclusions**
Desmoplastic fibromas represent an extremely rare primary osseous tumor and localization to the thoracic spine has been described only in a few case reports. Due to the paucity of cases, the radiologic characteristics have not been fully delineated. A combination of CT and MR imaging is recommended in the literature for full characterization of the osseous matrix and evaluation of intramedullary involvement for pre-operative planning. A wide margin of excision is recommended, as tumor recurrence has been reported to be between 37-72%. In cases where en bloc resection is not performed, follow up with contrast-enhanced MR is recommended for continued surveillance. Now, two years postresection, the patient has no radiologic evidence of recurrence and is pain-free, working and living an active life.

**KEYWORDS:** Spinal Neoplasm
Case Report: Very Rare, High Risk HPV Oropharyngeal Squamous Cell Carcinoma Metastasis Arising in a Preexisting Cervical Spine Arthrodesis.

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Purpose
Osseous metastases from primary oropharyngeal cancer is the second most common site of metastases after lung, however cervical spine bony metastatic disease is uncommon. This is the first reported case of bony metastatic disease arising at the site of a pre-existing anterior cervical diskectomy and fusion (ACDF) from a primary high risk human papilloma virus (HPV) oropharyngeal squamous cell carcinoma (OPSCC).

Materials and Methods
A 53-year-old male presented with a slowly enlarging left neck mass. The patient had undergone an ACDF of C4-C7 four years prior to presentation and posterior decompression and fusion of C3-C7 three years prior to presentation. Biopsy of the tonsil returned nonkeratinizing squamous cell carcinoma (SCC) positive for high risk HPV by in situ hybridization. Staging PET-CT showed contralateral nodal disease without distant metastases. Final diagnosis was HPV positive
stage IVa (T3N2cM0) SCC of the palatine tonsil. Surveillance PET-CT three months following completion of radiation therapy found a new 7mm FDG avid nodule in the lingula and FDG uptake in the C4 vertebral body without fracture or osteolysis. Computed tomography-guided biopsy of the lung nodule confirmed metastatic SCC. Tissue sampling of the cervical disease was not obtained and metastatic disease was presumed based on imaging.

Results
Sagittal T2 and sagittal T1 postcontrast show an expansile T2 hypointense, enhancing C4 mass corresponding to the FDG avid lesion.

Conclusions
The imaging findings are consistent with a metastatic lesion and given the presence of pulmonary metastatic OPSCC the cervical vertebral lesion is very likely from the same primary. There are no findings to support differential considerations of bony fracture, arthrodesis failure, infection, or radiation induced osteonecrosis. There is a theoretical increased risk of metastatic disease at the site of arthrodesis given the altered micro environment with active cytokine and molecular interactions. Patients with bony spinal metastatic disease are at increased risk of pathologic fracture and neurologic compromise. Patients with metastatic disease at the site of prior spinal fusion and decompression have fewer treatment options and are at greater risk for complication than those with no prior spinal surgery. The potential for metastasis at the site of prior spinal fusion should be a consideration at the time of initial cancer diagnosis in order to anticipate potential future complications.

KEYWORDS: Arthroplasty, Cervical, Metastases

EE-110

Extramedullary Anaplastic Ependymoma: A Rare Cause of Spinal Cord Compression

B Griffith1, B Carter1, J Corrigan1, S Patel1, A Mahmood1
Purpose
Ependymomas are the most common intramedullary spinal neoplasm in adults, typically occurring in the cervical or thoracic spine. Intradural extramedullary ependymomas are quite rare, and when present, are often initially misdiagnosed as neuromas or meningiomas. This excerpt describes a rare case of an intradural extramedullary anaplastic ependymoma causing compression of the spinal cord.

Materials and Methods
We present the case of a 49-year-old female with a four-month history of left leg numbness and weakness, as well as a band-like burning sensation in her thoracic region. The patient also complains of increasing difficulty with urination. The patient underwent a T6-T12 laminectomy with microdissection at which time a large intradural extramedullary tumor was removed from the spinal canal. The tumor was noted to be separate from the cord with only a thin extension to the filum. Pathology demonstrated an ependymal neoplasm with hypercellularity, microvascular proliferation, tumor necrosis, and a Ki-67/ MIB-1 proliferation index of up to 15%. These findings are consistent with an intradural extramedullary anaplastic ependymoma. Despite achieving gross total surgical resection, the patient had persistent leg weakness and was to undergo radiation and chemotherapy.

Results
Thoracic spine MR demonstrates a large T2 hyperintense, T1 isointense solid enhancing mass in an intradural and extramedullary location. The mass causes severe mass effect along the anterior aspect of the thecal sac resulting in spinal cord compression and faint cord edema. There is no neuroforaminal remodeling or evidence of leptomeningeal or intramedullary enhancement. Upon imaging the remainder of the central nervous system, no additional enhancing lesions are identified.

Conclusions
Ependymomas are the most common intramedullary spinal neoplasm in adults. In contrast, intradural extramedullary ependymomas are quite rare, with less than 20 reported cases in the literature. Ependymomas typically arise from cells lining the ventricular system of the brain or central canal of the spinal cord. However, extramedullary ependymomas are postulated to arise from ectopic ependymal cells that are pinched off from the neural tube during its closure. Given the rarity and the potential for confusion with more common lesions such as neuroma or meningioma, it is important that neuroradiologists consider ependymomas in the differential diagnosis of intradural extramedullary spinal lesions.

KEYWORDS: Cord Compression, Ependymoma, Extramedullary
Isolated Hypoglossal Nerve Palsy Caused by an Atlantoaxial Synovial Cyst

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Purpose
Hypoglossal nerve palsy is an uncommonly encountered phenomenon with a wide variety of causes, often creating a difficult diagnostic dilemma for the clinician. Typical underlying pathologic processes include brainstem infarctions, demyelinating diseases, gliomas, infections, and hypoglossal nerve schwannomas. We report a rare case of isolated hypoglossal nerve palsy secondary to hypoglossal nerve impingement by an atlantoaxial synovial cyst. Distinguishing this entity from other more common lesions responsible for hypoglossal nerve palsy can have important treatment and prognostic implications, as emphasized by our case report.

Materials and Methods
A 69-year-old female presented with a two-year history of progressive tongue weakness, paresthesias, and right-sided tongue atrophy. Pertinent physical exam findings included isolated right 12th nerve palsy with ipsilateral tongue deviation and fasciculations. Outside MR imaging (MRI) described a small mass contiguous with the right hypoglossal canal, felt to be most consistent with a meningioma. Following radiation oncology consultation at our institution, a planning MRI was obtained prior to stereotactic radiation for presumed meningioma. MR imaging revealed a T2 hyperintense, marginally enhancing lesion adjacent to the right hypoglossal canal and approximating the hypoglossal nerve. The lesion had decreased in size when compared to an outside study performed 10 months earlier. Meningioma and schwannoma were excluded on the basis of predominant T2 hyperintensity, marginal enhancement, origin extrinsic to the hypoglossal nerve, and interval size decrease. Upon careful review of contiguous T1 postgadolinium images, a connection was established between this marginally enhancing lesion and the superior aspect of the right atlantodental joint. This constellation of findings was believed most suggestive of a superiorly projecting atlantoaxial synovial cyst compressing the cisternal segment of the hypoglossal nerve. In our brief literature search, cranial nerve XII palsy secondary to a craniocervical junction synovial cyst only has been described in four other case reports. The patient opted for conservative treatment as symptoms were not significantly limiting.

Results
MR imaging demonstrated a small skull base mass along the medial margin of the right hypoglossal canal adjacent to the cisternal segment of the hypoglossal nerve. The lesion is T1 hypointense, T2 hyperintense, and shows marginal enhancement postcontrast. Contiguous slices show a clear connection to the superior aspect of the atlantodental joint. Findings are most compatible with a atlantoaxial synovial cyst. Selected axial T2 space and T1 postcontrast MR images are shown below with yellow arrows identifying the lesion.

Conclusions
Hypoglossal nerve palsy rarely is seen in isolation, more common in the setting of multiple lower cranial nerve palsies. Imaging evaluation of hypoglossal nerve palsy requires high resolution imaging and detailed understanding of the nerve anatomy as it courses from the medulla to the intrinsic and extrinsic muscles of the tongue. A segmental approach has been proposed in the literature to organize hypoglossal nerve pathology based on the portion of the nerve affected. Craniocervical junction synovial cysts may clinically present with hypoglossal nerve palsy, and
have been previously reported. While uncommon, this entity should be remembered when a juxtaarticular, T2 hyperintense lesion lacking central enhancement is seen on MRI.

KEYWORDS: Hypoglossal Nerve, Skull, Spinal Cysts

(Filename: TCT_EE-105_SynovialcystASNRabtractimages2.jpg)

EE-112  

Leptomeningeal Carcinomatosis: Case Report of an Unusual Manifestation of Multiple Myeloma

O Banon\textsuperscript{1}, G Popradi\textsuperscript{2}, D Tampieri\textsuperscript{1}, D Melancon\textsuperscript{1}, M Cortes\textsuperscript{1}  
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\textsuperscript{2}Royal Victoria Hospital, McGill University, Montreal, Quebec, Canada

Purpose  
Involvement of the central nervous system (CNS) in multiple myeloma (MM) has been described as a rare entity, with an incidence of only 1%.\textsuperscript{*} Among the various CNS manifestations, leptomeningeal myelomatosis (LM), with the characteristic presence of monoclonal plasma cells in the cerebrospinal fluid (CSF), is observed in less than 1% of all the MM cases.\textsuperscript{*} We would like to report a case of LM, which illustrates some common clinical and imaging findings of the disease.
Materials and Methods
A 57-year-old female presented to the emergency department with bilateral leg weakness, fecal incontinence and back discomfort. One year earlier, she had been diagnosed with a lambda light chain myeloma that was treated with radiation and chemotherapy. Her past medical history revealed partial resection of a cavernous meningioma, one year prior to the MM diagnosis. Magnetic resonance imaging (MRI) of the brain and spine were obtained and the findings are described below. Cerebrospinal fluid (CSF) analysis demonstrated the presence of plasmacytoid cells, and further correlation with CSF flow cytometry confirmed the diagnosis of LM. Pathology report at the time of MM diagnosis showed deletion of the p53 gene locus, a feature that has been associated with LM.*

Results
MR imaging of the spine revealed diffuse and extensive leptomeningeal enhancement along the spinal cord and cauda equina, consistent with leptomeningeal carcinomatosis. Brain MRI demonstrated intraventricular enhancing nodules. Of note, no bony lesions were present to suggest multiple myeloma. Figure 1 (attached image). Sagittal T1 view with gadolinium demonstrating diffuse leptomeningeal enhancement and thickening of the cauda equina roots. No bone lesions are noted.

Conclusions
We report an unusual case of leptomeningeal carcinomatosis in a patient with multiple myeloma. The patient presented with symptoms suggestive of cauda equina syndrome. Radiographic findings, as well as cerebrospinal fluid sampling and flow cytometry supported the diagnosis of leptomeningeal myelomatosis. With an incidence of less than 1%, LM is a rare manifestation of MM, and is associated with chromosomal abnormalities such as p53 gene alterations.*

KEYWORDS: Cauda Equina, Leptomeningeal, Multiple Myeloma

(Filename: TCT_EE-112_LeptomeningealMyelomatosis.jpg)

EE-113 6:30AM - 9:00PM

MRI Guided Focused Ultrasound (MRgFUS) for the treatment of Fibroids complicated by Lumbosacral Plexopathy and Sciatic Nerve Injury

V Trinh1, M Ngo1
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Purpose
To illustrate a rare case of lumbosacral plexopathy and sciatic nerve injury treatment-related complication of MRI-guided focused ultrasound (MRgFUS) for the treatment of fibroids. MRI-guided focused ultrasound for the treatment of fibroids is a relatively new FDA approved technique (approved in October 2004) in the treatment of symptomatic fibroids. Although determined relatively safe, possible neurologic complications include lumbosacral plexopathy and sciatic nerve injury. The case report will reveal the classic imaging features of these complications that, in our case, directly correlate with nonradiologic objective examinations and the patient's physical symptoms.

Materials and Methods
A 38-year-old female presents with worsening right leg weakness. The patient had no significant prior medical history other than symptomatic fibroids. She revealed she had undergone MRgFUS for the treatment of her fibroids a few weeks prior to her presentation but did not have any symptoms immediately after the procedure. The patient underwent nerve conduction testing which revealed an unrecordable right superficial peroneal (sensory) response. Additionally, electromyography showed abnormal spontaneous activity and decreased recruitment in the right L5-S1 anterior myotome. The constellation of findings was determined by the neurology service as consistent with subacute right lumbosacral plexopathy affecting the L5-S1 anterior myotome, with ongoing denervation consistent with Wallerian degeneration. An MR imaging (MRI) pelvis was ordered to further evaluate these findings. The MR pelvis exam corroborated the findings with evidence of abnormal asymmetric edema involving the right lumbosacral plexus and right sciatic nerve. Additionally, there was new anterior sacral bone marrow edema when compared to a preprocedural pelvic MRI, a key finding which adds specificity to the diagnosis of a MRgFUS treatment-related complication. The finding of sciatic nerve injury due to this procedure has been reported previously and the proposed mechanism of nerve damage is thought secondary to thermal injury and heating of the adjacent bone (sacrum).

Results
Axial sequential fat saturated T2 sequences are provided from cranial to caudal at the level of the pelvis. There is crescentic configuration of subperiosteal bone marrow edema along the ventral surfaces of S1 and S2. Additionally, there is increased edema involving the right lumbosacral plexus and extending peripherally to involve the right sciatic nerve. Preprocedure MRI of the pelvis prior to the MRgFUS exam (no attached given the limited character requirement) revealed a normal appearance to the sacrum, lumbosacral plexus, and sciatic nerve.

Conclusions
MRI-guided focused ultrasound is a relatively new noninvasive treatment for symptomatic fibroids (FDA approved in 2004). Our case report will illustrate the rare but reported possible neurologic complication of this procedure including lumbosacral and sciatic nerve injury. The proposed mechanism of injury is not related to direct burning of the nerve itself, but actually related to the heating of the sacrum and secondary thermal injury of the adjacent sciatic nerve.

KEYWORDS: Peripheral Nerve, Sacrum, Sciatic Nerve
Spontaneous Spinal Epidural Hematoma: Unusual Site of Bleeding in a Case of DIC.

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Purpose
Spontaneous spinal epidural hematoma (SSEH) is a rare entity characterized by nontraumatic bleeding into the epidural space. The dorsal aspect of the thoracic or lumbar region most commonly is involved. The source of hemorrhage is typically venous but also can be arterial. We present an interesting case of SSEH in the setting of fulminant disseminated intravascular coagulation (DIC) likely secondary to leukemia.

Materials and Methods
A 64-year-old female presented to the ED with acute nontraumatic low back pain. She denied a past history of trauma. Physical exam was positive for splenomegaly and subcutaneous
ecchymosis. Emergency abdomen/pelvis CT showed a left retroperitoneal hematoma, bleeding into the psoas and thoracolumbar paraspinal muscles, and high density material in the spinal canal consistent with blood products. Follow-up thoracolumbar spinal MR imaging (MRI) confirmed a large acute epidural hematoma causing severe spinal cord compression. Additionally, diffuse low signal intensity in the vertebral bodies on T1-weighted images suggested an underlying bone marrow infiltrative process. Subsequent blood work revealed pancytopenia, bandemia and features of DIC. Unfortunately, the patient's condition progressed to quadriparesis and she expired shortly after.

Results
Spontaneous spinal epidural hematoma is a rare neurological condition. Typical clinical presentation of SSEH is sudden back pain that can rapidly progress to paraparesis or quadriparesis, as with our patient. Spontaneous spinal epidural hematoma often is related to an underlying coagulopathy, infection, or underlying lesion such as a vascular malformation or neoplasm. MR imaging is considered the first choice diagnostic imaging method for SSEH. MR imaging typically shows a well circumscribed biconvex epidural hematoma. Acute to subacute hematomas show a characteristic high signal intensity on T1-weighted images. However, the appearance and signal characteristics of the SSEH depends on its age. A CT should be performed if MRI is unavailable, and typically shows a hyperdense epidural collection with features of cord compression. Early surgical intervention is the standard treatment; however multilevel acute hematomas may be difficult to treat operatively in patients with underlying coagulopathy, as in our patient. In such cases, conservative treatment has been documented.

Conclusions
Spontaneous spinal epidural hematoma is a rare but potentially fatal entity that needs to be recognized on early imaging. Computed tomography can help with early diagnosis by the presence of blood in the epidural space in the setting of coagulopathy, even before MRI can be obtained. Urgent decompression, in the absence of contraindications like severe coagulopathy can be lifesaving.

KEYWORDS: Hematoma
Vertebral body infarct and ventral cauda equina enhancement: two findings confirming an acute spinal cord infarct

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Purpose
To present a recently e-published case of an acute spinal cord infarct (SCI) in a young adult male, in which two confirmatory MR imaging (MRI) findings were present: a concomitant vertebral body infarct and the rare enhancement of the ventral nerve roots of the cauda equina.

Materials and Methods
A 24-year-old man experienced sudden onset of lower back pain and bilateral leg cramping while bending. On the subsequent day, acute leg weakness caused him to collapse. At a local hospital, bilateral lower extremity paralysis, areflexia, decreased pain/temperature sensation, and urinary retention were noted. Evaluation consisted of an entire spine MRI without/with intravenous gadolinium (findings described below). Intravenous steroids and immunoglobulin were initiated for suspected Guillain-Barré syndrome. After seven days of inpatient therapy he could once again self-transfer and was discharged to home in a wheelchair. Two days later he experience sudden sharp chest pain as well as loss of left leg sensation and strength. At the outside hospital, autonomic instability was documented. Neither head computed tomography (CT) nor CT of the chest/abdomen/pelvis with aortic dissection protocol revealed an etiology. An ECG and cerebrospinal fluid (CSF) analysis were normal. A repeat spine MRI was performed, 15 days after the initial MRIs (findings described below). Upon transfer to our institution, examination revealed areflexic paraplegia with pain/temperature discrimination absent below a
T11 sensory level, compatible with an anterior cord syndrome. Intravenous methylprednisolone was administered empirically to treat vasculitic or autoimmune etiologies. Extensive laboratory evaluation for infectious, rheumatologic and autoimmune causes of arterial thrombosis and for genetic/acquired hypercoagulability was unrevealing. Given this and the history of recent mild back injury, the presumed cause was fibrocartilaginous embolism. The patient was discharged to a rehabilitation facility, afebrile, hemodynamically stable, and with unchanged neurologic deficits.

Results
Sequential MRIs demonstrate progressive cord/conus signal abnormality/enhancement compatible with evolving anterior SCI, presumably from occlusion of the artery of Adamkiewicz. An osseous infarct develops in the posterior aspect of the T12 vertebral body, clinching the diagnosis of spinal cord infarct. Mild diffuse enhancement of the ventral cauda equina nerve roots develops, without enlargement or nodularity, and also confirms SCI.

Conclusions
Neuroradiologists should be aware that associated findings can definitively diagnose SCI. Ventral cauda equina nerve root enhancement is unusual, but probably an under-recognized confirmatory sign. A more commonly seen but still likely underappreciated finding is the concomitant presence of vertebral body infarct(s). These signs are likely most useful subacutely, especially when the clinical picture is not classic for SCI. This was true for the subject of this case report, as an inflammatory condition was being considered clinically given the stuttering symptoms; recognition of these two imaging signs led to accurate diagnosis.

KEYWORDS: Cauda Equina, Spinal Cord, Spinal Stroke

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Poster - Adult Brain
EP-55

6:30AM - 9:00PM

320-Row Multidetector CT Angiography for Detection of Critical Cerebrovascular Anomalies: Comparison with Conventional Digital Subtraction Angiography

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Purpose
The acquisition of a new 320-row multidetector CT scanner at the Montreal Neurological Institute and Hospital has provided higher quality imaging with less radiation exposure and shorter time of acquisition. However, its reliability has not been fully proven in critical vascular lesions, when it comes to replace a more invasive exam such as cerebral angiography. We wished to validate the accuracy of this equipment to investigate four common indications for patients to undergo conventional digital subtraction angiography (DSA): subarachnoid hemorrhage, vasospasm, unusual intracerebral hemorrhage, unruptured aneurysm.
Materials and Methods
Medical records and relevant imaging from 102 consecutive subjects who underwent a 320-row multidetector CTA and subsequently cerebral angiography from February 2010 to February 2013 were retrospectively analysed. Reports from both imaging modalities were compared to determine the diagnostic accuracy of CTA.

Results
The overall sensitivity and specificity of 320-row multidetector CTA for detecting cerebrovascular abnormalities were, respectively, 97.60 and 63.20%. Similar results were obtained for all four categories of clinical indications and a detailed breakdown per indication will be shown during the presentation.

Conclusions
Results obtained from CTA were consistent with those obtained on DSA regardless of the vascular pathology. To our knowledge, this study is the first validating the accuracy of 320-row CTA in diagnosing critical vascular lesions. This is the foundation for a prospective investigation aiming to reassure clinicians on the high reliability of a 320-row CTA thus limiting the need of cerebral angiography.

KEYWORDS: Cerebral Angiography, Cerebrovascular Disease, CT Angiogram

EP-85 6:30AM - 3:00PM

3D MRI in multiple sclerosis: A comparison of 3D DIR, 3D FLAIR, and 2D FLAIR

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Purpose
Many neurologists utilize the McDonalds criteria in the diagnosis of multiple sclerosis (MS), which relies heavily on the ability of MRI to detect white matter lesions (characterized as hyperintense on T2-weighted/FLAIR sequences). According to the criteria, patients must have 2 clinical attacks with dissemination in time (DIT) and space (DIS) (1). DIS requires lesions in 2 of the following locations: infratentorial, periventricular, or juxtacortical. For DIT, there must be a new lesion on a subsequent MRI. Therefore, accurate lesion detection in diagnosis and management of MS patients is essential. The purpose of our study is to compare the efficacy and clinical feasibility of 3D Double Inversion Recovery (DIR), 3D FLAIR, and conventional 2D FLAIR turbo spin echo sequences in the evaluation of multiple sclerosis lesions.

Materials and Methods
Internal review board approval was sought for this prospective analysis of adult multiple sclerosis patients (N = 30). All MRIs will be performed on a 3T MR scanner, to include 3D-FLAIR, 3D-DIR, and 2D FLAIR turbo spin echo sequences. The MR images will be reviewed by 2 neuroradiologists, with attention to white matter lesions.

Results
Preliminary findings from 6 patients demonstrated increased sensitivity of 3D FLAIR in the detection of white matter lesions when compared 2D FLAIR, particularly in the posterior fossa.
(174 supratentorial and 17 infratentorial lesions versus 115 and 7, respectively). The scan time for the 3D FLAIR sequence was marginally increased compared to the axial 2D FLAIR sequence (4:56 min versus 3:40 min), but significantly shorter than the combination of sagittal and axial 2D FLAIR sequences (9 minutes) which comprised our conventional multiple sclerosis protocol. In a subset of 2 patients, 3D DIR performed comparably with 3D FLAIR (56 supratentorial and 9 infratentorial lesions versus 66 and 8, respectively), although certain lesions were better characterized by one than the other (Figure 1).

Conclusions
Modern 3D MR sequences offer certain advantages over their 2D counterparts in light of increased signal-to-noise ratio as well as through-plane resolution, and within a reasonable scan time owing to fast spin echo and parallel imaging (2). Incorporating these features with DIR and FLAIR tissue contrasts should lead to clinically feasible improvements in MS lesion characterization and ultimately patient care (3) (4). Additionally, we will also attempt to illustrate the respective roles of 3D FLAIR and 3D DIR in this setting.

KEYWORDS: Inversion Recovery, Multiple Sclerosis, Multiple Sclerosis Plaques

Figure 1: 3D DIR versus 3D FLAIR axial MR images. The blue arrow (a) in the 3D DIR image indicates a left frontal white matter lesion not seen on the corresponding FLAIR image (b).

*DIR = Double Inversion Recovery; FLAIR = Fluid Attenuated Inversion Recovery*
4D-Dynamic CTA

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Purpose
To demonstrate the value of dynamic 4-D CTA in different intra and extracranial neurovascular pathologies

Materials and Methods
From July 2009 to June 2013, 1812 adult patients with acute neurological symptoms underwent dynamic CTA, on a 320 Toshiba CT scanner. The exam included non enhanced CT scan of the brain followed by dynamic CTA. IV bolus injection of 90 cc non ionic contrast was used to obtain perfusion studies and post-processing imaging including 4D time resolved images in coronal and sagittal planes. 3D reconstruction 4D imaging were obtained as well. Whole CTA from the aortic arch to the vertex was obtained. Dynamic CT angiogram (D-CTA) was performed in a 320-row volume CT scanner (Aquilion ONETM), which uses an ultra-high-resolution detector rows (0.5 mm in width) to image the entire brain in a single gantry rotation. D-CTA is a non-invasive technique to acquire a time series of bone subtracted or unsubtracted CT angiogram images of the whole brain, thus removing timing uncertainties found in typical static CT angiogram images. This approach also provides temporal flow information. The single volume acquisition takes 1 second resulting in a temporal resolution of 1/sec. By manipulating the raw data improved temporal resolution up to 5/sec is possible. The data acquisition of whole brain volumes at sequential time points starts at 7 sec from the time of contrast injection. This volume uses 300 mA 80 kV and is used as a mask for subtraction. The other volumes are acquired at 100 mA 80 kV. In the arterial phase (10 to 35 sec), whole brain volumes are acquired every 2 sec. In the venous phase (40 to 60 sec) volumes are acquired at 5 sec interval.

Results
955 patients with acute stroke, 529 patients with non traumatic subarachnoid hemorrhage, 328 patients with spontaneous intraparenchymal bleed. On ischemic stroke patients we were able to identify abnormal areas of perfusion, penumbra as well the site of arterial occlusion on intracranial vessels form large to small caliber, i.e., ICA or Vertebral artery to M3 branches. On patients with AVM or AVF we were able to identify dynamically the efferent and afferent vessels as well aneurysms associated to the vascular malformation. On patients with intraparenchymal bleeds related to hypertension or coagulopathies it was possible to identify the presence or absence of the spot sign, predicting value for possible hemorrhage progression. Other neurovascular pathologies were clearly identified such as traumatic or spontaneous vascular dissection, occluded stents, venous thrombosis, etc.

Conclusions
For a long period of time, DSA was considered as the gold standard method to diagnose neurovascular pathologies. With the new generation of multi slice helical CT scanners, post processing reconstruction, perfusion studies and dynamic evaluation of the vasculature from the arterial to the venous phase is very useful to determine precise site of the anomaly in cases of arterial occlusion, aneurysm, AVM or AVF. It helps to evaluate differences in timing between
vascular territories, allows guidance for neurovascular interventional procedures or neurosurgical treatment as well in the decision process on non-invasive treatments.

KEYWORDS: Adult Brain, CT Angiogram, Dynamic CT Angiogram

EP-15

A Multi-Reader Assessment of MRI Diagnostic Accuracy in Sporadic and Variant Creutzfeldt-Jakob Disease

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¹Western Clinical General Hospital, Edinburgh, UK, ²Southern General Hospital, Glasgow, UK, ³National Creutzfeldt-Jakob Disease Surveillance Unit, Edinburgh, UK, ⁴Division of Clinical Neurosciences, Edinburgh, UK

Purpose
A high incidence of pathognomic magnetic resonance imaging (MRI) findings previously have been described in both sporadic and variant Creutzfeldt-Jakob disease (sCJD/vCJD). We hypothesized that there may however be significant inter-rater variation in the identification of many of the described findings, particularly when presented with mixed cases of sCJD, vCJD and controls.

Materials and Methods
Anonymized MRI studies from 50 patients referred to the UK National CJD Surveillance Unit and for whom MRI was available were reviewed. These comprised 20 consecutive cases with final diagnosis of sCJD, 15 cases of vCJD and 15 control cases referred as suspected CJD in whom a final non-CJD diagnosis was made. Imaging acquisition protocols were variable - all available T2, FLAIR and diffusion-weighted imaging (DWI) sequences were reviewed. A consensus read by two neuroradiologists with a specialist interest in CJD was used as the imaging reference standard. A further 20 assessors recruited from international CJD surveillance networks reviewed all 50 studies, blinded to the final diagnosis. Images were reviewed via a browser-based portal, with all sequences for each case presented concurrently. A structured reporting system prompted each reviewer to grade the appearances of deep gray matter nuclei and cortical regions for each sequence. Assessors also offered a final diagnosis of sCJD, vCJD or non-CJD, and their degree of certainty. Reviewer demographics including experience and frequency of scan assessment were captured.

Results
The overall agreement of the imaging reference standard with the final diagnosis was 72%. There was high specificity for CJD, with all 15 noncases correctly identified. The positive predictive value for sCJD was 85% and vCJD 91%. The overall agreement of reviewers with the imaging reference standard was 79%; when adjusted for agreement expected by chance, this was moderate to good (kappa=0.64). No significant association could be demonstrated between diagnostic accuracy and length of interest, frequency of MRI assessment or clinical role. There was very good agreement between assessors and the imaging reference standard in assessment of the caudate head, anterior putamen and pulvinar. Assessment of the 'pulvinar sign', an important MRI finding in vCJD, also showed good agreement (k=0.78). There was only moderate agreement in assessing the presence of cortical high signal and poor agreement on specific
cortical regions involved. Correct scoring of abnormal signal in caudate, pulvinar nucleus relative to anterior putamen, and cortical regions were all associated with overall diagnostic accuracy. In sCJD the likelihood of an accurate diagnosis were significantly increased if DWI was the preferred sequence. Sequence preference was not associated with diagnostic accuracy for vCJD cases.

Conclusions
There is a range of inter-rater performance in the diagnostic accuracy for CJD based on MRI, even among reviewers with a specialist interest. Correct assessment of key gray matter and cortical signal change is associated with overall diagnostic accuracy. Our study highlights the importance of diffusion-weighted imaging, particularly for sCJD where cortical hyperintensity may be the only imaging finding.

KEYWORDS: Creutzfeldt-Jakob Disease, Diffusion-Weighted Imaging, MR Imaging

EP-33

A Novel Observation of Hyperacute Ischemic Stroke in Rats: Using Prospective 3 T Diffusion MRI and 3 Dimensional Voxel-Based Analysis

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Purpose
For the translational research of focal cerebral ischemia, rat middle cerebral artery occlusion (MCAO) models have been used most commonly. And yet previous reports revealed rat MCAO models were very diverse in their nature. This is to present our novel observation of experimental stroke in rats with similar lesion characteristics after MCAO.

Materials and Methods
Rats were subject to left MCAO using the suture technique. Immediately after occlusion, the animals were placed into an MRI scanner (3.0 T) and diffusion-weighted imaging (DWI) was repeated with a rat coil every 10 minutes. Every first MR imaging was started within 10 minutes after stroke onset. Immediately after each MR scan, DWI and apparent diffusion coefficient (ADC) maps were evaluated to determine whether successful MCA territorial infarction was obtained by two neuroradiologists. Five rats were followed with repeated DWI for 60 minutes and four rats for 120 minutes. Percentage of hemispheric lesion volume (%HLV), ADC value (ADC) were evaluated for quantitative analysis of ADC-derived lesion characteristics using voxel-based analysis. For voxel-based analysis, 3D volume analysis of lesion segmented by automatic method was performed using FSL software package (http://fsl.fmrib.ox.ac.uk/fsl/fslwiki/).

Results
Successful MCA territorial infarction was induced in nine rats (9/32, 28.1%) and they showed MCA territorial infarction at the first DWI 10 minutes after MCAO. Three dimensional voxel-based analyses showed that all ADC-derived lesion volumes did not change during the MRI follow-up period (%HLV at the first MRI: 52.1% (39.7~67.3%), Last 54.8% (39.7~66.4%)).
Apparent diffusion coefficient values of the ischemic lesions did not show the temporal changes during the DWI observation. At the first MR scan mean ADC value was 405 $\times 10^{-6}$ mm$^2$/sec (range 361~434$\times 10^{-6}$ mm$^2$/sec), the last was 390$\times 10^{-6}$ mm$^2$/sec (363~430$\times 10^{-6}$ mm$^2$/sec).

Conclusions

Applying prospective diffusion MRI and 3D voxel-based analysis, very early on after MCAO in rats, we observed experimental brain infarctions remaining unchanged with very similar lesion extent and the diffusion MR characteristics.

KEYWORDS: Acute Ischemic Stroke, Animal Model, MR Imaging/Diffusion

EP-56

A Report of Twin Cases of Ruptured Epidermoid Cyst: A Rare Phenomenon

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Purpose

Epidermoid cysts are congenital lesions of epidermal origin, representing 0.2% to 1.8% of all primary intracranial tumours. They usually present in the second to third decade of life. The most common symptoms are due to mass effect; headache, seizure, tinnitus, hearing loss, facial spasm, and trigeminal neuralgia and intracranial pressure etc. Epidermoids may rupture, although very rare, resulting in dissemination of the intracystic contents into the subarachnoid space and ventricles, and consequently, present with recurrent episodes of aseptic meningitis. In this case series, we report the rare complication of rupture of intracranial epidermoid cysts in two patients with emphasis on magnetic resonance imaging (MRI) characteristics and associated complications.

Materials and Methods

Patients presented to our hospital emergency room and subsequently underwent neuroimaging. Both the patients were subjected to MRI brain, which was performed on 3 Tesla MR units (Siemens and GE) with all the standard imaging sequences, which included diffusion weighted imaging and gadolinium enhanced study. On the basis of imaging diagnosis and clinical evaluation, surgical excision of the lesions was done. Histopathology was consistent with epidermoid cysts.

Results

Epidermoid cysts are congenital lesions of epidermal origin at the time of neural tube closure, between the third and fifth week of fetal development, hence they are also called 'inclusion tumours'. Their common sites are cerebellopontine angle and perimesencephalic cisterns. They are histologically benign and slow growing tumours. They usually tend to spread along normal cleavage planes and insinuate around vessels and nerves. However, in later stages of growth, they do behave as mass lesions, remaining clinically silent for many years. The presence of a fat component or cyst content within the ventricles or subarachnoid space is a rare finding; it may occur spontaneously or during the postoperative course. First patient's imaging revealed a large epidermoid cyst in quadrigeminal cistern with rupture of contents into bilateral
lateral ventricle while in second case with a cerebellopontine epidermoid, similar signal intensity contents were seen in temporal and parietal subarachnoid spaces.

Conclusions
Though extremely uncommon, rupture of intracranial epidermoid cysts can occur, leading to spillage of intracystic contents into subarachnoid spaces and ventricles. It is a potentially lethal complication that can result in repeated attacks of asptic meningitis, obstructive hydrocephalus, cranial nerve palsies, vasospasm and cerebral ischemia or infarction.7,9,10 Hence, in every case of epidermoid, evidence of intraventricular or subarachnoid contents or chemical meningitis should be diligently sought for early diagnosis and prevention of grave consequences of rupture.

KEYWORDS: Cysts, Epidermoid, Restricted Diffusion

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EP-20
6:30AM - 9:00PM

A short acquisition time dynamic contrast-enhanced perfusion imaging for the diagnosis of brain tumors with fixed T1 method and full automatic detection of vascular input function

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Purpose
T1-weighted dynamic contrast-enhanced (DCE) MR imaging (MRI) is useful for the diagnosis of brain tumors. By using the pharmacokinetic model introduced by Tofts et al, volume transfer contrast Ktrans, extravascular extracellular volume Ve and fractional plasma volume fPV can be
calculated. Because imaging time over five minutes generally is recommended in this method, the use in clinical setting is difficult. Further, because the result varies depending on the position of the AIF, which generally is set manually, a standardization of the analysis was necessary. In this study, we examined a short acquisition time DCE sequence which is easy to use in clinical settings, using simple analytical methods (fixed T1 method and automatic vascular function detection).

Materials and Methods
MR examinations were performed by a 3 T MR scanner using a standard eight-channel head coil. Dynamic contrast-enhanced MRI was performed using the following parameters: TR/TE, 4.4/1.0ms; flip angle 12°; field of view, 300 × 210 mm; matrix, 128 × 90; slice thickness, 8 mm; number of slices, 16; consisting of 64 phases with a temporal spacing of 3.3 seconds. Total scan time was three minutes and 31 seconds. A gadolinium-DTPA (0.1 mmol/kg) was injected with power injector at a rate 2.5ml/s and 20ml saline subsequently was injected. This study included 24 patients and 28 lesions (four low grade glioma (LGG), 12 high grade glioma (HGG), seven metastasis, five lymphoma). The diagnosis was made histologically or radiologically. Pharmacokinetic model analysis was performed by using commercially available software (GenIQ, GE Medicalsystems, Milwaukee, WI). VOF and AIF were automatically detected. Analysis was performed by using fixed T1 method. Ktrans, Ve and fPV map were acquired. In each map, the round region of interest (ROI) was placed manually on the hot spot. The sizes of the ROIs were about 100mm2. The averaged signal intensity was measured. Another ROI was placed on the high intensity area on the T2-weighted image adjacent to an enhanced lesion in each tumor, if possible. To assess the differences between DCE parameters and tumor histology, Mann-Whitney-U test was performed. A P value of less than 0.05 was considered statistically significant. Receiver operating characteristics (ROC) curve analysis was performed to evaluate the diagnostic performance. Optimal cutoff value, sensitivity, and specificity also were calculated.

Results
Ve was the most useful parameter to differentiate LGG from other tumors (p=0.0031), lymphoma from other tumors (p=0.0020). But Ve showed no significant difference between HGG and metastasis (p=0.3980). In the T2-weighted image hyperintense area, Ktrans, Ve, and fPV were higher in HGG than metastasis. The area under the ROC curve for differentiating LGG or lymphoma was highest for Ve (LGG from other tumors: Ve cutoff: 0.176, sensitivity: 96%, specificity: 100%, lymphoma from other tumors: Ve cutoff: 0.95, sensitivity: 87% specificity: 100%). For differentiating HGG from metastasis, fPV value on the T2-weighted imaging hyperintense area showed the highest accuracy (fPV cutoff: 0.008, sensitivity: 75%, specificity: 71%, p=0.063)

Conclusions
A short acquisition time DCE sequence with simple pharmacokinetic model analysis (fixed T1 method and automatic VOF/AIF detection) is useful for the diagnosis of brain tumors.

KEYWORDS: Brain Neoplasms, Brain Perfusion, Dynamic Contrast-Enhanced MR

EP-01

6:30AM - 9:00PM

A Systematic Review, Critical Appraisal and Analysis of the Quality of Economic Evaluations in Stroke Imaging
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Purpose
To review the quality of economic evaluations of acute stroke imaging to direct thrombolytic therapy and to identify areas for improvement in future economic evaluations.

Materials and Methods
We conducted searches of electronic databases including Medline, EMBASE, CINAHL, Econlit, the NHS Economic Evaluation Database and the Tufts Cost-Effectiveness Analysis (CEA) Registry from January 1950 through July 2012. Inclusion criteria were empirical studies published in any language that reported economic evaluation results of two or more imaging interventions for patients presenting with symptoms suggestive of acute stroke. Study quality was assessed by a 35-item checklist published by the British Medical Journal (BMJ).

Results
A total of 1,063 citations were identified, and five met the inclusion criteria. Four of five papers were explicit in their analysis perspectives, which included health care system payers, hospital and other stroke service providers. Two studies reported results for five-year time horizons and three reported lifetime results. All reported morbidity outcomes using the modified Rankin Scale score. The median quality score using the BMJ tool was 84.4% (range = 71.9-93.5%). Three studies evaluated perfusion computed tomography (CTP) as a comparator to unenhanced CT (UCT) but due to a paucity of data, assumed that CTP outcomes were equivalent to those of patients assessed by other imaging modalities. Most studies included post-thrombolysis intracranial hemorrhage states but most did not take into consideration the effects of AIS patients who could not tolerate contrast media or who incurred contrast-induced nephropathy (CIN).

Conclusions
Economic evaluations in acute stroke imaging are of high quality with respect to published methodological guidelines. Economic analyses of imaging in AIS patients may benefit from the inclusion of important clinical components of AIS imaging modeling including the incidence of CIN and recurrent stroke in addition to the incorporation of CTP-specific outcome data.

KEYWORDS: Economics, Image Guidance, Stroke

EP-94

6:30AM - 3:00PM

Abnormal Cells Discrimination Using the Different Shape Parameters

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Purpose
A time critical process in optical microscopy application such as cancer cells detection, is the determination of the cells position in the histopathological image. Aiming at short time and efficiency identification, we propose the shape features extracted from the three abnormal cells
detection, namely, Benign Hyperplasia (BH), Intraepithelial Neoplasia (IN), and Carcinoma (Ca) in order to discriminate between the grade of cancer cells.

Materials and Methods
Active contour method was developed using the progressive division of the image dimension to achieve faster segmentation. Three cell types were analyzed based on the morphological parameters computation and the Naive Bayes classifier. Bio-images were extracted from the optical microscopy using special filter, Liquid Crystal Tunable Filter (LCTF) and high resolution camera, Charge Coupled Device (CCD). Therefore, there are 16 sequential bands images for each type of abnormal cancer cells, BH, IN and Ca. We demonstrate the efficiency of the proposed method using the real data from optical microscopy. The performance indicator was evaluated by the classifier accuracy computation for each type of cancer cells.

Results
18 images from each cancer type were analyzed. Simulation results showed that the segmentation of microscopic images using this technique was of higher efficiency than the conventional snake method resides in its ability to segment Ca type cells that was difficult through other segmentation procedures. The time consumed during segmentation was decreased in a ratio of more than 50%. The classification accuracy result showed the perfect accuracy value in a particular the carcinoma type which was difficult previously.

Conclusions
The shape parameters (such us: area, Xor-convex and solidity) were found to be effective to discriminate between the three types of abnormal cell. In addition, classification of unknown cell was possible using this PNN classifier method. Our proposal proved to be a powerful method. It was able to identify multiple cancer types in optical microscope images. This method can also be used to detect objects with irregular shapes such as carcinoma cells. The classification accuracy increased significantly which is indicated to be highly promising in the discrimination between the grade of cancer cells.

KEYWORDS: Cancer, Shape Analysis

<table>
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<th>Simulation results of performance indicator</th>
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<td>Cancer cells type</td>
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<td>BH</td>
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<td>IN</td>
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<td>Ca</td>
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Accounting for contrast bolus delay and dispersion in perfusion imaging of experimental stroke improves the predictive value for infarct growth rate

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1Northwestern University, Chicago, IL, 2Northwestern University Feinberg School, Chicago, IL, 3University of Chicago, Chicago, IL

Purpose
Singular value decomposition of the arterial input function (AIF) with tissue curves is commonly used in to measure cerebral blood flow (CBF), cerebral blood volume (CBV), mean transit time (MTT) and time to residue function maximum (Tmax) in ischemic stroke. Deconvolution analysis is known to be sensitive to delay and dispersion (DD) effects, which alter the true AIF to a vascular territory in a setting of collateral arterial supply. The DD results in overestimation of the volume of hypoperfusion in acute stroke. Paradoxically, this overestimation will be greatest in patients with robust collateral arterial supply, which slows infarct growth. We hypothesize that the degree of DD distortion of local AIFs, as measured by DSC perfusion reflect the presence of collateral supply, and can predict infarct growth rate in ischemic stroke.

Materials and Methods
Permanent middle cerebral artery occlusion (MCAO) was induced in six adult dogs. Leptomeningeal collateral recruitment was quantified on angiography. Serial MR diffusion and perfusion imaging was acquired every 30 minutes over the first four hours and at 24 hours. Infarct growth rate was modeled as the square root of imaging time (Figure 1) and compared to 24 hour infarct volume. Bolus delay and dispersion was determined from DSC images using a previously reported model: $R(t) = A/(ATD+1) e^{(-\beta t)/ATD}$ The predictive value of the existence of collateral flow at DSC (i.e. $\beta/ATD$) was determined using Pearson correlation and was compared to more standard indicators of hypoperfusion (MTT, Tmax, CBV, and CBF) to determine the added value of DSC perfusion kinetics in predicting infarct growth.

Results
Bolus kinetics from DSC images predicted infarct growth rate. Table 1 reports Pearson correlation coefficients and statistical significance between MR and angiographic imaging markers to infarct growth rate. Perfusion parameters showed expected linear trends with infarct growth rates. Although not statistically significant, the strength of these linear trends improves...
with DD correction. Collateralization recruitment score and the DD coefficient showed the strongest correlation with infarct growth (Pearson Correlation>0.9 and P<0.01) (Figure 1). Furthermore DD-coefficient was strongly linear with collateralization score (Pearson=0.9, P-value=0.01). In Figure 1 we have confirmed prior finding that the rate of growth of a infarct is slower in the presence of leptomeningeal flow (left, red curve) than when collateral flow is poor (left, blue curve). Local AIFs in DD modeling account for collateral arterial supply enabling prediction of infarct growth rate.  

Conclusions  
The degree of DD, correlates with collateralization score and is predictive of infarct growth rate in permanent MCAO occlusion.

**KEYWORDS:** Collateral Circulation, MR Imaging Perfusion, Stroke

<table>
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<tr>
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<th><strong>Post DD Correction</strong></th>
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**EP-49**

**Acute Basilar Artery Occlusion: Do MRI and CTA-Source Images Agree?**

D Boulter¹, A Yoo¹, T Leslie-Mazwi¹, R Gonzalez¹, P Schaefer¹
Purpose
The natural history of acute basilar artery occlusion (BAO) is dismal. Several papers report prognostic imaging findings for BAO treated with intra-arterial therapy (IAT). Three scoring tools have been described for use with CTA source images (CTA-SI). None have evaluated prognostic MRI features prior to IAT. The purpose of this study was to assess the agreement between MRI and CTA-SI for early ischemic change by parenchymal region, and to determine the effect on existing scoring tools.

Materials and Methods
17 patients with acute BAO were treated with IAT and also received pre-treatment MRI. 14 of these patients also received CTA. Neuroradiologists who were blinded to clinical information reviewed CTA-SI and MRI images during separate sessions. MRI diffusion-weighted images (DWI) and CTA-SI were scored using criteria from the previously described 32-point global score, the 8-point pons-midbrain index (PMI), and the 10-point pc-ASPECTS score. A separate scoring of the DWI data was obtained with more stringent criteria that excluded isolated small infarcts measuring less than 15 mm in the cerebrum or cerebellum, although small thalamic and brainstem infarcts were still included. Agreement between the modalities was assessed by region and correlated with patient outcomes and reperfusion status. Functional outcome was dichotomized into good (mRS 0-3) or poor (mRS 4-6). Mortality (mRS 6) was also independently assessed. Reperfusion status was dichotomized into reperfusers (TICI 2B-3) versus non-reperfusers (TICI 0-2A).

Results
Overall correlation between DWI and CTA-SI for the global score was moderate (Spearman rho: 0.73). When small cerebral and cerebellar infarcts were excluded from the DWI analysis, correlation with CTA-SI improved (Spearman rho: 0.77). The correlation was similar for pc-ASPECTS (Spearman rho: 0.69). Agreement between CTA-SI and DWI differed by anatomic region (Table). The medulla and parietal regions were excluded from this analysis as they were involved in fewer than 2 patients based on MRI. Overall, the best agreement was seen in the thalamus and cerebellum with moderate kappa scores. There was minimal to weak agreement in the remainder of the regions, with the worst agreement in the brainstem (weighted kappa: 0.15 for pons and 0.02 for midbrain). As a result, there was minimal agreement between CTA-SI and DWI for scoring the PMI (weighted kappa: 0.16). Outcomes were good in 4 patients and poor in 13 patients, 9 of whom died. There were 10 patients who reperfused, 4 of whom died. None of the existing scoring scales predicted dichotomized outcomes with statistical significance. Only the degree of pons involvement on CTA-SI predicted mortality (p=0.02).

Conclusions
Existing scoring metrics for CTA-SI can be applied to DWI, with overall moderate correlation between these modalities for global measures of early ischemic change following basilar artery occlusion. However, agreement varies markedly by region, with virtually no agreement in the brainstem where lesion morbidity has been reported to be the highest. These findings have important clinical implications for the application of existing prognostic scores.

KEYWORDS: Basilar Artery Occlusion, Diffusion-Weighted Imaging, Stroke
Agreement between DWI and CTA-SI by region.

<table>
<thead>
<tr>
<th>Region</th>
<th>Agreement (Weighted Kappa)</th>
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<tr>
<td>Pons</td>
<td>0.15</td>
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<tr>
<td>Midbrain</td>
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<td>Thalamus</td>
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**EP-80**

**6:30AM - 9:00PM**

**Advanced Multimodal Imaging in Epilepsy: The Abnormal Human Connectome**

S Stufflebeam¹, J Polimeni¹, T Witzel¹, C Catana¹, N Tanaka¹, R Zanzonico¹, A Cole², E Eskandar², O Rapalino², B Buchbinder²

¹Massachusetts General Hospital, Charlestown, MA, ²Massachusetts General Hospital, Boston, MA

**Purpose**

Here we illustrate an approach to combine advanced multimodal neuroimaging datasets in a patient with medically refractory epilepsy who is undergoing pre-surgical evaluation. Structural MRI, MR diffusion-derived connectivity, hemodynamic & electromagnetic functional connectivity, and glucose metabolism were acquired. This includes some unique imaging technology and protocols: The Connectom MRI with high-performance gradients for advanced diffusion MRI, and the BrainPET for simultaneous resting-state fMRI and FDG PET.

**Materials and Methods**

Subject: A 52-year-old left-handed woman with medically refractory epilepsy undergoing pre-surgical mapping. Image Acquisition: 3T Connectom MRI (300 mT/m gradient strength): Multi-shell Q-ball diffusion (b = 0, 1k, 3k, 5k, 10k); Diffusion toolkit used for reconstruction and whole-head tractography (http://www.tractvis.com). 3T Siemens Skyra MRI: Pre- and Post-Gad 1mm isotropic multi-echo MPRAGE. 7T MRI: 32-channel head coil: T2* 2D FLASH and TSE @ 330x330micron, 1mm thick slice; axial slab of 200 micron time-of-flight MR angiogram through the hippocampi. fMRI: 1.2mm isotropic resting-state BOLD. MEG: 306 Channel Elekta-Neuromag MEG with 70-channel EEG cap; Minimum norm estimate (MNE) was performed on the inter-ictal discharges using a boundary element model. The dipolar currents were fused to the meMPRAGE. MR-PET: 3T TIM MAGNETOM Trio MR scanner (Siemens Healthcare Inc.) modified to support the BrainPET (Siemens), a MR-compatible brain-dedicated PET scanner prototype. ~5 mCi of FDG was administered to the subject and the emission data were recorded. PET images were reconstructed with a 3D OP-OSEM algorithm. The head attenuation map was derived from the MPRAGE data acquired simultaneously. Simultaneously, 3mm isotropic resting-state BOLD fMRI images were also acquired. Image Analysis: Resting-state functional...
connectivity analysis: After typical pre-processing, the Pearson correlation was calculated between a seed voxel and at every other voxel's time course, within a 12 mm radius. The degree of local coupling was calculated by summing the number of voxels above a correlation threshold of 0.25 (Stufflebeam, et al., 2009). After the initial analysis of the imaging modalities as outlined above, we used FreeSurfer tools to combine the images.

Results
A non-enhancing, 1cm oval lesion impinged on the left hippocampus, that had a significant intraventricular component. The 7T MRI T2* images demonstrated 'popcorn' hemosiderin deposition, and surrounding serpiginous tubular structures (see Figure). 7T MRA did not show any significant flow-related enhancement. The FDG MR-PET showed hypometabolism in the left hippocampus, extending into the posterior medial temporal lobe. MEG show rare interictal discharges in the lateral and medial temporal lobe. The language fMRI suggested right-hemisphere dominance (overall LI = 0.2). Functional connectivity analysis showed increased local connectivity in the medial temporal lobe consistent with a posterior medial temporal lobe ictal onset zone. Tractography of the Connectom diffusion images showed displacement of the fornix by the lesion, and possible invasion. Preoperative diagnosis was thought to be most likely a cavernous malformation or an arteriovenous malformation (AVM). Pathology was AVM.

Conclusions
A common challenge facing imaging centers is how to best combine imaging data to maximize it's usefulness for pre-surgical planning. We used a FreeSurfer-based solution to combine the diffusion, structural, and functional data. Each imaging technology played a critical role in the management of this patient's surgical plan. The structural and functional connectivity analysis identified an abnormal connectome with a seizure onset zone in the left hippocampus, yet showed abnormalities well beyond the medial temporal structures.

KEYWORDS: Functional Brain Mapping, Magnetoencephalography, MR Imaging/PET

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Purpose
Retrospective review of MR Imaging characteristics of three cases of histologically proven extraventricular neurocytomas (EVN) and its clinical outcome.

Materials and Methods
The three patients underwent pretreatment MR examination. The MR imaging (MRI) examinations were performed on a 1.5 T scanner using our tumor protocol which includes: coronal T1-weighted spin-echo imaging, axial and coronal T2-weighted imaging, axial GRE T2* imaging, axial FLAIR T2 imaging, diffusion-weighted B-1000 imaging and postcontrast volumetric 3D T1-weighted imaging, MR spectroscopy (MRS) and MR perfusion (MRP). The diagnosis was based on histological evidence after surgery.

Results
Three male patients of 21, 31 and 34 years of age presented with headache and dizziness, all showing large cerebral tumors in frontal or parietal lobes with cystic-necrotic changes, perilesional edema, marked contrast enhancement and partly with hemorrhagic foci or calcificactions in MR Imaging. MR spectroscopy revealed an increased Cho/NAA ratio and a glycine peak at 3.60 ppm. Histology demonstrated EVN with tumor angiogenesis, increased mitotic activity and nuclear atypia. All three patients underwent surgery and received radiotherapy, suffering relapses, the survival rate being 12, 16 and 48 months.

Conclusions
Despite both central and extraventricular neurocytomas being considered as a WHO grade II central nervous system tumors with a relatively low aggressive behavior, the three EVN cases we present showed high grade tumor malignancy characteristics with an aggressive behavior and a considerably shortened survival rate compared to that of central neurocytomas. MR spectroscopy and MRP can indicate an atypical behavior when showing high grade malignancy features and peritumoral infiltration as presented. The average survival rate is shortened especially when Ki:67 marker is increased.

KEYWORDS: MR Imaging Brain, MR Spectrocopy, Neurocytoma
Alterations in cerebral grey matter volume in patients with a first episode of psychosis and chronic schizophrenia: VBM study.

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Purpose
To study potential changes in volume of cerebral gray matter in patients with a first episode of psychosis (FEP), and if these changes differ from those of schizophrenics. To evaluate if changes in volume in schizophrenics depend on the presence of auditory hallucinations.

Materials and Methods
The following groups of subjects were included: 1) FEP patients (n=22, 14 males, aged (in years) 25.591 ± 5.234. 2) Schizophrenics (n=77). This group included patients with auditory hallucinations (n=42, 26 males, aged 37.952 ± 8.551) and without (n=35, 21 males, aged 34.857 ± 9.481). 3) Healthy controls (n=62, 35 males, aged 34.113 ± 9.570). A subgroup of 22 age/sex-matched controls was defined for additional comparison to FEP patients, in view of the differences in mean ages. High field brain, volumetric T13D-MPRAGE MRI was obtained (3 T Philips Achieva, software version 2.6.3). The voxel-based morphometry (VBM, SPM 8) methodology was applied searching for voxel-wise differences in gray matter volume among groups (corrected p<0.05, family wise error, FWE).

Results
First episode of psychosis patients compared to controls showed volume loss in the lateral temporal, medial parietal (precuneus, posterior cingulate), occipital and insular regions bilaterally. This same pattern was observed when compared to schizophrenics. Additionally, FEP patients had, compared to controls, volume gain in the anterior, medial and inferior temporal, occipital, medial-inferior frontal regions, and cerebellum. This same pattern was observed when compared to schizophrenics. On the contrary, schizophrenics compared to controls and to FEP patients showed a different pattern of volume loss, including the anterior, medial and inferior temporal, medial parietal and medial-inferior frontal regions. This same pattern was observed when PEP patients were compared to matched controls, and to schizophrenics having/not having hallucinations. There was no volume gain in schizophrenics compared to controls. No differences were seen between hallucinating and nonhallucinating schizophrenics.

Conclusions
There are volume changes - gain and loss -, having different patterns of involvement, already seen in FEP patients. These changes differ from those observed in schizophrenics, being indepedendent from the presence of auditory hallucinations. Our results suggest
plasticity/cortical reorganization and neuronal loss in schizophrenia along the temporal spectrum, independently from the phenotype. This work has been partly supported by grant 091230/091231 (La Marató de TV3), and by grants FIS 08/0705, 08/0475 and ETES 09/91030 (Instituto de Salud Carlos III, Ministerio de Economía y Competitividad, Spain).

KEYWORDS: Psychiatry, Voxel-Based Morphometry

Anti-NMDA Receptor Encephalitis: A Case Series from a Radiological Perspective

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Purpose
Anti-N-methyl-D-aspartate (NMDA) receptor encephalitis is a relatively novel diagnosis. It was first reported in the literature in 2005. The purpose of this poster is to present the radiological findings of a series of six proven cases of anti-NMDA receptor encephalitis and to review the current literature from clinical and neuroimaging perspectives.

Materials and Methods
Imaging and chart review of six clinically proven cases of anti-NMDA receptor encephalitis treated at the Montreal Neurological Institute from 2005 to 2013 was performed. The current published literature concerning the topic also was reviewed.

Results
Anti-NMDA receptor encephalitis is one of the top causes of autoimmune encephalitis, surpassing any viral-induced encephalitis in young individuals, with an increasing number of
cases reported from around the world yearly. It commonly is associated with ovarian teratoma and mostly it affects women of child-bearing age. Clinically, it is a challenging clinical diagnosis, as there are different phases with variable onset and a wide range of symptoms. The clinical picture is supplemented with laboratory testings, EEG recordings and MRIs. MR imaging is reported as normal in approximately 50% of cases, in literature and in our experience. When positive, the MRI findings demonstrate T2 and FLAIR hyperintensities involving the medial temporal lobes, the cerebellar and cerebral cortex, the basal ganglia, the brainstem, and rarely the spinal cord. The imaging pattern of this condition is not homogenous or typical. Furthermore, imaging plays a vital role for the search of associated tumors and ovarian teratomas.

Conclusions
We present the imaging findings of a rare but not uncommon condition: anti-NMDA receptor encephalitis. This is a relatively novel diagnosis most often affecting young women of child-bearing age associated with ovarian teratomas. This condition has to be known in order to provide adequate diagnosis and plan for more extensive imaging in this group of patients since often they require abdominal imaging and surgery for the primary teratoma. We illustrate some specific clinical and radiological aspects of this condition that need to be kept in mind for the diagnosis.

KEYWORDS: Encephalitis, Teratoma
Application of SWI for Scolex Demonstration in Calcified Neurocysticercosis Lesions

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Purpose
Neurocysticercosis (NCC) is an infectious disease caused by the larvae of the pork tapeworm Taenia Solium and is considered the most common parasitic disease of the CNS. Calcified brain lesions are a common finding. Identification of the scolex is pathognomonic, but sometimes it is difficult to differentiate a calcified neurocysticercosis cyst from other calcified lesions. This study was performed to describe SWI (susceptibility-weighted imaging) findings in calcified NCC lesions, focusing on scolex detection.

Materials and Methods
Subjects with the diagnosis of NCC, presenting single or multiple calcified lesions were studied with computed tomography (CT) and SWI sequence obtained on a 3T magnet. The study was IRB-approved and all subjects provided written informed consent.

Results
Twenty-six patients were included in this analysis. Scolex could be detected in a single calcified lesion in only one patient by CT. However SWI was able to identify the scolex in 15 patients. A total of 365 calcified lesions were identified by CT, in 46 of which scolices could be depicted by SWI, instead of only one identified by CT.

Conclusions
Susceptibility-weighted imaging sequence allows a better identification of the scolex in calcified lesions, allowing diagnosis of NCC. These findings indicate that SWI sequence is extremely useful in clinical practice, especially in the scenarios of single calcified lesions or in non-endemic regions, where the presumptive diagnosis of NCC can be challenging.

KEYWORDS: Intracranial Calcification, Intracranial Infections, MR Imaging Susceptibility
Association between carotid artery plaque inflammation and brain MRI

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Purpose
There are several evidences that carotid plaque composition is independent risk factor in ischemic stroke. The purpose of this work was to explore the association between the entity of inflammatory cells present in the carotid plaques and brain MR imaging (MRI) findings.

Materials and Methods
Forty consecutive (males 33; median age 64±7 years) patients were analyzed prospectively.
Brain MRI was performed using a 1.5 T system and lesions pertinence of the anterior circulation was recorded. All patients underwent carotid endarterectomy "en bloc"; histological sections were prepared and immuno-cytochemical study was used to characterize and quantify the inflammatory cells present in plaques, using the CD68, CD3 and CD45 monoclonal antibodies. Cell counting was performed at a magnification of X400 using a test grid with an area of 0.25 square mm and graded according do the degree from one to five. Receiver operating characteristic (ROC) curve analysis, Pearson Rho correlation and Mann-Whitney test were applied.

Results
The immuno-cytochemical study demonstrated that the cap of ruptured plaques in patients affected by stroke\TIA (n=25) was characterized by many inflammatory cells, principally macrophages (CD68) compared with those caps observed in ruptured plaques from patients without symptoms (Mann-Whitney = p < 0.001, ROC curve area = 0.901). Correlation analysis showed a statistically significant association between the number of brain nonlacunar infarct and the entity of macrophages (p < 0.001); no association was found with lacunar infarct (p = 0.1934).

Conclusions
Results of this preliminary study suggest that the entity of inflammatory cells in the carotid artery plaque is associated with the presence of cerebrovascular events and with the number of MRI brain detectable infarct.

KEYWORDS: Carotid Plaque

**EP-08**

**Atypical developmental venous anomaly associated with contrast enhancement and hyperperfusion in the surrounding basal ganglia**

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Purpose
Developmental venous anomalies (DVAs) are the most common type of cerebral vascular malformations. They generally are accepted as variants of venous development and frequently identified incidentally, particularly on contrast-enhanced MR imaging. Most of the DVAs do not affect the integrity of the surrounding parenchyma. The purpose of this article is to illustrate DVA with atypical hemodynamic pattern and discuss the role of imaging for diagnostic workup of DVA.

Materials and Methods
A 55-year-old woman presented with dizziness, vertigo, and disequilibrium. No abnormalities were reported on unenhanced cranial MR imaging performed at another facility three days previously. Therefore, MR imaging was repeated with contrast enhancement at our institution.

Results
Postcontrast MR images showed DVA with classical caput medusa appearance in the right basal ganglia draining to the deep venous system. In addition, there was contrast enhancement in the basal ganglia around DVA. However, there was no associated parenchymal signal intensity
abnormality on MR images. On perfusion MR imaging, there was increase in cerebral blood flow (CBF), cerebral blood volume (CBV), mean transit time (MTT), and time-to-peak (TTP) of both DVA and surrounding basal ganglia. DVA, which could not be seen on conventional MR imaging, was easily distinguished on SWI. The symptoms of the patient resolved completely within a few days. The MR imaging findings were stable at her 6- and 12-month follow-up.

Conclusions
Developmental venous anomalies may present with atypical imaging findings, such as contrast enhancement and increased perfusion in the surrounding parenchyma, probably due to anomalous venous drainage. These unusual perfusion patterns of the DVAs should be differentiated from other entities such as hypervascular brain tumors or ischemia with hemodynamic changes, which have different clinical management.

KEYWORDS: Basal Ganglia, Developmental Venous Anomalies, MR Perfusion-Weighted Imaging
Atypical manifestation of CNS tuberculosis

A Alazzaz, S Alzubaidi

Purpose
Our objective was to evaluate the uncommon CT and MR features of CNS TB in order to make a definite diagnosis. Discuss their pathogenesis, diagnosis, and treatment. Highlight the awareness to know the atypical TB pattern that help in early diagnosis and management & prevent fatal complication.

Materials and Methods
Abstract Still tuberculosis is significant public health concern & its prevalence is markedly increased in recent years, approximately 5 to 10% of cases of TB have CNS involvement. This article presents the range of atypical manifestations of tuberculosis (TB) of the craniospinal axis which is including rare location, unusual pattern with some rare complication as well as concurrence of two or more rare finding in same patient. We provide group of cases with rare location like pineal gland, suprasellar cistern & pituitary stalk involvement, an abscess formation is uncommon complication as a solely lesion in 3 of our patient & one case is with concurrent with all different tuberculomas stages. big pachymeningeal masses are illustrated in four cases as well as two cases mimicking intra axial tumor. we also illustrated a rare TB complication on brain vasculature e.g ruptured cerebral mycotic aneurysm. Involvement of vertebral column is common in tuberculosis but intra & extramedullary tuberculoma are rare as well as tuberculous myelitis. Generally all these atypical manifestation can mimic other disease like malignency or demyelinating disease. its complication on brain vascular is fatal & increase the mortality & the delay in the diagnosis of intra axial & intra/extra medullary involvement will also increase the morbidity. So awareness of the atypical TB pattern help in early diagnosis and management.

Results
Abstract Still tuberculosis is significant public health concern & its prevalence is markedly increased in recent years, approximately 5 to 10% of cases of TB have CNS involvement. This article presents the range of atypical manifestations of tuberculosis (TB) of the craniospinal axis which is including rare location, unusual pattern with some rare complication as well as concurrence of two or more rare finding in same patient. We provide group of cases with rare location like pineal gland, suprasellar cistern & pituitary stalk involvement, an abscess formation is uncommon complication as a solely lesion in 3 of our patient & one case is with concurrent with all different tuberculomas stages. big pachymeningeal masses are illustrated in four cases as well as two cases mimicking intra axial tumor. we also illustrated a rare TB complication on brain vasculature e.g ruptured cerebral mycotic aneurysm. Involvement of vertebral column is common in tuberculosis but intra & extramedullary tuberculoma are rare as well as tuberculous myelitis. Generally all these atypical manifestation can mimic other disease like malignency or demyelinating disease. its complication on brain vascular is fatal & increase the mortality & the delay in the diagnosis of intra axial & intra/extra medullary involvement will
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Conclusions
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KEYWORDS: Tuberculosis

EP-25

Brain Herniations into the Dural Venous Sinuses or Calvarium: MRI of a Recently Recognized Entity

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Purpose
Brain herniations into the dural venous sinuses (DVS) are rare findings that recently have been described and their etiology and clinical significance are controversial. In this exhibition, we present five patients with brain herniations into the DVS or calvarium that were identified on MR imaging (MRI) and discuss their imaging findings, possible causes, and relationship to patient's symptoms.

Materials and Methods
Recently, we observed five patients showing brain herniation into the DVS or calvarium containing various amounts of cerebral or cerebellar parenchyma surrounded by CSF. All patients were examined with MRI including high resolution pre and postcontrast T1- and T2-weighted sequences. With respect to brain herniations we documented their locations, signal intensities in different sequences, and size. We then reviewed clinical records in an attempt to establish if any symptoms were related to the presence of these herniations.

Results
Three males and two females were examined (age range, 11-68 years). Three patients had unilateral temporal lobe herniations into the transverse sinuses, one had a cerebellar herniation
into the skull, and one had bilateral temporal lobe herniations into the transverse sinuses as well as a cerebellar herniation into the sigmoid sinus. In all, the herniated brain and surrounding cerebrospinal fluid (CSF) had normal signal intensity on all MRI sequences. When correlated with clinical symptoms, brain herniations were thought to be incidental and asymptomatic in three patients and two patients had histories of headaches.

Conclusions
Brain herniations with surrounding CSF into the DVS/skull should be considered as potential sources of filling defects in the DVS. We believe that they are probably incidental findings that may be more common than previously recognized and should not be confused with the more common arachnoid granulations, clots, or tumors. Two patients had headaches, but their relation to the presence of herniated brain was uncertain.

KEYWORDS: Arachnoid Granulation, Brain, Meningoencephalocele

EP-11
6:30AM - 9:00PM

Brain metabolic response to ketogenic diet in patients with primary brain tumors: 1H-MRS study

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Purpose
Normal cells depend on glucose metabolism as their sole energy source, but can switch to the usage of fat products (ketone bodies) during caloric restriction. In contrast, tumor cells lack metabolic flexibility and are largely dependent on glucose. Thus, high-fat and low carbohydrate ketogenic diet (KD) was suggested as a therapeutic option for malignant brain cancer. This study aimed to detect and characterize longitudinal brain structural and metabolic changes in patients with malignant brain gliomas under KD.

Materials and Methods
Proton magnetic resonance spectroscopy (1H-MRS) was performed in five patients with high grade gliomas, treated with KD and bevacizumab. MR scans were performed before and every two months following KD initiation, including conventional imaging and 1H-MRS obtained at the normal appearing white matter.

Results
Substantial reductions in tumor volumes were detected two months following KD, in three of five patients (Figure 1A), attributed to the effect of bevacizumab, initiated alongside KD. After two months of therapy, an increase in tumor volumes was detected in these patients. During KD, a single peak of Aceton (Acn) was identified at a chemical shift of 2.22 ppm in two patients (Figure 1B). In addition, an increase in Glutamate and/or Glutamine (Glu+Gln) was detected in four of five patients, which may indicate Acn accumulation rather than an actual Glu+Gln increase due to misdetection of Acn in this chemical shift range. All other detected metabolites showed nonspecific and varied longitudinal patterns.

Conclusions
1H-MRS can provide biomarkers for accumulation of cerebral acetone, and can be a useful tool.
KEYWORDS: MR Imaging, MR Spectroscopy, Neoplasm

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EP-54
Purpose
In treating dural arteriovenous fistulas (dAVFs), the goal of embolization is occlusion of the dural vein close to the shunt point; We have recently reported the efficacy of superselective shunt occlusion (SSSO) in which coiling only the small venous pouch or compartment just downstream of the shunt point. Thus, detection of the shunt point is crucial in performing this method. The purpose of this study is to establish a more intelligible technique to detect shunt point compared with conventional DSA images and 3-dimension rotational angiography (3-D RA) images.

Materials and Methods
We have developed a new technique named circular color coding (CCC): in which arrival time of contrast media was determined by time-density curve obtained from conventional DSA pixel by pixel, followed by converting the arrival time to circular color phases. By this technique, blood flow is demonstrated as sequential "rainbow-colored" imaging(figure 1). CCC was applied to 18 dAVFs, and neuroradiologists/neurosurgeons assessed the shunt points with CCC, conventional DSA, and 3-D RA images separately.

Results
SSSO were available in 6 of 18 cases, and CCC showed more accuracy and required shorter time in determining shunt points in all 6 cases than either conventional DSA or 3-D RA images alone.

Conclusions
CCC achieved easier and better understanding of the shunts by coloring blood flow compared with conventional DSA in which difference of contrast density should be strictly discriminated. By complementary use of 3-D RA which has better spatial solution, CCC would be a very useful technique in therapeutic process for dAVFs.

KEYWORDS: Angiography, DAVF, Shunt
Cerebellar white matter degeneration in patients with spinocerebellar ataxia type 6 measured with diffusion kurtosis imaging

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Purpose
Diffusional kurtosis imaging (DKI) is a novel method based on non-Gaussian water diffusion model. We performed analyses of DKI in patients with spinocerebellar ataxia type 6 (SCA6), which is a rare, autosomal dominant neurodegenerative disease. The purpose was to investigate microstructural changes of the cerebellar substructures including the cerebellar peduncle tracts based on DKI-derived metrics to better understand the specific involvement of SCA6.

Materials and Methods
Diffusional kurtosis imaging data were obtained in three patients with SCA6 and five age and sex-matched controls with 3T MRI (Skyra, Siemens) with b-values of 0, 1000, 2000s/mm\textsuperscript{2} along 30 different motion probing gradient directions. The data with b-value of 1000s/mm\textsuperscript{2} were used for diffusion tensor analysis, while the data with 3 b-values were used for mean kurtosis.
computation. Tract-specific analysis was performed for the superior cerebellar peduncle (SCP), middle cerebellar peduncle (MCP), and inferior cerebellar peduncle (ICP). Region of interest (ROI) analysis was performed for the cerebellar white matter. Regions of interest were set at the vermis, medial and lateral part of the cerebellum. Fractional anisotropy (FA), apparent diffusion coefficient (ADC), and mean kurtosis (MK) were compared between two groups.

Results
Significant increase of ADC (MCP: \( p = 0.003 \), ICP: \( p = 0.015 \)) and decrease of MK (MCP: \( p = 0.022 \), ICP: \( p = 0.002 \)) were found in patients as compared to controls. There was no significant changes in SCP. Fractional anisotropy did not show changes in the cerebellar peduncles. Region of interest analyses showed significant decrease of FA (\( p = 0.03 \)) and MK (\( p = 0.001 \)) only in mid part of the cerebellum.

Conclusions
Despite the small number of subjects, our results of significant decrease of ADC and MK suggested that they are more sensitive than FA in detecting degenerative changes in cerebellar subregions in patients with SCA6. The microstructural changes were mainly seen in ICP, MCP, and mid parts of the cerebellum. These imply degeneration of afferent fibers of the cerebellum and the paleocerebellum is prominent and characteristic, but further investigation with larger number of subjects is warranted.

KEYWORDS: Cerebellum, Diffusional Kurtosis Imaging, Spinocerebellar Ataxia Type

EP-26

Cerebral White Matter Changes in Patients with Obstructive Sleep Apnea

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Purpose
Obstructive sleep apnea (OSA) is a frequent sleep disorder characterized by respiratory pauses during sleep, which provoke hypoxemia and sleep fragmentation (1). A recent study showed that OSA is an independent risk factor for white matter changes (WMC) (2). However, how theses WMC are distributed across brain regions in OSA patients remains unclear. The aim of the present study was to compare white matter changes distribution by the observation of white matter hyperintensities (WMH) between OSA patients and healthy control subjects. Moreover, this study aimed at exploring variables associated with increased WMH in OSA patients.

Materials and Methods
Fifteen male patients with moderate to severe OSA (age: 64.7 ± 4.8, body mass index (BMI): 28.4 ± 3.6, Apnea-Hypopnea Index (AHI): 31.5 ± 13.9) were compared to 15 control subjects (5 women, 10 men, age: 62.8 ± 4.9, BMI: 26.4 ± 3.0, AHI: 2.6 ± 2.0) matched for vascular risk factors (Vascular burden scale) (3). All subjects underwent an overnight polysomnography and a 3 T magnetic resonance imaging (MRI) scan with T2-weighted images and FLAIR. White matter hyperintensities were evaluated with the complex version of the Scheltens Visual Rating Scale (SVRS) (4,5) and analyses were performed on total scores and on the regions scores. Student t-tests were used to compare group differences on WMH and Pearson's correlations were used to
assess the relationship between SVRS scores and other variables including age, BMI, AHI, sleep time with an oxygen saturation < 90% and vascular burden scale score. Results were considered significant at p < 0.05.

Results
Ninety-three percent of subjects showed WMH in the OSA group as well as in the control group. No significant group difference was observed for the SVRS total score. When WMH for each region were compared between groups, OSA patients showed less WMH than control subjects in the occipital lobe (p < 0.05), but no other group differences were observed. A negative correlation was found between the minimal oxygen saturation during sleep and the SVRS total score in OSA patients (r=-0.56, p < 0.05), where lower oxygen saturation was associated with more WMH. No other significant correlations were observed in the OSA or the control group.

Conclusions
In this preliminary study, no increase in WMH was found in OSA patients compared to control subjects. Moreover, no major group difference was observed in the distribution of WMH, except for a lower occipital WMH among the OSA group. Interestingly, OSA patients with lower oxygen saturation during sleep showed higher WMH. Further studies should investigate whether the presence of white matter changes is associated with anomalies on diffusion tensor imaging and/or with greater cognitive deficits among the OSA population.

KEYWORDS: MR Imaging Brain, Obstructive Sleep Apnea, White Matter Disease

EP-68
6:30AM - 9:00PM
Characterization, Demographic and Casuistic Assessment of Superficial Brain Hemorrhages.

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Purpose
Hemorrhages that happen near surface of the brain, confined to subpial space or trapped focally in one segment of the subarachnoid space, may have distinct prognostic implications. It has been speculated that this distribution may be associated with development of laminar infarcts, arguably as a result of vasoconstriction of the most distal superficial vessels within the subpial space. However, epidemiology and detailed imaging characteristics of this possible distribution are undefined. Our study proposes to characterize imaging findings and assess epidemiologic information for hemorrhages located along the surface of the brain.

Materials and Methods
Three radiologists retrospectively assessed head CTs and clinical history in 361 patients with intracranial hemorrhage, aiming for classification of the hemorrhage, cause, and demographics. The hemorrhages were classified as intraparenchymal, epidural, subdural, subarachnoid and superficial. Superficial hemorrhage was considered when focal widening of the sulci or fissure and displacement of the adjacent cortex were present.

Results
In our group of patients with intracranial hemorrhage 35 (9.7%) had "superficial" characteristics. From those, 16 (45.7%) were associated with trauma, 12 (34.3%) with aneurysm rupture, 3
(8.6%) were related to other causes such as coagulopathy, post-surgical or endovascular treatment, pseudo aneurism and hypertension, and in 4 (11.4%) cases we were not able to determine the cause. Two most frequent locations were frontal lobes (n=18) and Sylvian fissures (n=8). Median age was 58 years (mean 58.3; range 3 months to 84 years) and there was a slight female prevalence (female 60%, male 40%). 3 month old female with superficial and subdural hemorrhage in right temporoparietal lobe was a term, C section infant suffering from cardiomyopathy, awaiting heart transplantation. Traumatic injury caused right frontal superficial and overlaying subdural hemorrhage in a 3 year old female. Almost all (n=34) patients had other hemorrhage present, mostly subarachnoid (n=31). All the superficial hemorrhages showed hypodensity of the surrounding/displaced cortex.

Conclusions
A small percent of intracranial hemorrhages may show a distribution that does not fit the usual classification. The distribution could be the result of subpial location or a confined clot in a localized segment of the subarachnoid space. The subpial distribution has been previously described in term neonates after what was considered to be a birth trauma and in a small case series of 10 adult patients. Based solely on acute imaging modality, separation between subpial hematoma and a localized clot in a focal segment of the subarachnoid space is not possible. However, the possible consequences of both these superficial hemorrhage patterns to the adjacent displaced cortex are similar, leading to laminar edema with subsequent infarction. Our study shows that this distribution is not infrequent, happens in adults and kids, usually after trauma and aneurysm rupture. In all cases the displaced parenchyma shows evidence of edema, which may progress to infarct. Attention to superficially located intracranial hemorrhage should be made and further investigation and better understanding of imaging characteristics are necessary considering the possible impact on the adjacent brain parenchyma, patient treatment and clinical outcome.

KEYWORDS: CT And Stroke, Intracranial Hemorrhage, SAH

EP-66
6:30AM - 9:00PM

CLINICAL VALUE OF 7T IMAGING IN MEDICALLY REFRACTORY EPILEPSY: COMPARISON TO 1.5 AND 3T MR IMAGING

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Purpose
Ultra-high field magnetic resonance imaging (MRI) offers significant gains in signal- and contrast-to-noise ratio but is affected by increasing susceptibility artifacts and magnetic field inhomogeneity. The FDA has approved 7T MRI for research, but currently there are no 7T MRI scanners that have been approved for clinical use. While several studies have shown the utility of 7T MRI for anatomical imaging, there is a paucity of reports evaluating its use in identifying intracranial pathologies. With the success that surgical approaches can provide for localization-related epilepsy, identification of potential causes of seizure is critical. This study evaluates the
potential clinical value of 7T MRI in medically refractory epilepsy cases comparing findings at 7T to those at 1.5T/3T MRI.

Materials and Methods
34 patients with medically refractory epilepsy (age: 15-52 years; 21 females) underwent 1.5 and/or 3T MRI performed as part of routine clinical presurgical evaluation and an IRB-approved 7T MRI examination. 1.5/3T imaging studies were retrospectively reviewed and compared with 7T MRI studies by two neuroradiologists by consensus. Additional clinical information (including EEG/MEG) as well as pathological sampling was used for retrospective analysis of the datasets.

Results
Compared to 1.5/3T MRI, findings on 7T MRI improved conspicuity of pathology and impacted clinical management in 13 of 34 cases (38.2%). 7T MRI demonstrated pathology in 4 cases that were interpreted as negative on 1.5/3T. 7T MRI resulted in a change in imaging interpretation of the pathology in 3 cases where the initial finding was detected on 1.5/3T MRI. 19 patients with refractory epilepsy cases had focal EEG findings; 11 of these 19 patients had focal abnormalities at 1.5/3T, while 14 of 19 patients had focal abnormalities on 7T imaging.

Conclusions
With improvements in signal-to-noise ratio, 7T MRI may provide additional clinical information in patients with refractory epilepsy, particularly with respect to better visualization and definition of intraparenchymal vascular and focal cortical dysplastic lesions. This modality has the potential to alter clinical management in patients with medically refractory epilepsy.

KEYWORDS: Epilepsy, High Field, MR Imaging Brain

EP-45

Comparison of Vessel Occlusions Shown by CT Angiography to Conventional Catheter Angiography in the Evaluation of Patients in the Acute Stroke Setting

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Purpose
Purpose is to determine the inter-reader reliability within CTA as well as any inter-modality discordance between CT angiography and the gold standard conventional catheter angiography of the head and neck for detection of different levels of vessel occlusion in the acute stroke setting.

Materials and Methods
This study retrospectively compared CT angiography studies to catheter angiography in the evaluation of head and neck arteries in patients with suspected acute stroke. Using the Radiology Information System, a list of all head and neck CT angiography followed by cerebral angiogram studies performed for acute stroke from April 1, 2004 to December 31, 2009 was obtained. All studies were performed on 64-slice GE LightSpeed Scanners (GE, Milwaukee Wisconsin) and Philips Biplane Angiography Suite (Philips Medical Systems, Bothell, Wash). The pair of studies was read in a blinded fashion independently and prospectively using PACS. The ages of the
patients undergoing these studies ranged from 22 to 92 with an average 66.7 (S.D. 14.2 yrs). 15 females and 8 males comprised the study population. Cases were presented in a random order. Readers were permitted to use their own reconstructions, including TeraRecon (TerRecon, San Mateo, CA) 3D reformations as well as Volume Viewer 2 (AW suite 2.0 6.5.1.w). For each case, the reader was asked to evaluate major arteries of the anterior and/or posterior circulation including the carotid, middle cerebral, anterior cerebral, posterior cerebral, basilar, and vertebral arteries as dictated by the areas of documented lesions. The readers would designate a vessel as 1) severely stenotic, 2) nearly occluded, or 3) occluded or 4) Open. The readers true impression of the physiologic status of nearly occluded and occluded vessel on the CT were then labeled as most likely to be true occlusions or most likely to be patent on conventional catheter angiography. Catheter Angiography studies were analyzed in a similar manner to their CTA counterparts. Each study was read by a blinded reader and in random order. Criteria used to define severe stenosis were as per WASID trial 1) severely stenotic, 2) nearly occluded, or 3) occluded or 4) open.

Results
812 vessel segments (Common carotid, Extracranial ICA, Intracranial ICA, M1, M2, A1, AComm, A2, P1, P2, Vert, Basilar, PICA, AICA, SCA) were analyzed. 29/812 (3.5%) stenotic, occluded, or nearly occluded vessels were identified and analyzed by 3 independent readers in a blinded fashion. On CTA there was complete agreement on 21/29 vessels (72.4%). There was partial agreement (2 out of 3 readers) between severe and near occlusion on 3 vessels (9.7%) and between near occlusion and complete occlusion in 5 vessels (16.7%). On catheter angiography, there was complete agreement between readers on 26/29 vessels (89%). To compare CTA with catheter angiography, vessels in which disagreement was present were reviewed as a group and consensus decision was made. When comparing the reader results for CT angiography to the gold standard there was 24/29 (83%) vessel agreement. In 3 of the cases of disagreement there was visualization of an occlusion on CTA, while a severely stenotic, but patent, vessel was noted on conventional angiography. The converse occurred in the other two cases, where a severely stenotic lesion was present on CTA and was found to be completely occluded on conventional angiography. Among the pairs of studies where disagreement existed, 3 cases had reader discordance within one or both of the individual imaging modalities.

Conclusions
CT angiography in the acute stroke setting is rapidly becoming the triage modality of choice. As it becomes increasingly relied upon for crucial decisions in urgent settings, the validity of the results are all that more important to demonstrate. Although evaluated previously, prior reports did not take into account collaborative reading, analysis of nearly occluded vessels, or extracranial vascular disease. It is impractical to provide gold standard imaging for all patients in the acute stroke setting. The current study demonstrated lower sensitivity and specificity for vessel occlusion on CTA than has been shown previously. This discrepancy was seen in specific situations. Imaging was degraded by poor cardiac function, patient motion, and metal from teeth and surgical clips which limits all CTA exams. Some stenosis or occlusions in patients with unique collateral anatomy, adjacent veins, plaque architecture, or thrombus pathology may be intrinsically difficult to characterize on CTA. In these unusual situations group analysis may increase the accuracy of CTA in characterizing nearly occluded vessels when making these critical triage decisions in an acute stroke setting.

KEYWORDS: Angiogram, CTA, Diagnostic Accuracy
Compartmentation of Brain Water in the acute phase of Ischemic Stroke

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¹Henri Mondor, Creteil, IDF

Purpose
To characterize brain water motion during an acute ischemic stroke.

Materials and Methods
Ten patients with an acute ischemic stroke < 48 hours have been explored on a 1.5 T Siemens Avanto System with diffusion Imaging using multiple b factor-values from 0 to 5000 s/mm² by steps of 500 s/mm² and with T2-SE weighted Imaging using multiple TE values from 8.8 ms to 265.6 ms by steps of 8.8 ms. The compartments with fast and slow diffusion (ffast and fslow) and the respective apparent diffusion coefficient (ADC) values of the two compartments could be calculated by using the relation: S= S0.(ffast.exp(-b.ADCfast)+fslow .exp(-b.ADCslow). By using the relation: S(t)= S0.(fT2long.exp(- TE/T2long) +fT2short.exp(-TE/T2short) , it is possible to extract the fractions of water with short (fT2short) and long (fT2long) TE and the respective TE values (TEshort and T2long) of the two compartments. Measurements were localized on the ischemic and the contralateral normal brain.

Results
By comparison with the normal parenchyma, ischemic brain is characterized by a lower ffast (0.52 versus 0.67, p =0.0035) with no modification of ADCfast and ADCslow and by an increase of fT2long (0.69 versus 0.59, p=0.047) associated with an increase of the T2long(157.9 ms versus 124.3 ms, p=0.021).

Conclusions
These observations disagree with the concept of a "volumic" compartmentation of brain water because the both increased fT2long and T2 long should be associated with an increased ffast. These observations could agree with a "dynamic" compartmentation (decreased trans-membrane diffusivity related to aquaporine-4 under-expression) or with a microperfuive explanation (astrocytic end-foot edema responsible for a decreased microcirculation).

KEYWORDS: Diffusion MR Imaging, Stroke

Computer Aided Diagnosis of Acute Brain Ischemic Stroke of CT Imaging

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Purpose
The purpose of this study is to improve sensitivity of diagnosis of acute infarction using computer-aided diagnosis system with unsupervised feature perception enhancement method.

Materials and Methods
This system mainly uses unsupervised region growing algorithm to segment the CT imaging into eight important areas. And, it uses coinciding regional location method to highlight the infarction areas. Two neuroradiologists blinded to all patient identifiers and clinical data, first evaluated only the standard noncontrast CT imagings for the area of infarction. Readers then were asked to rediagnosis of infarction area after reviewing the computer aided diagnosis imagings.

Results
After reviewing the computer-aided diagnosis imagings, the sensitivity of acute infarction detection revealed a significant increase from 39% to 90%.

Conclusions
We proposed an unsupervised feature perception enhancement method to detect the acute infarction area in brain CT images. This computer-aided diagnosis system has the potential to assist radiologists in diagnosis of acute brain infarction.

KEYWORDS: Brain And Stroke, Computer-Aided Diagnosis

EP-95 6:30AM - 3:00PM

Contrast-enhanced MR Venography in Patients with Multiple Sclerosis to Assess Stenoses of the Internal Jugular Veins. Is There Correlation with CCSVI Criteria?

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Purpose
Zamboni et al suggest that multiple sclerosis (MS) may develop secondarily to impaired central nervous system venous outflow and describes this as Chronic Cerebrospinal Venous Insufficiency (CCSVI). Internal jugular vein (IJV) stenosis is suggested as a cause. This study assesses the prevalence of IJV stenosis in patients with multiple sclerosis and age matched controls using contrast enhanced MR venography (CE-MRV). Potential correlation of IJV stenosis with CCSVI defined by Doppler ultrasound (US) is evaluated.

Materials and Methods
This was a single-center, prospective, observational study of 50 subjects with a confirmed diagnosis of multiple sclerosis with age-matched controls. Research ethics approval and informed consent were obtained. Subjects were randomly selected from 6 MS categories. CE-MRV was performed on a 3T magnet. US evaluation of the intra and extracranial circulation was used to define CCSVI criteria. Imaging results were reviewed independently by pairs of neuroradiologists blind to subject assignment. From MRV images the degree of stenosis was
graded within the lower, mid and upper 1/3 segments of the IJV. US evaluation was considered positive if 2 or more CCSVI criteria were present.

Results

100 studies were undertaken. 13 could not be evaluated due to poor MRV quality (6 patients, 7 controls). Median ages (range) were 50 (27-67) for patients and 54 (25-73) for controls. The female to male ratio was 1.9 for patients and 0.6 for controls. Inter-observer variability for IJV stenosis was fair for lower 1/3 (ICC 0.45 (0.24-0.61)), poor for mid 1/3 (ICC 0.18 (-0.03-0.38)) and good for upper 1/3 (ICC 0.71 (0.58-0.80)) IJV segments. IJV stenosis was identified in 85 (98%) of subjects. Stenosis >= 50% was identified in 31 (70%) of patients and 32 (74%) of controls and was more probable in both groups in the upper 1/3 IJV segment. Stenosis of the lower 1/3 IJV segment was more frequently observed in patients (p=0.01, RANOVA). A positive CCSVI score was identified in 12 patients and no controls (p < 0.001, Fisher's exact test). For positive CCSVI there was a greater proportion of IJV stenosis >= 50 but only in the lower 1/3 IJV segment (p < 0.001) where a weak correlation (Spearman-Rank – 0.4, p <0.001) exists between CCSVI score and stenosis.

Conclusions

IJV stenosis is highly prevalent on MRV and does not distinguish between MS and control subjects. A weak correlation exists between lower 1/3 segment IJV stenosis and CCSVI criteria.

KEYWORDS: CCSVI, Contrast-Enhanced MR Angiography, Multiple Sclerosis

EP-39

Correlation between voxel based morphometry and resting state functional connectivity in Alzheimer Disease

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Purpose

Multimodal imaging aims to seize the best of the worlds offered by each modality employed. Previous reports indicate feasibility of applying voxel-based morphometry (VBM) in parallel with functional images. Results disentangle the relationships between cortical atrophy and decreased metabolic signals in the anterior and posterior cingulate regions of the Default-mode Network (DMN) in older participants. Although these are core areas in the maintenance of brain connectivity, basal areas like the hippocampus and lateral temporal cortex play a role in the default network (Greicius et al., 2004). Here, we sought to correlate differences in functional connectivity and cortical variations as shown by VBM. Resultant volumes-of-interest from the comparison between AD patients and normal control T1-weighted image volumes were used to identify disease-related deviations of brain functional connectivity. Our aim was to verify the relationship between structural variability and functional compromise depending on each resting state network.

Materials and Methods

A group of 17 elderly were recruited for this study. Mean age for experimental group was 74 years old (s.d. 4.5). Data gathered from a control group was used as age-paired controls for comparison of T1-weighted morphometry and functional connectivity (n=17, mean age 71, s.d.
Patients were diagnosed as Alzheimer patients as confirmed by a specialist examination (mean CDR=1, mean MMSE=16). The research protocol was approved by the local Ethical Committee and all participants signed an informed consent. Resting state functional images were acquired in an Achieva 3 T MR scanner (Philips, The Netherlands) using a noise-attenuated EPI. Tridimensional T1-weighted images were acquired for functional co-registration and morphometry in SMP8. Volumes were matched to the MNI template, segmented, normalized with volume preserving modulation, smoothed (8 mm FWHM) and submitted to statistical test. Functional data were submitted to preprocessing and independent component analysis (ICA) in BrainVoyager QX (Brain Innovations, The Netherlands). After group ICA calculations, (Esposito et al., 2005), functional connectivity values were acquired using resulting VOIs from VBM as binary masks.

Results

Voxel-based morphometry analysis showed differences in medial posterior cingulate cortex, left amygdala, parahippocampal gyrus, medial frontal cortex, and fusiform gyrus. The areas are mainly related to DMN, Salience network and Visual network. Group-wise comparison between standardized ICA values of each VBM resulting VOIs showed differences in zICA of areas coincident with the DMN. Posterior cingulate (Brodmann Area 31) and precuneus (BA 7) showed lower values for patients. Values in posterior cingulate reached 3.50 zICA for patients (1.55 SD) and 4.85 (1.18 SD) controls. Precuneus VOIs showed 2.16 (1.18 SD) for patients and 3.09 (1.40 SD) for controls. Pearson r coefficient for gray matter content and ICA values in posterior cingulate reached 0.45 (d.f= 32, p<<0.05) when all 34 participants are considered.

Conclusions

We identified differences between controls and Alzheimer disease patients by analyzing T1-weighted morphometry and functional resting state data. Results point to an association between cortical thinning and differences in functional connectivity related to AD. Findings may be useful to point out the prodromal phase of Alzheimer disease, shedding light on possible anatomical markers for the progress of the disease.

KEYWORDS: Alzheimer Disease, FMRI, Morphometry

Table 1. zICA values in VBM resulting VOIs of each group.

<table>
<thead>
<tr>
<th>Region</th>
<th>Brodmann</th>
<th>zICA DMN CTR</th>
<th>zICA DMN PTS</th>
<th>t test</th>
<th>Voxels</th>
<th>x</th>
<th>y</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>rCingulate</td>
<td>BA31</td>
<td>4.85 (1,18)</td>
<td>3.50 (1,55)</td>
<td>0,008</td>
<td>191</td>
<td>4</td>
<td>-53</td>
<td>33</td>
</tr>
<tr>
<td>rPrecuneus</td>
<td>BA7</td>
<td>3.09 (1,40)</td>
<td>2.16 (1,18)</td>
<td>0,045</td>
<td>512</td>
<td>7</td>
<td>-51</td>
<td>38</td>
</tr>
<tr>
<td>rAmygdala</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n.s</td>
<td>170</td>
<td>23</td>
<td>-6</td>
<td>-14</td>
</tr>
<tr>
<td>lMedialFrontal</td>
<td>BA10</td>
<td>-</td>
<td>-</td>
<td>n.s</td>
<td>117</td>
<td>-3</td>
<td>44</td>
<td>-1</td>
</tr>
<tr>
<td>lParahippocampal</td>
<td>BA19</td>
<td>-</td>
<td>-</td>
<td>n.s</td>
<td>142</td>
<td>-23</td>
<td>-54</td>
<td>-5</td>
</tr>
<tr>
<td>rFusiform</td>
<td>BA19</td>
<td>-</td>
<td>-</td>
<td>n.s</td>
<td>10</td>
<td>38</td>
<td>-62</td>
<td>-9</td>
</tr>
<tr>
<td>lParahippocampal</td>
<td>BA19</td>
<td>-</td>
<td>-</td>
<td>n.s</td>
<td>113</td>
<td>-23</td>
<td>-54</td>
<td>-8</td>
</tr>
</tbody>
</table>
Cortico-spinal Tract Signal Abnormality on MRI in Glioblastoma Multiforme: Is it Wallerian Degeneration or Tumor Infiltration?

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Purpose
Wallerian degeneration (WD) is an inflammatory response of the nervous system to various forms of axonal or neuronal insult. Glioblastoma multiforme (GBM) is an aggressive WHO grade IV tumor known for tumoral infiltration well beyond the enhancing margins. The aim of the study is to characterize the MR imaging (MRI) signal alteration of the cortical spinal tract (CST) in GBM patients and to determine if imaging model best represent Wallerian degeneration or tumoral infiltration.

Materials and Methods
Retrospective review of 63 consecutive patients (mean age 58; 52 males: 11 females) with histologic confirmation of GBM was performed. MR imaging tumor protocol was done on Siemens 1.5 T Symphony and Siemens 3.0 T Skyra MR systems. The location of GBM and
extent of white matter infiltration [centrum semi ovale, (CST)] was documented on T2 and FLAIR images. Two independent authors (CC-TH and SB) reviewed the studies and zonal classification was used to define extent of abnormality. Zones were defined as I) Centrum semiovale to posterior limb of internal capsule, II) Posterior limb of internal capsule to cerebral peduncle of midbrain, III) Midbrain to pons, IV) Pons to pyramids of medulla. In addition DWI/ADC was used to determine restricted diffusion and postcontrast T1 axial and coronal to assess extent of enhancement. Follow-up examinations (mean duration of 15 months) also were reviewed to document zonal progression of disease and or atrophy. Statistical analysis was performed using Fisher's exact test, Binomial regression and Spearman's rank correlation.

Results
On initial MRI examination 54% (34/63) of GBMs in the frontal, temporal or parietal lobes with involvement of the centrum semi ovale had T2 and FLAIR high signal intensity in the CST. There was no CST involvement in patients with occipital lobe primary. Initial zonal distributions were as follows: 17 in zone I, 10 in zone II and 7 in zone III. Only 6% (2/34) of patients with signal alternation of CST demonstrated enhancement and none showed restricted diffusion. On follow-up examination 39% (24/62) of patients showed new high signal intensity in the CST (46%; 11/24) or progression of zonal stages (46%; 11/24). Only 8% (2/24) had no interval progression. Follow-up zonal distributions were as follows: five in zone I, nine in zone II, five in zone III and five in zone IV. Atrophy of the middle cerebral peduncle was observed in 60% (14/24) of follow-up patients.

Conclusions
Signal abnormality in the CST in patients with GBM is not uncommon. Progressive signal change with associated atrophy of the middle cerebral peduncles best is likely to follow the Wallerian degeneration model over white matter tract infiltration. It is further supported by lack of enhancement even on follow-up studies. The progression of zonal stages on follow-up examination and presence of atrophy in half of the patients is a supporting evidence that Wallerian degeneration of CST is a feature seen in GBMs.

KEYWORDS: Corticospinal Tract, Glioblastoma
Cynomolgus MRI label atlas and map for fully automated morphometric analyses

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Purpose
Currently available non-human primate templates typically require input of a skull-stripped brain for structural processing. This can be a manually intensive procedure, and considerably limits their utility. The purpose of this study was to create a cynomolgus MRI population template, associated tissue probability maps (TPM), and a label atlas to facilitate true fully automated MRI structural analyses for morphometric analyses.
Materials and Methods
Structural T1-weighted 1.5T MRI scans of 16 experimentally naive cynomolgus monkeys (Macaca fascicularis) were used in this study. An unbiased population average template was created using a symmetric diffeomorphic registration (SyN) procedure. Skull stripping, segmentation, and label map generation were performed using the publically available rhesus INIA19 MRI template and NeuroMap label atlas (1). A 6-class TPM and a 6-layer 2-class normalization template was created from the cynomolgus segmentation for use within the SPM framework. Fully automated morphologic processing of all of the cynomolgus MRI scans was then performed using the cynomolgus TPM and cynomolgus normalization template including skull-stripping, segmentation and normalization.

Results
The cynomolgus template creation procedure resulted in excellent skull stripping, segmentation, and NeuroMap atlas labeling with 720 structures successfully registered. Fully automated processing was accomplished for all cynomolgus scans, demonstrating excellent skull-stripping, segmentation, and normalization performance.

Conclusions
We describe creation of an unbiased cynomolgus structural MRI population template and atlas. The template includes an associated 6-class TPM and DARTEL 6-layer 2-class normalization template for true fully automated skull-stripping, segmentation, and normalization of cynomolgus structural T1-weighted MRI scans. We describe the most detailed cynomolgus label atlas currently available based on the NeuroMaps atlas with 720 labels successfully registered. We additionally describe a novel method for atlas label generation that capitalizes on previous work in this area using high-dimensional highly accurate image matching procedures for inter-species morphologic normalization.

KEYWORDS: Brain

EP-63
Diagnostic Accuracy of MRI vs. FDG-PET in the Evaluation of Temporal Lobe Epilepsy

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Purpose
Approximately 30% of patients with EEG or pathological evidence of temporal lobe epilepsy (TLE) have normal MRI scans [1,2] (so-called non-lesional TLE). The purpose of this study was to compare the diagnostic accuracy of MRI vs. PET in pathologically confirmed TLE, and identify the type of pathology in negative cases for each modality.

Materials and Methods
Fifty five adult patients (mean age 41 ± 13 years; 31 female) who had both FDG-PET/CT and MRI for presurgical evaluation of temporal lobe epilepsy between 2010 and 2012 were identified from a query of clinical radiology database. All these patients subsequently underwent unilateral temporal lobectomy and/or amygdalohippocampectomy, or laser ablation of the mesial temporal lobe. Clinical data, EEG pathology and surgical outcome results were compiled, and the final
overall clinical diagnosis in patients with successful outcome (Engel class I) was used to assess the diagnostic accuracy of MRI and FDG-PET/CT.

Results
Forty one (75%) patients had successful outcome during mean follow up period of 16.5 ± 10 months; fifteen patients had <12 months follow up. Among all patients who had successful outcome, 30 were PET+/MRI+, 9 were PET+/MRI-, and 2 were PET-/MRI-. The 9 PET+/MRI-subjects included 4 with neocortical epilepsy, 3 with both reactive changes of the neocortex consistent with chronic epilepsy and mesial temporal sclerosis (MTS) (3/9), and 2 with neocortical epilepsy and undetermined hippocampal pathology due to fragmentation of the samples (2/9). The pathology of 2 PET-/MRI- group was reactive changes of the neocortex consistent with chronic epilepsy.

Conclusions
Even with optimized imaging protocols, MRI fails to identify 27% of TLE cases in the current study, similar to rates reported in the literature. The false negative rate is lower with PET (5%), confirming PET as the more sensitive modality for guiding surgical decisions. The negative imaging cases involving the neocortex are likely subtle focal cortical dysplasias that remain a major challenge for structural, and to a less extent, metabolic imaging techniques.

KEYWORDS: MR Imaging, PET, Temporal Lobe Epilepsy

EP-16
Differences Between the Findings of Ultrasonography and Magnetic Resonance Imaging for Evaluation of Carotid Artery Stenosis

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Purpose
Ultrasonography and MR imaging (MRI) are indispensable study for screening of carotid artery stenosis. Each study can evaluate a stenosis degree of carotid artery. But there may be a difference in the results of stenosis degree with each studies, and so we sometimes need cerebral angiography to determine a stenosis degree of carotid artery. Furthermore, the cases of carotid artery stenting gradually increase, and it became apparent that a vulnerable plaque makes carotid artery stenting difficult for high risk of ischemic stroke. Vulnerable plaque is detected by ultrasonography with hypoechoic lesion, and by MRI in a black blood sequence with hypersignal lesion. But there is the case which have different findings of a vulnerable plaque between ultrasonography and MRI in a black blood sequence. We compared a result of ultrasonography and MRI with cerebral angiography, those were performed to the cases of carotid artery stenting or percutaneous transluminal angioplasty, and evaluated superiority of ultrasonography and MRI with consideration from literatures.

Materials and Methods
The cases of carotid artery stenosis performed CAS or PTA from April 2007 through May 2013 were evaluated (CAS 196 cases, PTA 30 cases). We measured a stenosis degree of carotid artery in the North American Symptomatic Carotid Endarterectomy Trial (NASCET) in MRA, echo, DSA each. It was classify in the following four groups. (1) 0〜49%, (2) 50%〜69%, (3) 70%〜
99%, (4) 100%. In addition, we evaluated a vulnerable plaque by ultrasonography and MRI in a black blood sequence, and checked the difference between each test result.

Results
The ratio that a stenosis degree of carotid artery in MRA accorded with cerebral angiography was 78% (63 of 81 cases). The number of overestimated cases was 11, underestimated cases were seven. MR angiography (MRA) had a tendency to overestimate a stenosis degree of carotid artery. The ratio in ultrasonography accorded with cerebral angiography was 47% (38 of 81 cases). The number of overestimated cases was eight, underestimate cases were 35.

Ultrasoundography had a tendency to overestimate a stenosis degree of carotid artery. In the measurement of a stenosis degree, MRA was higher in accuracy than ultrasonography. In the evaluation of a vulnerable plaque, the result of ultrasonography tended to depend on the subjectivity of the ultrasonographer, but it was useful for a mobile plaque evaluation.

Conclusions
In the evaluation of carotid artery stenosis lesion, MRI and ultrasonography are effective methods, and they are minimally invasive. But there are good and bad points with both modalities. It is necessary to use MRI and ultrasonography properly by evaluation points for understanding well the pathophysiology of carotid artery stenosis.

KEYWORDS: Carotid Artery Stenosis, MR Imaging, Ultrasonography

EP-31

Differentiating melanoma and lung cancer brain metastases using dynamic contrast-enhanced T1-weighted MR perfusion imaging

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Purpose
It is difficult to predict the primary origin site of brain metastases based on conventional MR imaging. Dynamic contrast-enhanced T1-weighted MR imaging (DCE-MR) can provide physiologic information about tumor vascularity. We hypothesize that DCE-MR imaging can help differentiate melanoma brain metastases from non-small cell lung cancer brain metastases based on the quantitative analysis of their hemodynamic imaging properties.

Materials and Methods
A total of 50 brain metastases for which the primary tumor origin was either melanoma (23 patients) or non-small cell lung cancer (27 patients) were included. The kinetic enhancement of tissue during and after injection of Gd-DTPA was obtained using a 3D T1-weighted fast spoiled-gradient (SPGR) echo sequence. Preprocessing included background noise removal, spatial and temporal smoothing, and detection of the arterial input function (AIF) from the aorta. All regions of interests (ROIs) around the lesions were placed by a neuroradiologist. Anatomical images that matched the DCE-MRI images were used to guide ROI placements. Voxel-by-voxel estimates of perfusion parameters, including vascular permeability (Ktrans), plasma volume (Vp), slope and peak-enhancement were calculated. A Mann-Whitney U test, at a significance level of p≤0.05, was performed to compare differences of the DCE-perfusion parameters between the two groups.
Results
Of the four perfusion parameters, Vp was observed to have the largest difference in mean (µ) between melanoma (mean=4.1/sec) and lung cancer brain metastases (mean=2.2/sec). A Mann-Whitney U test showed a significant difference between the observed Vp values for the two groups (p≤0.04). However, other parameters were not significantly different between two groups.

Conclusions
Our data demonstrate brain metastases from non-small cell lung cancer brain metastases based on quantification of hemodynamic properties derived from dynamic contrast-enhanced T1-weighted MR perfusion imaging. Identifying the primary tumor site can be especially important in patients with coexisting malignancies. Additional studies are warranted to assess and compare the perfusion characteristics of other types of brain metastases.

KEYWORDS: Brain, Melanoma, Metastases

Top Row: Right frontal lobe NSCL metastasis with Vp of 1.52 on perfusion color map.
Bottom Row: Right frontal melanoma metastasis with Vp of 8.46 on perfusion.

(Filename: TCT_EP-31_ASNR2014.jpg)

EP-12
Differentiation between vasogenic edema versus tumor-infiltrative area in patients with glioblastoma during bevacizumab therapy: a longitudinal MRI study

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Purpose
Bevacizumab generally brings about an initial substantial radiologic response in most patients with glioblastoma (GB). Yet, several studies have shown that following bevacizumab, GB is more likely to progress to an infiltrative pattern, associated with an increased MR imaging (MRI) T2-weighted signal. This work seeks to differentiate between vasogenic edema versus tumor-infiltrative area in GB patients.

Materials and Methods
Fourteen patients with GB were scanned longitudinally, before and during bevacizumab therapy (40 MR scans). MR imaging included conventional imaging, diffusion, dynamic susceptibility contrast, dynamic contrast enhancement imaging, and MR spectroscopy (MRS). Classification of the non-enhancing fluid attenuation inversion recovery (FLAIR) area was performed based on mean diffusivity, cerebral blood volume and flow maps. The components obtained were characterized further using multiple MRI parameters. Validation of classification results was obtained using MRS. Longitudinal changes of the different components were studied.

Results
The non-enhancing FLAIR lesion area was classified based on its MRI fingerprint into vasogenic edema and tumor-infiltrative area (Figure 1A). The tumor-infiltrative area demonstrated a higher malignant pattern compared to the vasogenic edema, supported by MRS. Substantial reductions of the enhanced T1-weighted and hyperintense FLAIR lesion areas were detected. However, these reductions were accompanied by a reduction of the vasogenic edema yet with an increase/no change of the tumor infiltrative area, in most patients (Figure 1B).

Conclusions
Quantifying the infiltrative tissue in patients with GB following bevacizumab therapy provides a more accurate assessment of the response to therapy in these patients.

KEYWORDS: Advanced MR Imaging, MR Imaging, MR Imaging Perfusion
Diffusion Tensor Tractography in Mild & Moderate Traumatic Brain Injury

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Purpose
Diffuse axonal injury (DAI), the neuropathology in mild & moderate traumatic brain injury (TBI), produces microscopic brain changes, challenging to assess with conventional neuroimaging. Diffusion tensor tractography (DTT) may have advantages over other methods as it allows 3D quantification of entire length of white matter (WM) tracts of interest. Present study aims to evaluate WM tracts integrity with DTT in acute mild & moderate TBI using: fractional anisotropy (FA), that represents degree of alignment of fibers in a voxel & mean diffusivity (MD), that represents restrictions to water diffusion.

Materials and Methods
18 patients (age group 19-48 yrs) were recruited within 7 days of TBI. Inclusion criteria: mild or moderate TBI, injury mechanism consistent with DAI; at least 8th grade education level; age above 16 yrs. Exclusion criteria: prior history of TBI & history of any neuropsychiatric illness or
Drug abuse.17 age-matched healthy controls with no neurocognitive disorders were recruited (age group 16-46yrs). Imaging was performed on a 3.0T imager (Skyra, Siemens) using a 32-channel head coil. Protocol: T1 & T2W, FLAIR, SWI & DTI sequences. Fiber assignment by continuous tracking (FACT) algorithm was used for fibre reconstruction. Corpus callosum (with parcellation into 7 subregions), superior & inferior longitudinal fasciculus, corticospinal tracts, cingulum, superior cerebellar peduncle, middle cerebellar peduncle, inferior cerebellar peduncle; anterior, superior, posterior thalamic radiations were generated and quantified using JAVA-based software. Independent t-test was performed to see the difference in FA (fractional anisotropy) and MD (mean diffusivity) values between controls and patients. p value ≤ 0.05 was considered significant.

Results
Conventional MRI scans revealed changes of DAI and small focal hemorrhagic contusions, more on the left side, in 11 patients. Patients displayed significant reduction in FA (p<0.05) in several tracts: the fornix, corpus callosum, left uncinate fasciculus, left inferior fronto-occipital fasciculus, left superior thalamic radiation, left superior and right inferior cerebellar peduncle. MD was not significantly increased in most tracts, except the fornix, right and left superior cerebellar peduncle.

Conclusions
Diffusion Tensor Tractography in acute mild and moderate TBI can identify axonal injury neuropathology, over and above that visualized on conventional MRI.

KEYWORDS: Diffuse Axonal Injury, Diffusion Tensor Image, Traumatic Brain Injury

**EP-42**

**6:30AM - 9:00PM**

**Distinction of neuromyelitis optica lesions from multiple sclerosis in brain MRI**

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**Purpose**

Neuromyelitis optica (NMO) and multiple sclerosis (MS) are two demyelinating diseases sometimes showing similar central nervous system (SNC) injury pattern at brain MR imaging (MRI). Brain lesions in NMO patients are more common than what one might expect. There are cases when both the clinician and the radiologist have difficulties in differentiating them. We investigated if brain MRI can help to differentiate NMO patients from MS patients by analyzing the morphology of the brain lesions.

**Materials and Methods**

We retrospectively analyzed the brain MRI of 25 aquaporin-4 antibodies (NMO-IgG) seropositive patients with proved NMO spectrum. Then, the brain MRI was compared with 25 MS patients. The brain lesions were classified as 1) NMO suggestive or 2) MS suggestive, based on morphology and localization. Neuromyelitis optica suggestive was extensive corticospinal tract lesion, extensive hemispheric, extensive lateral periventricular, cervicomedullary, or periependymal lesions surrounding the third and fourth ventricles. Multiple sclerosis suggestive
was lesions ovoid and perpendicular to the lateral ventricle, juxtacortical lesions in the U-fiber, the callosal-septal interface and the peripheral brainstem involvement.

Results
Eight (32%) patients with NMO have lesions that fulfilled the 2010 revised McDonald criteria for MS. Six (24%) patients have only NMO characteristic lesions. Six (24%) have both NMO and MS suggestive lesions. Six (24%) patients have both NMO and MS suggestive lesions. Only one (4%) NMO patient had only MS suggestive lesions. Six (24%) NMO patients had normal brain MRI.

Conclusions
Although NMO and MS share similar cerebral parenchymal lesions with perivenular distribution, there are some characteristics of a parenchymal lesion that allow differentiation. Neuromyelitis optica are more extensive supratentorial, central in the brainstem, and more common in the cervicomedullary junction.

KEYWORDS: MR Imaging Brain, Multiple Sclerosis, Neuromyelitis Optica

**EP-07**

**DWI in Adult Medulloblastoma**

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Purpose
To describe diffusion-weighted imaging (DWI) findings in patients with adult medulloblastoma. Cerebellar medulloblastoma is a common tumor in the pediatric population, often demonstrating restricted diffusion, but is uncommon in adults. In this review, we evaluated MR imaging (MRI) of adult medulloblastomas, with a particular interest in DWI characteristics.

Materials and Methods
After IRB approval, we screened our pathology database for all pathology proven medulloblastomas in patients 18 years of age or older at the time of diagnosis with available preoperative MRI images. We evaluated the following features: age at presentation, gender, pathologic diagnosis, location, enhancement characteristics, cystic component, T2 appearance, DWI appearance, and margin characteristics. Images were reviewed by two neuroradiologists.

Results
Our database yielded 18 patients (11 men, 7 women, ranging in age from 28 to 77 years) who had pre-operative MRIs available for review. Twelve of the 18 tumors (66%) were centered in the cerebellar hemispheres, while the other six were primarily vermian in location. Fourteen out of 18 (78%) demonstrated some degree of enhancement. Fifty percent of the tumors were partially cystic. Diffusion-weighted imaging was performed in 13 out of the 18 patients, all of which demonstrated some component of restricted diffusion.

Conclusions
Adult medulloblastomas demonstrate some degree of restricted diffusion. Based on this retrospective review, a mass which does not demonstrate restricted diffusion is unlikely to be a medulloblastoma. Other characteristics such as the presence of enhancement or a cystic component are encountered less frequently.
Dynamic contrast-enhanced perfusion imaging analysis for diagnosis of brain tumors using different measurement method

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Purpose
T1-weighted dynamic contrast-enhanced (DCE) MR imaging (MRI) is useful in the diagnosis of brain tumors. By using the pharmacokinetic model introduced by Tofts et al, the transfer contrast Ktrans, extravascular extracellular volume Ve and fractional plasma volume fPV can be calculated. Most of brain tumors are heterogeneous; the result can be changed by setting of region of interest (ROI). In this study, we compare the maximum method and peak method to assess the usefulness in the diagnosis of brain tumor.

Materials and Methods
MR examinations were performed by a 3 T MR scanner using a standard eight-channel head coil. Routine pre and postcontrast clinical imaging was performed according to local protocol. Dynamic contrast-enhanced MRI was performed using the following parameters: TR/TE, 4.4/1.0ms; flip angle 12°; field of view, 300 × 210 mm; matrix, 128 × 90; slice thickness, 8mm; number of slices, 16; consisting of 64 phases with a temporal spacing of 3.3 seconds. Total scan time was three minutes and 31 seconds. A gadolinium-DTPA (0.1 mmol/kg) was injected with power injector at a rate 2.5 ml/s and 20ml saline subsequently was injected. This study included 24 patients and 28 lesions (four low grade glioma (LGG), 12 high grade glioma (HGG), seven metastasis, five lymphoma). The diagnosis was made histologically or radiologically. Pharmacokinetic model analysis was performed by using commercially available software (GenIQ, GE Medicalsystems, Milwaukee, WI). In each map, the round region of interest (ROI) was placed manually on the hot spot. The sizes of the ROIs were about 100mm². The averaged signal intensity (peak method) and maximum signal intensity (maximum method) were measured. To assess the differences between DCE parameters and tumor histology, Mann-Whitney-U test was performed. A P value of less than 0.05 was considered statistically significant. Receiver operating characteristics (ROC) curve analysis was performed to evaluate the diagnostic performance. Optimal cutoff value, sensitivity, and specificity also were calculated.

Results
Ve-peak was the most useful parameter to differentiate LGG from other tumors (p=0.0031), lymphoma from other tumors (p=0.0020), but showed no significant difference between HGG and metastasis. The diagnostic performance of the other parameters (Ve-max, Ktrans-peak and Ktrans-max) was lower than Ve-peak. The area under the ROC curve for differentiating LGG or lymphoma was highest for Ve-peak (LGG from other tumors: Ve-peak cutoff: 0.176, sensitivity: 96%, specificity: 100%, lymphoma from other tumors: Ve-peak cutoff: 0.95, sensitivity: 87% specificity: 100%).
Conclusions
In the diagnosis of brain tumors using DCE perfusion technique, accuracy was different depending on the measurement method. In this study, Ve-peak has the best diagnostic performance, and it was useful for the diagnosis of LGG and lymphoma in particular.

KEYWORDS: Brain Neoplasms, Dynamic Contrast-Enhanced MR

EP-47

Dynamic Education: Teaching Carotid and Vertebral Artery Dissection Evaluation to Residents

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Purpose
In our experience carotid and vertebral dissections are often missed by residents on-call. This directly impacts patient care as delayed diagnosis may result in stroke. We demonstrate a method to improve resident accuracy in detecting extra-cranial carotid and vertebral artery dissections through evaluation, educational intervention, and finally re-evaluation

Materials and Methods
In this IRB-approved study, we will evaluate the use of the flipped classroom educational technique to improve resident accuracy in the diagnosis of extra-cranial carotid and vertebral artery dissections. Residents from Dartmouth-Hitchcock Medical Center and University of Arizona Medical Center will participate in this study. First, the baseline diagnostic accuracy of residents will be determined by administering 20 anonymized neck CTAs that will contain normal and abnormal cases. The residents will be instructed to provide free text "on-call" interpretations. Their performance will be scored by an attending neuroradiologist. Next, residents will watch an educational video using a flipped classroom online lecture discussing the evaluation, diagnosis, and treatment of dissections. Residents will then participate in a case based workshop with faculty guidance in diagnosis. Finally, we will determine the accuracy of resident interpretation after participation using the same testing method.

Results
We will report resident diagnostic accuracy pre and post-intervention at 2 separate institutions.

Conclusions
We hypothesize that the flipped classroom model of classroom education can improve resident diagnostic accuracy when interpreting extra-cranial carotid and vertebral artery dissections.

KEYWORDS: Dissection, Educational

EP-14

Emergent, Off-Hours MR Imaging of the Head and Soft Tissue Neck: an Institutional Review
Purpose
Over the past decade after hours emergent MR imaging anecdotally appeared to be increasing at our tertiary care referral center. A review was performed of emergent Head and Soft Tissue Neck MRI utilization including the types of exams requested, the specialties of the ordering clinicians, and how these MR results did or did not impact patient care and clinical management.

Materials and Methods
Following approval by an Institutional Review Board, MR imaging (MRI) reports were obtained from 37 emergent head MRIs performed over the last 13 years. The corresponding relevant medical records were reviewed to categorize the type of imaging findings, if any therapy was administered and if so, determine the interval between completion of the MRI exam and delivery of the therapy.

Results
Emergent after hours head and soft tissue neck MRI utilization remained relatively stable while adult emergency department visits increased by 24% over the last 13 years. Sixty-two percent (23/37) of MRIs demonstrated significant findings and 57% (13/23) of these patients received a definitive therapy based on the MRI finding. Only 22% (8/37) of patients received a definitive therapy within six hours of MRI completion. Sixty-five percent (24/37) of head MRs included either MRA or MRV. The neurology department ordered the majority (46%) of scans.

Conclusions
Despite increases in overall patient volumes, emergent head and soft tissue neck MRI utilization has not changed over 13 years at our institution. Over 60% of emergent head and soft tissue neck MRIs demonstrated significant findings, but only a minority of patients received a definitive therapy within six hours.

KEYWORDS: Emergencies
Evaluation of cerebrovascular reserve by acetazolamide-challenge ASL perfusion MRI: Comparison with acetazolamide-challenge SPECT using I-123 iodoamphetamine

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Purpose
The purpose of this study was to determine the relation between change in cerebral blood flow (dCBF) evaluated using acetazolamide (ACZ)-challenge SPECT (ACZ-SPECT) with I-123 iodoamphetamine and dCBF evaluated using ACZ-challenge arterial spin labeling perfusion MRI (ACZ-ASL) in patients with major cerebral artery steno-occlusive disease.

Materials and Methods
The study was performed in 10 patients with stenosis of the unilateral internal carotid artery (n = 4), bilateral occlusion of the internal carotid artery (n = 1), stenosis of the unilateral middle cerebral artery (n = 1), and cerebrovascular moyamoya disease (n = 4). MR imaging (MRI) was performed with a 3T MRI unit. Fast spoiled gradient-recalled acquisition in the steady state (FSPGR) images were obtained before ASL sequences. After the skull structures were stripped using VBM8 (http://dbm.neuro.uni-jena.de/vbm8/), ASL images were aligned to FSPGR images using affine registration. The standardized normal structures of the computerized brain atlas (SRI24 atlas, http://www.nitrc.org/projects/sri24/) were fitted to FSPGR images by nonlinear registration. Pulsed continuous ASL MRI were acquired before and 5, 10 and 15 min after administration of ACZ with the following parameters: field of view = 24 cm, slice thickness = 4
mm, repetition time = 5216 ms, echo time = 9.8 ms, points × arms = 512 × 8, post-labeling delay = 2525 ms, number of excitations = 2, acquisition time = 3 min 39 s. ACZ-SPECT was performed using the quantitative SPECT dual-table autoradiographic method (Iida H, J Nucl Med 2010:51:1624). The first scan was acquired from 0 to 28 min and the second scan was acquired from 30 to 58 min. I-123 iodoamphetamine was administered at 0 and 30 min. ACZ was administered 20 min after the first I-123 iodoamphetamine injection. The whole-blood count for the input function was taken at 10 min. kACZ-induced dCBF was evaluated in the anterior cerebral arterial, middle cerebral arterial, and posterior cerebral arterial territories of the brain. Those three data points per subject were included in the analysis. The LBPA40/SRI24 atlas (http://www.nitrc.org/projects/sri24/) was used to define the major arterial territories of the brain. The relation between dCBF evaluated using the two techniques was evaluated using simple linear regression.

Results
The dCBF of ACZ-SPECT ranged from -19.3 to 66.9%. The dCBF of ACZ-ASL ranged from 3.1 to 72.6% at 5 min post-ACZ administration, -29.7 to 65.6% at 10 min post-ACZ administration, and -36.5 to 67.4% at 15 min post-ACZ administration. dCBF of ACZ-SPECT correlated with dCBF of ACZ-ASL at 5 min post-ACZ administration (r = 0.63, p < 0.01), but not with dCBF of ACZ-ASL at 10- (p = 0.73) or 15- (p = 0.95) min post-ACZ administration. Conclusions
dCBF determined using ACZ-ASL 5 min after ACZ administration correlates with dCBF determined using ACZ-SPECT, and can be used to evaluate cerebrovascular reserve in patients with cerebrovascular disease. ACZ-ASL is an alternative to ACZ-SPECT.

KEYWORDS: Arterial Spin-Labeling, Cerebral Blood Flow, Cerebrovascular Reserve
Evaluation of the Vessel Wall in Patients with Untreated Intracranial Aneurysms

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Purpose
To develop and implement high resolution methods for evaluating the vessel wall in individuals with untreated intracranial aneurysms

Materials and Methods
Subjects with untreated intracranial aneurysms who are part of an ongoing longitudinal study to evaluate aneurysm progression were recruited for evaluation of their intracranial vessel walls. High resolution three dimensional vessel wall imaging was performed pre and post injection of Gadolinium. The following sequences were implemented on a Siemens 3T Skyra: A T1-weighted 3D SPACE sequence (0.5mm x 0.5mm x 0.5mm); a 3D balanced steady state sequence (TrueFISP) (0.7mm x 0.7 mm x 0.7 mm); and a 3D contrast-enhanced MRA sequence (0.7mm x 0.7 mm x 0.7 mm)

Results
Five subjects were studied. Three subjects had aneurysms of the internal carotid artery, one of the basilar tip, and one had a giant fusiform basilar artery aneurysm with substantial intralumenal thrombus. In all cases, the SPACE sequence provided excellent black blood images both pre and post contrast injection without any apparent intralumenal flow artifact. CE-MRA sequences (30 sec acquisition) provided high quality images which were demonstrated to have an error of reproducibility of less than 3%. Visualization of the vessel wall could be obtained with good contrast (see Figure 1 which is a single slice image of the basilar artery selected from a 3D volume.) Visualization of the aneurysmal wall was variable. In some cases, the wall appeared thickened and clearly apparent. In other cases it was thinned and difficult to visualize. Contrast enhancement could be seen in different vessel segments, particularly at regions of vascular stenosis.

Conclusions
The 3D T1-SPACE sequence provides excellent visualization of the vessel wall that can be useful in assessing the thickness of the wall in aneurysmal disease. The sequence produces robust black blood images. Isotropic image resolution permits reformattting in planes that best display the vessel wall. Even though the sequence is long – 10 minutes – images did not appear to be degraded by motion artifact and it provides more consistent imaging of the wall than the 2min 30sec TrueFISP sequence. In general, contrast enhancement appears to be diffuse and non-specific. In the case with intralumenal thrombus, substantial enhancement of different elements of the thrombosed volume was apparent.

KEYWORDS: Aneurysm, MR Angiography, Vessel Wall
Filtered Back Projection (FBP) vs. Iterative Reconstruction (AIDR 3D): comparison of dose and image quality in CT scans of the head and spine.

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Purpose
Compare dose and image quality between unenhanced computed tomography (CT) exams of head and spine obtained using two different techniques: conventional filtered back projection (FBP) and iterative reconstruction (AIDR 3D).

Materials and Methods
We retrospectively reviewed 30 consecutive CT scans of the brain, cervical spine and lumbar spine without injection of contrast media. The scans were performed with the AquilionOne (Toshiba) with the regular helical acquisition protocols: 1) fixed mA for brain CT and 2) modulated mA for the cervical and lumbar spine studies. The CT dose given by the CTDI values and image quality, assessed by SNR and CNR measures, were evaluated. The reconstructions techniques used were filtered back projection (FBP) and iterative Reconstruction (AIDR 3D).

Results
The iterative reconstruction allows a reduction of patient dose for CT scans of the head and spine. Dose, noise and contrast are reduced for brain CT scans. A significant dose reduction is noted for examinations of the cervical spine with a slight increase in image quality. And for exams of the lumbar spine, a dose reduction is observed with a major increase in image quality. It is possible to adjust the acquisition parameters that affect the dose to increase the image quality if necessary for CT of the cervical spine. For the scans of the lumbar spine, it is possible to reduce the dose while reducing the image quality which is greatly higher with AIDR 3D. The image quality of CT exams acquired with modulated mA is increased greatly with the iterative reconstruction while reducing dose to the patient. However, the brain still represents challenge to image with this modality due to its composition of soft tissue surrounded by the skull. A significant minimal dose is required to penetrate the bone structure and enable a diagnostic image of the brain anatomy.

Conclusions
Overall, the iterative reconstruction reduces patient dose for CT scans of the neurological system while maintaining diagnostic image quality. This reduction is even more important on exams with protocols allowing the use of modulation of the mA.

KEYWORDS: CT, Dose Reduction, Iterative Reconstruction

Flebographic Study Does Not Show Differences Between MS Patients and Controls

S Fabiano\textsuperscript{1}, S Marziali\textsuperscript{1}, M Stefanini\textsuperscript{2}, F di Giuliano\textsuperscript{1}, R Floris\textsuperscript{1}, G Simonetti\textsuperscript{1}
Purpose
Hypothetical correlation between chronic cerebrospinal venous insufficiency and multiple sclerosis (MS) has gained the attention of patients and the scientific community. Studies performed by eco-color-Doppler have shown different results and it's necessary to use more objective diagnostic techniques. The aim of our study was to evaluate the presence of stenoses affecting azygos veins and internal jugular veins using venography in patients with MS.

Materials and Methods
We recruited two groups of subjects who underwent venography: "study group" included 29 MS patients and "control group" included 15 healthy volunteers. The ileo-lumbar plexus, the azygos and the internal jugular veins were catheterized selectively. We considered to be a significant stenosis any cross-sectional area reduction of the venous lumen greater than 50%. Furthermore, blood pressure was measured in the studied vessels at the stenotic internal jugular veins.

Results
Selective venography showed at least one significant venous stenosis in 84% of subjects examined, without significant difference between the "study group" and the "control group". Positive venography was found in 50% of all subjects examined, without any significant difference between the two groups. The multivariate logistic regression analysis failed to assess any significant association between the presence of a positive venography and MS condition. The difference between the median blood pressure of stenotic and nonstenotic internal jugular veins was not statistically significant (p=0.46).

Conclusions
Our data exclude any direct correlation between chronic cerebrospinal venous insufficiency and MS, because venous abnormalities were equally present in both groups.

KEYWORDS: Multiple Sclerosis

Functional and Morphological Patterns of Involvement in Neurodegenerative Brain Disorders: A Combined Approach Using FDG-PET, ASL-MR Imaging, and Structural MR Imaging

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Purpose
A combined approach using metabolicfunctional and morphological information in neurodegenerative brain disorders has been advocated (1). However, the added value of this approach in current practice and the potential discrepancies between techniqueinformation has not been assessed yet in detail. The aim has been to present our preliminary experience in this regard.

Materials and Methods
Among 60 patients referred from a tertiary referral memory clinic, who underwent both FDG-
PET and structural MRI (3D-MPRAGE) at our institution during the last two years, 20 had additional 3 T single phase ASL. The most common indication for imaging was to support the clinical suspicion, adding in differential diagnosis between frontotemporal lobar degeneration – FTLD- and Alzheimer disease –AD-. Metabolic/functional patterns of involvement as provided by FDG-PET and ASL, and morphological (volume loss) on structural MRI were evaluated by visual, expert assessments on a blinded fashion. Table 1 summarizes final diagnosis as made by a dedicated neurologist after follow up, and evaluation results. Most characteristic functional and morphological patterns of involvement in FTLD (frontal and semantic variants), AD, corticobasal degeneration, Creutzfeldt-Jakob, and Huntington disease are shown. Examples of agreement/discrepancies between functional and morphological information are demonstrated.

Results
As shown in Table 1, there was agreement between functional (PET) and structural patterns in the four AD cases, with ASL and PET also being concordant. On the contrary, out of nine cases with FTLD, there was agreement between functional (PET) and structural MRI only in one. Additionally, five patients with FTLD had ASL/PET concordance. There were cases with more marked functional information, others with more profound loss of volume, and others with discrepancies between patterns at regional level.

Conclusions
Although characteristic patterns of involvement are seen on functional (PET, ASL) and structural (MRI) imaging, there may be disagreement between them. This is more frequent within the FTLD group, as has been reported recently (2). Recognition of the discrepancies between functional and morphological information may be an additional, useful diagnostic tool for the radiologist in clinical practice.

KEYWORDS: Alzheimer Disease, Arterial Spin-Labeling, FDG

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EP-03

6:30AM - 9:00PM

Generalized versus Patient-specific Inflow Boundary Conditions in Computational Fluid dynamic Simulations of Cerebral Aneurysms

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Purpose
Intracranial aneurysmal hemodynamics have been associated with aneurysm growth and rupture. Hemodynamics in aneurysms commonly are determined using computational fluid dynamics (CFD) using generalized inflow boundary conditions in a parent artery. Recently, patient-specific inflow boundary conditions are being implemented more frequently. Our purpose was to compare intracranial aneurysm hemodynamics based on generalized versus patient-specific inflow boundary conditions.

Materials and Methods
For 36 patients, geometric models of aneurysms were determined using 3D rotational angiography (3DRA). 2D phase contrast magnetic resonance imaging (PC-MRI) velocity measurements of the parent artery were done. Computational fluid dynamics simulations were performed twice: once using patient-specific PC-MRI velocity profiles and once using generalized Womersley profiles as inflow boundary conditions. Resulting mean and maximum WSS values were analyzed and hemodynamic characteristics were qualitatively compared.

Results
Quantitative analysis showed statistically significant differences for mean and maximum WSS values between the two inflow boundary conditions (p<0.001). Qualitative assessment of hemodynamic characteristics showed differences in 21 of the 36 cases. These consisted of differences in high WSS location (N=8), deflection location (N=3), lobulation WSS (N=12) or in vortex and inflow jet stability (N=9). The latter showed more instability for the generalized inflow boundary conditions in seven out of nine cases.

Conclusions
Using generalized and patient-specific inflow boundary conditions for CFD results in different WSS magnitudes and hemodynamic characteristics. Generalized inflow boundary conditions result in more vortices and inflow jet instabilities. This study emphasizes the necessity of patient-specific inflow boundary conditions for calculation of hemodynamics in cerebral aneurysms using CFD techniques.

KEYWORDS: Aneurysm, Aneurysm Classification, Computational Fluid Dynamics

EP-71
6:30AM - 9:00PM

Gradient of Perilesional Abnormalities is Associated with Degree of Lesion Abnormality in Quantitative MRI Parameters

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Purpose
In Multiple Sclerosis (MS) changes can be found in normal appearing white matter (NAWM) in comparison to healthy individuals using MRI. Changes of apparent diffusion coefficient (ADC) and magnetization transfer ratio (MTR) in are thought to reflect tissue destruction, i.e. in terms of demyelination and axonal loss. We hypothesized that changes of ADC and MTR in NAWM are
more pronounced in the vicinity of MS lesions indicating local tissue destruction invisible in conventional MRI.

Materials and Methods
19 untreated relapsing-remitting MS patients with an MRI examination including diffusion-imaging, magnetization-transfer-imaging and T2-weighted images were included. 395 lesions were marked on T2 weighted images and regions of interest(ROIS) in terms of lesion-surrounding concentric shells were defined for each lesion. NAWM was defined as white matter brain tissue voxels at least 10 shells distant of any lesion. Relative T2 values (rel.T2), ADC and MTR were measured within each lesion and each corresponding shell as well as in NAWM for each patient.

Results
Increased ADC and decreased MTR values in comparison to NAWM were detectable within lesion shells: increased ADC values within the shells closest to the lesion were measurable in 276 of the first shells and decreased MTR in 210. Values of ADC, MTR and rel.T2 within shells were independent of lesion size but significantly (p<0.001, R=0.68 for ADC and R=0.60 for MTR) correlated with values measured within the corresponding lesions.

Conclusions
Changes in the vicinity of visible MS lesions are measurable and seem to be dependent on the severity of tissue destruction within the lesion but not dependent on primary lesion size. Therefore in a number of cases MS lesions extend well beyond visible lesion boundaries on conventional MRI and pronounced tissue destruction is measurable within the NAWM in the vicinity of single MS lesions.

KEYWORDS: MR Imaging Brain, MR Imaging/Diffusion, Multiple Sclerosis

High Rate of Spontaneous Recanalization in Untreated Acute Ischemic Stroke Patients: A Natural History Study

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Purpose
The majority of the evidence of arterial recanalization in acute ischemic stroke comes from either intravenous thrombolytic or endovascular device data sets. Very limited information about spontaneous recanalization exists regarding stroke patients who have not received any reperfusion treatment. Our objective was to study the rate and predictive factors of spontaneous recanalization in untreated acute stroke patients.

Materials and Methods
From a large, prospectively collected acute stroke database (CHUV, UPMC and Sunnybrook
hospital), all untreated patients with baseline CT angiogram (CTA) within 24 hours and subsequent follow-up vascular imaging (CTA or MR angiogram) within 24-48 hours were compiled for analysis. Respectively, institutional review boards approved collection and analysis of data from the repository. Baseline CTA images were reviewed for the site and severity of arterial occlusion, clot burden score and degree of collateral circulation. The severity of arterial occlusion or stenosis was graded using the modified Thrombolysis in Myocardial Ischemia (TIMI) and Interventional Management of Stroke (IMS) III trial CTA scoring systems. Follow-up CTA/MRA imaging was reviewed to determine recanalization status. Multivariate regression models were used to assess variables predicting recanalization.

Results
Among 128 untreated patients (mean age 65 years, median NIHSS 12, baseline CTA mean 4.9 hours from stroke onset) with follow-up vascular imaging (mean 26 hours), 90 (70%) had proximal arterial occlusion. Of these 90 patients, 43 (48%) had spontaneous full recanalization, 43 (48%) had no evidence of recanalization, and 4 (4%) with unidentifiable recanalization status. Rates of recanalization by occlusion location subtype were: extracranial ICA 10 of 27 (37%); intracranial ICA 14 of 30 (47%); M1 29 of 51 (57%); M2 19 of 30 (63%). No differences in demographic and baseline characteristics between recanalization status groups were observed. There was no statistical difference between favorable outcomes (defined as 3 month mRS 0-2) between those who had spontaneous recanalization and those who did not (45% versus 34%, p-value=0.30). In the multivariable logistic regression model, spontaneous recanalization was associated significantly with higher collateral score (aOR=1.26, p-value=0.004) and lower clot burden score (greater thrombus length) (aOR=0.76, p-value=0.03) (Table 1). Adjusting for key variables, the multivariable model for clinical outcomes demonstrated that stroke severity (NIHSS) was the only significant predictor of good outcome and that spontaneous recanalization was not associated with favorable outcomes.

Conclusions
There is a high rate of spontaneous recanalization in 24-48 hours in untreated acute stroke patients, especially distal occlusion. Spontaneous recanalization is associated significantly with higher collateral score and lower clot burden score and is not a predictor of favorable outcome.

KEYWORDS: Acute Stroke, Recanalization

Table 1. Multivariable logistic model predicting spontaneous recanalization status

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>1.00 (0.97, 1.04)</td>
<td>0.97</td>
</tr>
<tr>
<td>NIHSS (continuous)</td>
<td>1.05 (0.97, 1.13)</td>
<td>0.21</td>
</tr>
<tr>
<td>ASPECTS Collateral score</td>
<td>1.26 (1.08, 1.48)</td>
<td>0.004</td>
</tr>
<tr>
<td>Extracranial ICA occlusion</td>
<td>0.27 (0.07, 1.00)</td>
<td>0.051</td>
</tr>
<tr>
<td>Clot burden score</td>
<td>0.76 (0.58, 0.98)</td>
<td>0.03</td>
</tr>
</tbody>
</table>

EP-79

High-resolution 3T MRI Characterization of cavernous and juxta-cavernous internal carotid aneurysms: preliminary experience.
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Purpose
Cavernous aneurysms are generally considered to be extradural lesions that, when ruptured, may result in cavernous carotid fistulae and, when sufficiently large, have been thought to be able to erode dura and enter the subarachnoid space. Accurate characterization of cavernous segment aneurysms and the relationship to the cavernous sinus may be useful in assessing the relationship with adjacent dura, and may eventually provide some insight into morphology and risks associated with untreated cavernous aneurysms. We describe high-resolution MR protocol (HRMRP) for detection and localization of intracavernous aneurysms.

Materials and Methods
The high resolution MR database at the institution was reviewed according to local IRB.8 patients with unruptured cavernous and paraclinoid aneurysms were identified, further selecting purely cavernous aneurysms. Coronal T1 post contrast "blackblood" TSE FS images were analyzed. In 1 of these patients the results were compared with the digital subtraction angiography data and in 1 with the results of CTA using previously described landmarks of extra- intradural localization.

Results
A total of 3 intracavernous aneurysms were reliably visualized using new protocol. MR imaging was concordant with CTA data in 1 patient and with digital subtraction angiography data in another. In the third patient our protocol allowed reliable intracavernous localization of the aneurysm and no further imaging was thought to be necessary.

Conclusions
HRMR is an innovative technique that may be used as an adjunct to conventional imaging of cavernous aneurysms, allowing visualization of the relationship of the aneurysm, the cavernous sinus and the nearby dura overlying the cavernous sinus. Early experience suggests utility but greater experience will be necessary to assess predictive value.

KEYWORDS: Aneurysm, Cavernous Sinus, MR Imaging
Hippocampal Malrotation: Epilepsy in disguise. What to look for.

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Purpose
Demonstrate the common characteristics of MR Imaging findings of patients with hippocampal malrotation and epilepsy using volumetric and high resolution imaging.

Materials and Methods
We reviewed MR Imaging of 12 patients with hippocampal malrotation diagnosed at our institution between 2009 and 2011 (4 female and 8 male patients) with a mean age of 28 years.
The MR imaging (MRI) examinations were performed on a 3.0 T scanner (GE Signa) using our epilepsy protocol which includes: sagittal T1-weighted spin-echo imaging, axial T2-weighted FRSE-XL imaging, axial proton-weighted FRSE imaging, axial GRE T2* imaging, axial and coronal FLAIR T2 imaging, coronal T2 FSE-XL high resolution imaging, volumetric 3D FSPGR imaging and diffusion-weighted B-1000 imaging.

Results
We evaluated the following morphological characteristics: incomplete inversion of the hippocampus with abnormally rounded shape, unilateral abnormality, normal signal intensity, unsharp internal structure, abnormal angulation of the collateral sulcus, abnormal size and localization of fornix, normal temporal lobe size and temporal horn enlargement. The most prevalent radiological signs were a round shape of the hippocampus with normal size and signal intensity, a more vertical collateral sulcus and an empty choroid fissure. The less prevalent radiological findings were a displaced fimbria, a reduced horizontal portion of the parahippocampal gyrus and a thick subiculum.

Conclusions
The hippocampal malrotation is a malformation to be considered in the differential diagnosis of patients with seizures.

KEYWORDS: Epilepsy, Hippocampus, MR Imaging Brain
EP-36

Histogram Analysis of Apparent Diffusion Coefficient Map in Distinguishing between Typical and Atypical Primary Central Nervous System Lymphomas and Tumefactive Demyelinating Lesions

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Purpose
This study aimed to investigate the usefulness of histogram analysis of apparent diffusion coefficient (ADC) maps for discriminating primary central nervous system lymphomas (PCNSLs), especially PCNSLs with atypical MR features from tumefactive demyelinating lesions (TDLs).

Materials and Methods
Forty-seven patients (33 men, 14 women, 29-82 years old) with PCNSLs and 18 (10 men, 8 women, 22-66 years old) with TDLs were enrolled in this study. Hyperintense lesions on T2-weighted images (T2WIs) were defined as regions of interest (ROIs) after T2WIs were registered to the corresponding apparent diffusion coefficient (ADC) maps (T2WI-ADC) using a dedicated software package (Nordic ICE; NordicNeuroLab, Bergen, Norway). Apparent diffusion coefficient histograms were calculated from the ROIs containing the entire lesions on every section on a voxel-by-voxel basis using in-house developed software. Apparent diffusion coefficient histogram parameters were compared in all of the PCNSLs and TDLs, and in the subgroup of atypical PCNSLs and TDLs. Receiver operating characteristic (ROC) curves were constructed to evaluate the diagnostic performance of histogram parameters and to determine the optimum thresholds.

Results
Discrepancies between the PCNSLs and TDLs were found in the minimum ADC values (ADCmin), the 5th and 10th percentiles (ADC5% and ADC10%) of cumulative ADC histograms. However, no statistical significance was found in the mean ADC value, the ADC value at mode, kurtosis and skewness. Lower ADCmin, ADC5% and ADC10% also were found in PCNSLs with atypical MR features when compared with those of the TDLs. ADCmin was the best indicator for this discrimination with the threshold of 599 × 10⁻⁶ mm²/sec (sensitivity 68.1%, specificity 77.8%).

Conclusions
Histogram analysis of ADC maps based on the entire lesion may help for the discrimination of PCNSLs from TDLs.

KEYWORDS: Apparent Diffusion Coefficient, Lymphoma, Tumefactive Demyelinating Lesion

EP-02

Imaging Findings of Central Nervous System Involvement in Multiple Myeloma

EP-02
Purpose

Central nervous system (CNS) involvement in multiple myeloma is rare, occurring in approximately 1% of all cases. It has a poor prognosis, which has somewhat improved with the most recent treatment protocols. Both the brain and the spine can be involved. MR imaging (MRI) is the best imaging test, and the diagnosis is generally made in combination with cerebrospinal fluid (CSF) cytology/flow cytometry. The aim of this project is to investigate different imaging manifestations of CNS involvement in multiple myeloma, estimate their prevalence and correlate them with CSF cytology/flow cytometry and biopsy results. A variety of images from brain and spine MRIs and CTs of multiple myeloma patients with CNS involvement will be included in this electronic poster.

Materials and Methods

After obtaining IRB approval, we carried out a retrospective review of imaging studies performed on multiple myeloma patients with confirmed or strongly suspected CNS involvement between 2002 and 2013. In collaboration with the departments of pathology and oncology, a list of 32 multiple myeloma patients with potential CNS involvement was compiled. Imaging studies of their brains and spines were reviewed and, if positive, were classified into different patterns of involvement: leptomeningeal enhancement in the brain or spine, parenchymal lesions in the brain or spinal cord, cranial nerve infiltration, intracranial dural-based involvement or epidural lesions in the spinal canal. The patients' electronic medical records were searched for CSF cytology/flow cytometry and biopsy results. Patients with negative or unavailable CSF results whose only abnormality on imaging were masses extending from adjacent osseous lesions were excluded. Twenty-three patients met the inclusion criteria for this study. Prevalence of different imaging manifestations of CNS involvement in these multiple myeloma patients was calculated.

Results

Eight of 23 (34.8%) multiple myeloma patients with suspected CNS involvement had positive CSF cytology/flow cytometry results. Four of the 8 (50%) patients had parenchymal brain involvement, 2 (25%) had leptomeningeal enhancement in the brain, 2 had intracranial dural-based lesions, 1 (12.5%) had cranial nerve infiltration, 1 had leptomeningeal spinal involvement, 1 had intramedullary spinal involvement and 1 had no imaging evidence of CNS involvement. Of these 8 patients, 4 (50%) had two sites of CNS involvement on imaging, which was most commonly seen with brain parenchymal (3/8 or 37.5%) and leptomeningeal brain lesions (2/8 or 25%). Fourteen of 23 (60.9%) patients had biopsy proven CNS involvement with multiple myeloma. Twelve of the 14 (85.7%) patients had epidural lesions in the spinal canal, 3 (21.4%) had evidence of cranial nerve infiltration, 3 had intracranial dural-based involvement and 1 (7.1%) had leptomeningeal enhancement in the brain. None of the 14 patients had CSF results available in our electronic medical records. Of the 14 patients, 3 (21.4%) had two sites of CNS involvement on imaging, which was seen most commonly with spinal epidural (3/14 or 21.4%) and intracranial dural-based lesions (2/14 or 14.3%). One of the 14 patients (7.1%) had three sites of CNS involvement on imaging. One of the 23 patients had dural-based intracranial and epidural spinal lesions on imaging with nonspecific CSF cytology, nondiagnostic flow-cytometry and no available biopsy results. Overall, the most common imaging manifestations were spinal epidural (13/23 or 56.5%), intracranial dural-based (6/23 or 26%), parenchymal brain (4/23 or 17.4%), cranial nerve (17.4%) and leptomeningeal brain lesions (3/23 or 13%). Nine of the 23
patients (39.1%) had two or more sites of CNS involvement on imaging, which was most commonly seen with spinal epidural (5/23 or 21.7%), intracranial dural-based (5/23), parenchymal brain (3/23 or 13%) and leptomeningeal brain lesions (3/23).

Conclusions
Imaging findings of CNS involvement in multiple myeloma are diverse. Epidural spinal lesions are the most common and intracranial dural-based lesions are the second most common manifestation. Parenchymal brain involvement and cranial nerve infiltration are the other relatively prevalent findings. Leptomeningeal enhancement in the brain and, less commonly, the spine also can be seen. Rarely, the spinal cord itself may be involved. Frequently, there are two or more sites of CNS involvement with multiple myeloma, which most commonly occurs when spinal epidural and intracranial dural lesions are present. Central nervous system involvement in multiple myeloma can infrequently be occult on imaging and be evidenced only by positive CSF cytology/flow cytometry results. It is important to identify CNS involvement in multiple myeloma since it affects treatment by determining the need for intrathecal chemotherapy and cranial irradiation as well as for prognostic purposes.

KEYWORDS: Brain Metastases, Multiple Myeloma, Spinal Neoplasm

EP-61
6:30AM - 9:00PM

Imaging Genomic Biomarker Signature for MGMT Promoter Methylation Identification in Glioblastoma

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Purpose
To create an imaging biomarker signature in order to identify those Glioblastoma (GBM) patients with MGMT promoter methylation.

Materials and Methods
We identified 99 treatment-naïve patients from The Cancer Genome Atlas (TCGA) who had both gene and microRNA expression profiles (MGMT methylation status) and pretreatment MRI from The Cancer Imaging Archive (TCIA). Qualitative VASARI imaging features for these 99 patients were assessed by 3 independent neuroradiologists and consensus was reached. Quantitative volumetric analysis was done in the 3D Slicer software 3.6(http://www.slicer.org) using segmentation module. Fluid Attenuated Inversion Recovery (FLAIR) was used for segmentation of the edema and post-contrast T1 weighted imaging (T1W1) for segmentation of enhancement (defined as tumor) and necrosis. Each qualitative and quantitative feature was correlated to MGMT methylation status both independently and as groups and subgroups. Survival analysis was done in all cases. Biomarker signature based on profiling and survival were created.

Results
An imaging biomarker signature was created that predicted MGMT promoter methylation status. Multiple qualitative and quantitative MRI features correlate with MGMT methylation status. Multiple parameters were associated with survival.
Conclusions
MGMT methylation status plays an important role in patient predictive and prognostic stratification of patients with GBM. The identification of a non-invasive biomarker signature as a surrogate for MGMT methylation can help stratify patients in specific therapy and predict response versus non response to therapy. An imaging genomic signature can be expected to promote a more robust personalized approach to patient care and accelerate drug development and clinical trials.

KEYWORDS: Glioblastoma, Imaging Biomarker, Imaging Genomics

EP-59

Imaging Genomic Texture Analysis Based on Haralick Features

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Purpose
In this study, we investigated the feasibility of using the Haralick Texture Features as a map from MRI images to genomic markers. We applied 19 features descriptors from literature to MRI of GBM and found that these features are dependent on the size of the image being analyzed, as well as the values used to calculate the grey level co-occurrence matrix that is used in the determination of Haralick's Features. Work has been done to classify GBM based on texture, but this is the first to our knowledge that uses the features defined by Haralick et. al.

Materials and Methods
Eighteen features were investigated as per Haralick feature set to include measurements of homogeneity, entropy, energy, dissimilarity, etc. Texture analysis was performed on our expert-segmented MR images that included segmentation of three individual components (contrast enhancement, necrosis, and edema/invasion). Each was calculated based on a grey level co-occurrence matrix. This matrix was a representation of the spatial distribution of the grey levels in the image. The texture features were statistical descriptions of this co-occurrence matrix. Our results were then applied to our validation set.

Results
Texture analysis on the expert segmented images demonstrated areas of GBM that were homogeneous and areas of that were heterogeneous. Using the texture analysis feature set, we were able to create an accurate landscape of "geneity" of GBM. These were also reproducible in our validation set.

Conclusions
We successfully applied several texture features to our previously expert-segmented MRIs of GBM. We were able to correlate the texture features of the tumor to the different regions (contrast enhancement, necrosis, and edema/invasion) and develop a base line on which to make predictions of genomic expression.

KEYWORDS: Glioblastoma, Postprocessing

EP-88
Infiltrating Gliomas Involving the Cranial Nerves: Case Series and Review of the Literature

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Purpose
Infiltrating glial neoplasms involving the cranial nerves are a rare but important entity to recognize. These tumors may simulate nerve sheath tumors, intracranial perineural spread of head and neck tumors, or leptomeningeal spread of disease. The purpose of our study is to characterize the imaging features of this rare manifestation of gliomas and to review the previously described cases in the literature.

Materials and Methods
Individual cases of gliomas infiltrating into or involving a cranial nerve were retrospectively identified through a search of our teaching file database and radiology reporting system. A retrospective review of the literature was performed using PubMed to identify original cases of glioma infiltrating within or along cranial nerves. Cranial nerve involvement as leptomeningeal spread or involvement of the olfactory or optic nerves were specifically excluded, as anatomically and histologically CN1 and CN2 are white matter tracts and not true cranial nerves.

Results
Eight original cases of gliomas involving a cranial nerve from our institution are presented. Six of the cases involved the trigeminal nerve, one case the oculomotor nerve, and one case the trigeminal and facial nerve. The mean age of patients was 41 years old (range of 9-67) old; four were women and four were men. Three cases were unifocal tumors and five cases were in the setting of multifocal glioma. In all three of the unifocal tumors and in one of the multifocal tumors the presenting symptom was cranial neuropathy. On histopathology, six cases were grade IV (glioblastoma), one case was grade II, and one case was grade III. In none of the cases was a gross total resection attempted or achieved, treatment consisted of radiation and chemotherapy.

On imaging, all eight cases showed tumors involving cranial nerves with typical features of infiltrating glioma. This comprised of expansion, irregular or rim enhancement, infiltrative T2 FLAIR signal hyperintensity, variable degree of reduced diffusion, increased cerebral blood volume on perfusion, and elevated choline/NAA on spectroscopy. These imaging features were key in distinguishing these tumors from other lesions that may occur in the same location such as nerve sheath tumors, perineural spread of head and neck malignancies, leptomeningeal spread of cancer, or meningiomas. Review of the literature revealed a total of eleven reported cases of glioma with cranial nerve involvement excluding leptomeningeal spread ranging in date from 1904 to 2011. The age is available for seven of the patients with a mean age of 36 years old (range of 8-70). Eight cases were reported to involve the vestibulocochlear nerve, one case to involve the oculomotor nerve, one case to involve the trigeminal nerve, and one case to involve the vestibulocochlear, facial, and trigeminal nerves. On histopathology nine of the cases are reported as low-grade gliomas (WHO grade I-II) and two cases are reported as glioblastomas (WHO grade IV).

Conclusions
We present imaging characteristics of infiltrating gliomas involving the cranial nerves, a rare but
important entity to recognize preoperatively. This presentation will improve the attendee's awareness of this process and the imaging features on standard and advanced imaging sequences.

KEYWORDS: Brainstem, Cranial Nerve Pathology, Glioma

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EP-28

6:30AM - 9:00PM

Inhospital Survival Following Conservative Therapy in Severe Acute Stroke Patients Within 3 Hours of Onset Due To Severe Hypoperfusion in the Middle Cerebral Artery Territory Displayed by MR Perfusion Study

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¹Shonan Kamakura General Hospital Stroke Center, Kamakura, Japan

Purpose
The purpose of our study was to investigate inhospital survival following conservative therapy in
severe acute stroke patients within three hours of onset due to severe hypoperfusion in the middle cerebral artery territory displayed by MR perfusion study.

Materials and Methods
Included in our retrospective analysis were acute stroke patients 1) who were admitted to our institution within three hours of onset from 2005 to 2013, 2) who had severe hypoperfusion in the affected MCA territory displayed by MRI/PWI study and 3) who undergo no revascularization therapy. Time intensity curves (TICs) of PWI were generated on region of interests set at symmetrical positions of the bilateral MCA territories. The time to peak (TTP) and the peak signal (PS) was compared between the affected side (a) with the contralateral side (c). Severe hypoperfusion was defined as TTPa minus TTPc of one second or more and PVa divided by PVc of less than 0.5. Evaluated were patient's baseline characteristics, NIHSS score on admission, emergency CT-ASPECTS and MRI DWI-ASPECTS, length of hospitalization stay. We investigated inhospital survival rate at 10 days and factors for survival.

Results
Forty-two patients were analyzed. Their average age was 81.7 years, median NIHSS on admission was 21.5 (18.7-25.5: interquartile range), median DWI-ASPECTS was two (0-3), median CT-ASPECTS was three (1.7-6), average length of hospital stay was nine days, 21 patients (50%) died during hospitalization. Among them, 20 patients (95%:20/21, 48%:20/42) died within 10 days. CT ASPECTS on admission was significantly correlated with inhospital survival. However, age, DWI-ASPECTS and NIHSS on admission were not related to survival. Indeed, DWI-ASPECTS and NIHSS on admission were very severe in all patients. Logistic regression analysis demonstrated that CT ASPECTS was the independent factor for survival (OR= 20.52, 95% CI=1.19 to 581, P<0.05). Receiver operating characteristic (ROC) curve (AUC 0.693) showed that cut-off-point for survival was three in ASPECTS.

Conclusions
When acute ischemic stroke patients within three hours of onset presenting severe hypoperfusion of the MCA territory, severe NIHSS and low DWI-ASPECTS were treated conservatively, inhospital survival rate was only 52% at 10 days. We must rescue patients with CT ASPECTS of two or less and improve clinical outcome of patients with CT ASPECTS of three or more.

KEYWORDS: MR Imaging Perfusion

Severe Hypoperfusion Type of TIC

(Filename: TCT_EP-28_TIC.jpg)
Insights from the Ventral Premotor Cortex (BA 44): Glial Tumor Spread Pattern Important for Survival and Functional Outcomes.

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Purpose
To describe the spread and functional outcomes of gliomas arising from or involving the ventral premotor cortex, also called "the motor of Broca's", Brodmann Area 44 (BA44) or pars frontalis.

Materials and Methods
Twenty-eight cases of diffuse glioma involving BA 44 were retrospectively reviewed. Pre-and postoperative deficits imaging and neurologic testing, pathology and survival were assessed. The volume representing BA44 was defined as the Brodmann defined cortex with the underlying superficial white matter ending at the crossing fibers of the corona radiata. Representative and difficult cases were rendered in volume for confocal viewing.

Results
Gliomas restricted solely to BA 44 (n=12) had a characteristic "C" or "lotus flower" shape, with a rounded deep border straddling the pre-central sulcus of the inferior frontal gyrus. Spread to adjacent operculum or insula was common (n=12), while 6 patients had deeper spread/multifocal disease. BA 44 is involved in fine motor hand coordination, verbal fluency, attention and executive functions. The glioma was left sided in 19 patients in close proximity to language function. Gross total resection of at least the enhancing component was obtained in 12 patients, with incomplete resection often due to sparing of the face motor cortex posteriorly, arcuate tract deep or Broca's area anteriorly. Available neurological exams 1-2 weeks after surgery showed significant decline in 3 patients, mild decline in 11 and a mixture of improvement / decline in 6. Patient often improved until time of recurrence. At last follow-up (40+/27 months), patients with gliomas restricted to BA 44 were more likely to be alive (83% versus 38%, p=0.02 by Fisher exact test) and less likely to have GBMs (17% versus 56%; p=0.05), than those spreading beyond.

Conclusions
BA 44 is an important area for integrating attention and proprioceptive information to voluntarily coordinate complex movements. The gliomas characteristic shape has important functional and survival implications for spread beyond BA44. BA44 has been deemed eloquent because it cannot be removed without deficit (ref. 1), however, in the majority of these patients the deficits were minor and some patients experienced partial improvement. Clinical relevance:
Understanding the characteristic shapes of BA 44 diffuse gliomas allow for detection of spread beyond this area, with important implications for functional outcomes, neurosurgical risk, and survival.

KEYWORDS: Broca'S, Functional Brain Mapping, Glioma
25 year old female with anaplastic astrocytoma involving the left ventral premotor cortex (BA44). The tumor is C-shaped, straddles the pre-central sulcus (arrowhead). Note that Broca’s area (BA 45) and the motor strip are spared (BA4; arrows). The smooth deep border is attributed to the underlying arcuate fasciculus (blue) and corticobulbar tract (yellow)
Intracranial Arterial Vascular Wall Imaging Using Volumetric Cube T1 MRI sequence at 3 Tesla - Initial Experience

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Purpose
Analyze the utility of volumetric sequence Cube T1, in a 3 T unit, for the characterization of intracranial arterial wall and their different pathologies.

Materials and Methods
We retrospectively analyzed brain of 741 patients who underwent magnetic resonance angiography (MRA) with TOF (time of flight) technique and volumetric Cube T1 in unit 3 T, in our department from June 2012 to December 2013, with different indications such as headache, suspected stroke/TIA, suspected dissection, for evaluation of atherosclerotic disease, dizziness, amnesia and suspected. Examinations performed on the equipment Discovery MR750 (GE Healthcare, WI, USA) using the CUBE T1 sequence, volumetric acquisition with contrast T1 - FSE modified to use higher echo train length (ETL), reducing time, without prejudice to final image. Geometry parameters adjusted to obtain isometric voxels of approximately 0.4mm with interpolation in order to maintain resolution when reformatted, the parameters adjusted for contrast T1-weighted and reduced sensitivity to flow (black blood). The acquired images were subsequently reformatted for better visualization of the vessel of interest, using minMIP (minimum intensity projection).

Results
From the 741 patients studied at MRA 542 (73%) were normal, 95 (13%) had mild arterial wall contour irregularity, 11 (1%) absence of flow, suggestive of thrombosis, one with moyamoya vascularization pattern and two arteriovenous malformation. Four patients (1%) had a concentric wall thickening, two with enhancement, suggestive of vasculitis. T1 hyperintense signal in the vascular wall probably due to dissection/parietal hemorrhage was observed in nine patients (35%). Eccentric wall thickening, with eccentric narrow, probably related to atherosclerotic disease was observed in nine patients (45%). Patients who had aneurysm as main finding were not considered in the analysis. All patients with findings suggestive of arterial dissection, atheroma plaques determining eccentric stenosis and concentric pattern of stenosis showed abnormalities in the sequence T1 Cube.

Conclusions
There was good correlation between the imaging findings of the volumetric T1 Cube and the TOF MRA alterations. The volumetric T1 "black blood" was an efficient method for evaluation of the vascular wall, showing the advantages of high spatial resolution, acquisition of the entire brain volume, without requiring the intervention of the radiologist during the examination, and the possibility of multiplanar reconstruction. Adding this sequence to our protocol has improved the diagnosis, providing greater confidence to demonstrate different pathologies. Larger studies are needed to define the impact of the use of this sequence in the diagnosis and management of patients with cerebrovascular diseases.
Is Diffusion-weighted Imaging at 3T Useful for Evaluating Nodular Disseminated Lesions in Malignant Gliomas?

T Hirai¹, H Uetani¹, K Iwashita¹, H Nakamura¹, S Nishimura¹, Y Yamashita¹
¹Kumamoto University, Kumamoto, Japan

Purpose

The purpose of this study was to evaluate whether diffusion-weighted imaging (DWI) at 3T is useful for the detection of nodular disseminated lesions in malignant gliomas.

Materials and Methods

We included consecutive 12 patients (8 men, 4 women; age range, 11 - 80 years old; mean age, 47 years) with nodular disseminated lesions of malignant gliomas that were confirmed by surgery or follow-up MR imaging. All underwent conventional MR imaging, DWI at b = 1000 and 3000 s/mm², post-contrast T1-weighted and 3D gradient-echo imaging on 3T MRI units. The main lesion per person was qualitatively and quantitatively assessed. Two radiologists independently evaluated the presence of additional information on DWI at b = 1000 or 3000 s/mm² compared with postcontrast T1-weighted and 3D gradient-echo images using a 4-point scoring system. Interobserver agreement was assessed by k statistics. On DW images, one radiologist performed region-of-interest measurements of the signal intensity (SI) of nodular disseminated lesions and the adjacent brain. The lesion-to-brain contrast ratio (LBCR) was calculated.

Results

Radiologists 1 and 2, respectively, assigned as DWI providing more additional information compared with postcontrast study (grade 3 and 4) in 3 (25%) and 2 (17%) DWI at b = 1000 s/mm² studies and 4 (33%) and 5 (42%) DWI at b = 3000 s/mm² studies. Interobserver agreement for DWI at b=1000 s/mm² and b=3000 s/mm² was very good (κ = 0.85; 95% CI, 0.63-1.00) and excellent (κ = 0.93; 95% CI, 0.78-1.00), respectively. The mean LBCR score was higher for DWI at b=3000 s/mm² than DWI at b=1000 s/mm², although there was no significant difference in the mean LBCR between the 2 types of DWI.

Conclusions

DWI at 3T can provide useful information for the detection of nodular disseminated lesions in malignant gliomas. In certain cases, 3T DWI at b = 3000 s/mm² might provide more additional information than b = 1000 s/mm².

KEYWORDS: Diffusion-Weighted Imaging
Is reperfusion mandatory for hemorrhagic transformation occurrence after rtPA treatment in patients with acute ischemic stroke?

A Horsch¹, J Dankbaar¹, Y Van der Graaf², W Mali¹, B Velthuis¹
Purpose
Recombinant tissue Plasminogen Activator (rtPA) is given in acute ischemic stroke patients to achieve recanalization and reperfusion. Hemorrhagic transformation (HT) is a serious complication of treatment with rtPA and even milder grades are known to effect outcome. HT is related to increased permeability after blood-brain barrier (BBB) injury. It is not clear whether this occurs (1) secondary to reperfusion in combination with ischemic BBB injury or (2) as a direct consequence of the disruptive effect of rtPA on the BBB. The aim of this study was to establish whether reperfusion is mandatory for the occurrence of HT.

Materials and Methods
From the Dutch acute Stroke Trial (DUST) patients were selected with (1) an ischemic deficit in the middle cerebral artery territory and (2) admission and follow up non-contrast CT (NCCT) and CT perfusion (CTP). Reperfusion status was divided in 2 groups: a (1) no-reperfusion group and a (2) complete- or partial-reperfusion group. Occurrence of any HT was assessed on follow up NCCT. HT rates between groups were compared with Fischer's exact test.

Results
Inclusion criteria were met in 191 patients of which 130 (68%) were treated with rtPA. Absolute risks of HT for patients treated with rtPA were not significantly different between no-reperfusion and complete- or partial-reperfusion groups (18% versus 15%, P=0.726). In the group without rtPA treatment there was a non-significant trend of higher HT rates in the no-reperfusion group (15% versus 4%, P=0.196).

Conclusions
Our results suggest that the increased risk of HT in acute ischemic stroke treatment is related to the direct effects of rtPA on the BBB and not to reperfusion status. Funded by the Netherlands Heart Association: Project number 2012T061

KEYWORDS: CT Perfusion, Hemorrhagic Transformation, Reperfusion Therapy

Table 1. Outcome summary: relation between rtPA treatment, reperfusion status and incidence of hemorrhagic transformation (HT)*.

<table>
<thead>
<tr>
<th></th>
<th>rtPA N=130</th>
<th>No rtPA N=61</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td>65 (48)</td>
<td>28 (20)</td>
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<tr>
<td>Partial</td>
<td>17 (12)</td>
<td>13 (5)</td>
</tr>
<tr>
<td>No</td>
<td>1 (12)</td>
<td>2 (15)</td>
</tr>
</tbody>
</table>

P=0.726
Lateralization of Temporal Lobe Epilepsy by T2-weighted FSTIR and Echo Spacing Optimized FSE T2 at 3T

S Sarkar\textsuperscript{1}, D Schomer\textsuperscript{2}, D Teich\textsuperscript{2}, R Bhadelia\textsuperscript{3}, S Herman\textsuperscript{2}, T Luu\textsuperscript{3}, M Plum\textsuperscript{3}, D Hackney\textsuperscript{3}  
\textsuperscript{1}Beth Israel Deaconess Medical Center, Harvard medical School, Boston, MA, \textsuperscript{2}Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, \textsuperscript{3}Beth Israel Deaconess Medical Center, Boston, MA

Purpose

Hippocampal substructures that have convoluted mixtures of GM/WM are often involved in temporal lobe epilepsy (TLE) although direct detection of abnormal sub-layers is challenging at 1.5 or 3T. FSE T2w sequences are preferred due to their high signal and tissue contrast imaging ability although with mixed success for hippocampus. We have noted that Fast Spin Echo based inversion recovery sequences (FSTIR and DIR) are sensitive to differentiate between cortical GM and myelin-rich WM due to the T1-weighting inherently built within those sequences (Ref 1). We hypothesize that excess or depletion of GM within the hippocampal subfields may be detectable by adding T2 weighting to FSTIR or by adjusting the echo spacing (ES) for varying T2 weighting in FSE T2 sequence for patients with well characterized temporal lobe epilepsy.

Materials and Methods

Using an IRB-approved criteria we studied 21 patients with chronic temporal lobe epilepsy divided into two subgroups without classifying them per frequency or severity of epileptic events: 13 patients with suspected focal epilepsy (test group) lateralized by clinical assessments and EEGs and 8 patients with no clear lateralization (generalized seizure or controls). None of the patients had any craniotomy, lobectomy or mass lesions. All imaging was done in a 3T GE imager at high resolution (0.6x0.6x2.4 mm3 voxels) in coronal plane orthogonal to hippocampal long axis. For ES based optimization of optimal T2 weighting, six patients (3 with lateralized and 3 with generalized seizures) were imaged with short (8 ms) and long ES (17 ms) at an effective TE of 105 ms. Based on greater cortical GM/WM contrast observed at short ES, the remaining 13 patients were scanned by the short ES T2 sequence as well as by an FSTIR sequence (equivalent to the FSE T2 except for the inversion preparation with 50 ms inversion delay). In addition to radiologic assessment to detect possible seizure foci, the local SNR from bilateral hippocampus were estimated using elliptical ROI (Figure below) placed within the hilar region of dentate gyrus (DG:H) and noise ROI in the mastoid air space. The % SNR asymmetry,

<table>
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<tr>
<th>PH</th>
<th>1 (2)</th>
<th>1 (2)</th>
<th>1 (6)</th>
<th>0</th>
<th>0</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI and PH combined</td>
<td>9 (14)</td>
<td>8 (17)</td>
<td>3 (18)</td>
<td>P=0.726</td>
<td>1 (4)</td>
<td>1 (5)</td>
</tr>
</tbody>
</table>

* HT: absolute number and (%) in relation to reperfusion group.

HI=hemorrhagic infarction and PH=parenchymal hemorrhage.

Absolute risks and Fischer’s exact test for all HT combined and any reperfusion (complete and partial combined) compared to no reperfusion.
computed by \( \frac{\text{SNR(Rt DG)} - \text{SNR(Lt DG)}}{\text{Mean SNR}} \), was compared for both the sequences and were plotted below.

**Results**

The generalized epilepsy cases showed a mean R>L SNR asymmetry of 5% per FSTIR and 3.8% per FSE T2 (baseline or control, plotted as mottled bars below). The figure below shows ROI locations (left) and the mean % SNR asymmetry for lateralized and generalized epilepsy patients (right) for T2w FSTIR (solid and mottled blue bars) and FSE T2 (solid and mottled pink bars). Eleven patients (test group) lateralized by EEG and clinical assessments were also lateralized with 9.5% SNR asymmetry per FSTIR (solid blue bar) and 5.4% per FSE T2 (solid pink bar). Two patients however showed contralateral correlation with EEG (mismatched laterality) although statistically significant ipsilateral match was observed for the test group over and above the baseline patterns from controls (Wilcoxon Signed Rank Test, P<0.05) for both the sequences.

**Conclusions**

In TLE patient group the affected dentate gyrus has lower SNR compared to the unaffected side in both the sequences. This indicates possible depletion of GM from the dentate gyrus on the affected side and is detectable significantly better by FSTIR since it produced almost twice the SNR asymmetry between the right and left dentate gyri compared to FSE T2 even though short echo spacing helped increase the tissue contrast and SNR asymmetry for FSE T2. Our results indicate that both T2 weighted FSTIR and FSE sequences correlate well in 11/13 cases with EEG and clinical lateralizations and thus can differentiate between lateralized and generalized epilepsy with a high degree of specificity. However, this approach needs to be validated on a larger patient pool and the duration and severity of illness need to be tested for correlation with our approach.

**KEYWORDS:** Epilepsy, Lateralization, MR Imaging

(Filename: TCT_EP-76_RevisedperDBHASNRFigHippo.jpg)
Measurement of Blood Brain Barrier Permeability: Comparison of Delayed Phase Versus First Pass Using a Distributed Parameters Model.

A Vagal¹, A Dunning², D Mir², P Sanelli²
¹University Hospital/University Cincinnati College Of Medicine, Cincinnati, OH, ²Weill Cornell Medical College, New York, NY

Purpose
Prior studies have compared the first pass versus delayed phase for blood-brain barrier permeability measurements using single compartment Patlak model for CT perfusion (CTP). However, similar comparisons for other alternative, non-Patlak permeability models have not been performed. Our primary objective was to compare first pass against delayed acquisition CTP using a distributed parameters permeability model. The secondary objective was to predict delayed phase permeability estimates using first pass data.

Materials and Methods
A retrospective study of patients imaged with a delayed acquisition CTP study was performed using an IRB approved database. Commercially available software (Oleasphere 2.2) was used to generate permeability maps. A distributed parameters model using adiabatic approximation, the Lawrence and Lee model (LL) was utilized. Permeability was measured in first pass (0–60 s after contrast administration) and delayed phase (0-180 s). The parameters included Kep (kinetic constant), Ktrans (volume transfer constant), Perm (permeability), Ve (extravascular extracellular space volume) and Vp (plasmatic volume), F (blood flow), E (extraction constant) and PS (permeability surface area product). Multilevel mixed model was conducted to test the paired differences in first pass and delayed phase CTP. Data were randomly split into development and validation dataset. Multilevel mixed linear model was applied to development dataset using first pass to predict delayed phase parameters. Regression equation from development data was applied to validation dataset and multilevel mixed model was used to test differences in observed and predicted delayed phase parameters.

Results
The study group included 44 patients with a total of 8600 observations. The mean difference between delayed phase and first pass was significant for Kep, Ktrans, Perm, Ve, Vp, F and PS quantitative measurements (p<0.05). There was no statistical significant difference between delayed phase and first pass for E (extraction constant) (p>0.05). Except for the Kep, the mean value of predicted permeability measurements did not differ significantly from the measured/observed value in both the development and validation groups (p>0.05) (Table). The predictive model allowed prediction of majority of delayed phase permeability measurements using the measured first pass data.

Conclusions
Although the use of the delayed versus first pass acquisition can lead to differences in permeability values when using a LL model, majority of the delayed phase permeability parameters can be estimated using the first pass data. This predictive method has important implications with the potential to reduce radiation dose, examination time and motion artifacts related to a longer CTP acquisition. Further studies are warranted in this direction.

KEYWORDS: Blood-Brain Barrier, CT Perfusion
Table: Prediction for permeability measurements using LL model

<table>
<thead>
<tr>
<th>Permeability parameter</th>
<th>Mean Difference between predicted and observed delayed phase</th>
<th>95% confidence intervals (CI)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kep</td>
<td>0.135</td>
<td>0.007369 to 0.2626</td>
<td>0.0399</td>
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<tr>
<td>Ktrans</td>
<td>-0.00696</td>
<td>-0.02784 to 0.01392</td>
<td>0.4786</td>
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<tr>
<td>Perm</td>
<td>0.007112</td>
<td>-0.03107 to 0.04530</td>
<td>0.692</td>
</tr>
<tr>
<td>Ve</td>
<td>-0.0445</td>
<td>-0.1667 to 0.07771</td>
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<td>Vp</td>
<td>-0.00514</td>
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<td>E</td>
<td>-0.01617</td>
<td>-0.03765 to 0.005303</td>
<td>0.1268</td>
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<tr>
<td>F</td>
<td>17.9202</td>
<td>-5.6734 to 41.5137</td>
<td>0.1238</td>
</tr>
<tr>
<td>PS</td>
<td>2.0691</td>
<td>-3.7279 to 7.8661</td>
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eP-95a

Measurement of Blood Brain Barrier Permeability: Comparison of Delayed Phase Versus First Pass Using a Two-Compartment Model

A Vagal¹, A Dunning², D Mir², P Sanelli²

¹University Hospital/University Cincinnati College Of Medicine, Cincinnati, OH, ²Weill Cornell Medical College, New York, NY

Purpose
Prior studies have compared the first pass versus delayed phase for blood-brain barrier permeability measurements using single compartment Patlak model for CT perfusion (CTP). However, similar comparisons for other alternative, non-Patlak permeability models have not been performed. Our primary objective was to compare first pass against delayed acquisition CTP using a two compartment permeability model. The secondary objective was to predict delayed phase permeability estimates using first pass data.

Materials and Methods
A retrospective study of patients imaged with a delayed acquisition CTP study was performed using an IRB approved database. Commercially available software (Oleasphere 2.2) was used to generate permeability maps. A two compartmental Kety Tofts model (KT) was utilized to measure permeability in first pass (0–60 s after contrast administration) and full phase (0-180 s). The parameters measured included Kep (kinetic constant), Ktrans (volume transfer constant), Perm (permeability), Ve (extravascular extracellular space volume) and Vp (plasmatic volume). Multilevel mixed model was conducted to test the paired differences in first pass and delayed phase CTP. Data were randomly split into development and validation dataset. Multilevel mixed linear model was applied to development dataset using first pass to predict delayed phase parameters. Regression equation from development data was applied to validation dataset and multilevel mixed model was used to test differences in observed and predicted delayed phase parameters.

Results
The study group included 44 patients with a total of 8600 observations. The mean difference between the full phase and first pass data was significant for Kep, Ktrans and Ve quantitative
measurements (p<0.05). There was no statistical significant difference between the full phase and first pass for Perm and Vp measurements (p>0.05). The mean value of predicted permeability measurements did not differ significantly from the measured/observed value in both the experimental and validation groups (p>0.05) (Table). The predictive model allowed prediction of full phase permeability measurements using the measured first pass data.

Conclusions
Although the use of the full phase versus first pass acquisition can lead to differences in the Ktrans values when using a KT model, the full delayed phase permeability can be estimated using the first pass data. This predictive method has important implications with the potential to reduce radiation dose, examination time and motion artifacts related to a longer CTP acquisition. Further studies are warranted in this direction.

KEYWORDS: Blood-Brain Barrier, CT Perfusion

Table : Prediction of permeability measurements using KT model

<table>
<thead>
<tr>
<th>Permeability parameter</th>
<th>Mean Difference between predicted and observed full pass</th>
<th>95% confidence intervals (CI)</th>
<th>P-Value</th>
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</thead>
<tbody>
<tr>
<td>Kep</td>
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<tr>
<td>Ktrans</td>
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</tr>
<tr>
<td>PERM</td>
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<td>-0.06235 to 0.009111</td>
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</tr>
<tr>
<td>Ve</td>
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</tr>
<tr>
<td>Vp</td>
<td>-0.00443</td>
<td>-0.01005 to 0.001186</td>
<td>0.1113</td>
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</tbody>
</table>

EP-46
6:30AM - 9:00PM

Mechanical thrombectomy in patients with acute vertebrobasilar occlusion using the Trevo device: a single-centre experience

D Lobsien¹, D Fritzsch², C Hobohm², U Quaesching², K Hoffmann², M Gawlitza²
¹University Hospital Leipzig, Leipzig, Germany, ²University Leipzig, Leipzig, Saxony

Purpose
To investigate the efficacy and safety of mechanical thrombectomy in patients with acute vertebrobasilar artery occlusion (VBAO) using the Trevo Stentriever device.

Materials and Methods
Stent-retriever thrombectomy using the Trevo device was performed in 16 patients with proven VBAO within the first 24 hours after symptom onset. Recanalization rates were assessed and device-related complication rates as well as patient outcome and mortality rates were recorded.

Results
Mean patient age was 70.4 years (± 13.8; range 36 – 85). Mean time from symptom onset until
the beginning of the DSA was 300.2 minutes (± 165.8 minutes; range 82 – 725). VBAO was situated at the basilar artery foot (18.8%), in the middle segment (31.3%), at the basilar apex (43.8%) and in the proximal PCA (6.3%). Six patients received IV rt-PA prior to DSA. The Trevo was used either as the sole device (56.3%) or in conjunction with additional devices or techniques (up to four in one patient). 33 clot retrieval maneuvers were performed (mean 2.1 ± 1.3, range 1 - 5); the device could be deployed and retrieved in all maneuvers (100%). No device-related complications occurred during the intervention. Mean duration of the endovascular intervention was 71.8 (± 39.9; range 22 - 144) minutes. Successful recanalization (TICI ≥ 2b) was achieved in 13 patients (81.3%), eight (50%) of them with TICI 3, five (31.3%) with TICI 2b. In three patients (18.8%) only incomplete reperfusion was achieved. All patients showed an improvement of at least one point in the TICI scale – two patients (12.5%) improved by one, five patients (31.3%) by two, three patients by three (18.8%) and six patients (37.5%) by four points. Eleven patients (68.8%) survived and three patients (18.8%) showed a good clinical outcome at discharge (mRS 0-2).

Conclusions

The present study shows that thrombectomy in patients with acute VBAO using the Trevo Stentriever™ – either as the sole device or in conjunction with other devices - is feasible and that it is as effective and as safe as its application in the anterior circulation. Furthermore, the Trevo device seems to be similarly suitable for the treatment of VBAO as other stent-retriever systems.

KEYWORDS: Brain, Stroke, Thrombectomy

EP-10 6:30AM - 9:00PM

Medial Temporal lobe Atrophy is underreported and predicts mortality in medical inpatients

D van Westen¹, G Torisson², L Minthon², L Stavenow², E Londos²
¹Skane University Hospital Lund, Lund, Sweden, ²Skane University Hospital Malmö, Malmö, Sweden

Purpose

Medial temporal lobe atrophy (MTA), a morphological hallmark of Alzheimer disease (AD), also is encountered in normal aging, cerebrovascular disease and neurodegenerative disorders other than AD (1). MTA is assessed easily and reliably from computed tomography (CT) using a visual rating scale that has shown very good agreement with manual volumetric measurement and is related to memory function in AD (2, 3). However, when imaging is performed outside the work up of dementia, MTA may be under-reported, for example when cognitive decline may not yet have been recognized, or when imaging is performed in the acute setting with the aim to rule out obvious pathology such as stroke or hemorrhage. We previously have demonstrated that cognitive decline is frequent and frequently unrecognized in medical inpatients (4). Here, we reassess cranial computed tomography (CT) from these patients for MTA, compare results with cognitive tests and determine the importance of MTA for survival.

Materials and Methods

Medical records from 200 consecutive medical inpatients aged over 60 years who had been
subjected to cognitive tests in our previous intervention study (4, 5), were reviewed for cranial CT performed within a year from cognitive testing. Coronal slices were re-assessed for MTA according to Scheltens visual rating scale (0-4) with abnormal score being >1 under and >2 over the age of 75, respectively. Findings were compared with the original radiological reports and cognitive tests, and survival analysis was performed.

Results
CT had been performed in 94 of 200 (47%) patients. The interval between scan and cognitive testing was 12 days (median, interquartile range 1-132 days). The referral for CT was issued by the emergency department or a hospital ward in 87 patients, by outpatient clinics at the hospital in five patients and by general practitioners in two patients. Symptoms of or simply cognitive impairment were mentioned in 35/94 (37%) of referrals. In 34/94 (36%) MTA was abnormal. None of the patients with abnormal MTA was reported as such originally (Table 1, Figure 1). Patients with abnormal MTA had lower results on cognitive tests. Abnormal MTA independently predicted mortality, with a HR (95%CI) of 2.43(1.39-4.27) in a multivariable model.

Conclusions
Medial temporal lobe atrophy in routine cranial CT performed on medical inpatients over 60 years is under-reported and holds important clinical correlates with prognostic value. Our results suggest that reporting MTA in this population should be part of the routine radiological work up.

KEYWORDS: Atrophy, CT, Neurodegenerative

<table>
<thead>
<tr>
<th>Medial Temporal lobe Atrophy</th>
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<th>At reassessment</th>
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<tr>
<td>NA</td>
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<td>4</td>
</tr>
<tr>
<td>0</td>
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<td>13</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>4</td>
<td>0</td>
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</tr>
<tr>
<td>MTA reported at all</td>
<td>8 (9%)</td>
<td>94 (100%)</td>
</tr>
<tr>
<td>Any MTA</td>
<td>4 (4%)</td>
<td>81 (86%)</td>
</tr>
<tr>
<td>Abnormal MTA</td>
<td>0</td>
<td>34 (36%)</td>
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</table>
Medial temporal lobe atrophy grade 2 (R) and 4 (L) respectively, not mentioned in the original report.

(Filename: TCT_EP-10_Bildmedtext.png)

EP-89

Metal Artifact Reduction using C-Arm Cone-Beam CT: A quantitative assessment and evaluation of artifacts after endovascular treatment of cerebral aneurysms

C Cay¹, M Wells¹, J Siewerdsen¹, A Wang¹, T Ehtiati², F Gundlack², C Rohkohl³, B Scholz⁴, M Radvany⁵
Purpose
To evaluate the performance of a metal artifact reduction (MAR) algorithm using C-arm cone-beam CT after endovascular treatment of cerebral aneurysms and examine post-processing artifacts.

Materials and Methods
Studies were conducted using a C-arm (Artis Zeego; Siemens AG) for 3D imaging and a novel MAR algorithm under development. A head phantom incorporating a natural skull in tissue-equivalent plastic and brain-equivalent gelatin was used with plastics representing hemorrhage, vessels, and CSF and metal spheres (steel, titanium, and tungsten with 3.2, 6.4, and 12.8 mm diameter) successively introduced to simulate coiled aneurysms. 3D images were reconstructed with and without MAR, and artifact magnitude was quantified in terms of the voxel value standard deviation in a region adjacent to the metal sphere. A 3D vascular model with a 9 mm aneurysm was also introduced into the phantom and treated with stent assisted coiling. 3D reconstructions were performed and artifact magnitude quantified. The MAR algorithm was then applied to clinical images along with a modified segmentation algorithm and the clinical images evaluated.

Results
The MAR algorithm demonstrated significant reduction in artifact allowing visualization of the metal component and surrounding structures. Artifact magnitude without and with MAR was, respectively: 440 vs 48 HU (3.2 mm tungsten); 472 vs 45 HU (6.4 mm tungsten); 568 vs 43 HU (12.8 mm tungsten). For the 9 mm simulated aneurysm, the MAR reduced artifact magnitude from 360 to 37 HU. Evaluation of the clinical images demonstrated reduced artifact with improved visualization of structures adjacent to the treated aneurysms.

Conclusions
The MAR algorithm provided excellent reduction of artifact magnitude even with large, complex metal components. Ongoing work includes implementing a semi-automatic segmentation algorithm, analysis of tolerance to MAR parameters, and clinical evaluation.

KEYWORDS: Beam Hardening Artifacts, Postprocessing

(Filename: TCT_EP-89_MARimage.jpg)

EP-57

6:30AM - 9:00PM
Objective Physiologic Based CSF Flow Assessment in Chiari I Malformation

N Madan1, Y Zhao2, C Heilman1, S Patz3, R Bhadelia4
1Tufts Medical Center, Boston, MA, 2Philips Healthcare, Cleveland, OH, 3Brigham and Women's Hospital, Boston, MA, 4Beth Israel Deaconess Medical Center, Boston, MA

Purpose
While invasive methods have demonstrated altered CSF flow in Chiari patients, with a physiologic challenge such as cough or Valsalva maneuver [1], assessment with MRI has previously not been possible due to the long acquisition time of CSF flow imaging techniques. Such an assessment would be helpful in non-invasively differentiating Chiari I patients who may benefit from surgery. The purpose of this study was to evaluate CSF flow changes in response to a cough maneuver in both normal subjects and patients with Chiari I malformation, using a real-time pencil beam technique with high temporal resolution.

Materials and Methods
A real time pencil beam flow imaging technique (temporal resolution of ~60 msec) was developed. Using this technique, 4 normal subjects and 6 patients with Chiari malformation were evaluated, to assess CSF flow just below the foramen magnum at rest, as well as after a short series of coughs. CSF mean displacement volume (V_CSF) during the cardiac cycle and CSF flow waveform peak to peak amplitude (A_pp) were determined. A t-test was used to compare each parameter at rest and immediately after the cough maneuver in both subject groups.

Results
Both qualitative and quantitative waveform analysis of CSF flow versus time (Figure 1) demonstrated a significant decrease in both V_CSF and A_pp immediately after the cough maneuver (red arrow) in all 6 patients with Chiari I malformation, with no significant decrease seen in any of the normal controls. Quantitative analysis revealed that in normal subjects, there was no significant change in either V_CSF (p = 0.11) between rest (0.66 ± 0.32 mL) and immediately post-cough (0.68 ± 0.40 mL) or A_pp (p = 0.34) at rest (5.49 ± 1.78 mL/s) versus immediately after cough (5.76 ± 1.84 mL/s). However, in patients with a Chiari I malformation, a significant decrease was observed in both V_CSF (p=0.020) at rest (0.44 ± 0.26 mL) versus post-cough (0.22 ± 0.17 mL) as well as in the A_pp (p=0.016) at rest (3.91 ± 2.47 mL/s) versus post-cough (1.90 ± 0.82 mL/s).

Conclusions
Significant decrease in both CSF flow displacement and waveform amplitudes in Chiari I patients indicate CSF flow obstruction at the foramen magnum in response to coughing. This is in keeping with previously published invasive reports [1]. PBI shows promise for identifying and quantifying an altered response to a physiological challenge, and may allow improved identification of patients who would benefit from surgery.

KEYWORDS: Chiari Malformation type 1, CSF Flow
Pathophysiologic Mechanism Underlying MRI Findings of Urea Cycle Disorders: Comparison of Conventional MRI with Diffusion Weighted Imaging

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Purpose
Urea cycle disorders (UCD's) are rarely encountered inborn errors of metabolism, and can be well visualized on DWI and FLAIR MRI, presumably due to hyperammonemia (1). Here we present conventional MRI findings of four of the five forms of the UCD's in a single series with their corresponding diffusion weighted imaging findings.

Materials and Methods
This retrospective study included 9 patients (6 males 3 females, ages 1 days - 39 years). We evaluated corresponding axial FLAIR, DWI, susceptibility weighted imaging, and post-contrast T1 weighted imaging (T1WI) for brain involvement. We also recorded serum ammonia levels at the time of presentation and within one week of the imaging studies.

Results
The study cohort included 4 Ornithine transcarbamolase deficiencies (OTCD), 3 Argininosuccinic aciduria (ASA), 1 Carbomoylphosphate synthetase deficiency (CPSD), and 1 Citrullinemia type 1 (CT1). In all 4 patients with OTCD, FLAIR and DWI revealed similar areas of involvement, including diffuse gray-white matter junction in frontal and parietal lobes. However, in one of them with adult-onset OTCD, FLAIR images demonstrated abnormalities of the basal ganglia and cerebellum in addition to the insulae and fronto-parieto-temporal cortices, but without clearly reduced diffusion; this patient had an ammonia level of 485 umol/L at presentation, which was 87 umol/L at the time of MRI. Similarly, in a patient with ASA, FLAIR images demonstrated involvement of basal ganglia in all 3 patients, while DWI was negative; there was brainstem involvement in 2 patients, frontoparietal cortex in 1 patient, and thalami in 1 patient. Additionally, in the one patient with CPSD, there was thalamic and basal ganglia involvement on FLAIR, without reduced diffusion. Finally, in the single patient with citrullinemia, both FLAIR and DWI revealed involvement of the insulae, globi pallidi, and centrum semiovale; DWI also revealed involvement of the cerebral peduncles, which was not visible on FLAIR images.

Conclusions
While this may be the largest combined series of UCD's evaluated by MR imaging, the findings are similar to previous reports, which include involvement of the perirolandic regions and insulae in a majority of patients (2). The pathophysiologic mechanism of involvement is thought related to accumulation of intracellular glutamine, and in turn astrocyte swelling, brain edema and cerebral hypoperfusion (2). Regarding the initial insult, the lack of reduced diffusion in the regions that were clearly abnormal on FLAIR images may be explained by high serum ammonia levels that later normalize with subsequent pseudonormalization on imaging with DWI and FLAIR.

KEYWORDS: Diffusion-Weighted Imaging, Hyperammonemic, Metabolic
Carbomoylphosphate Synthase Deficiency

Argininosuccinic Aciduria

EP-06

Perfusion-CT Enhanced CTA: an Original Method to Assess Collaterals

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Purpose
Propose a noninvasive technique that allows objective and reliable quantitative assessment of collateral circulation in healthy and ischemic tissue.

Materials and Methods
Anatomical information embedded in CTA is combined with the temporal information in PCT to construct a virtual sequential CTA. Patients with anterior-circulation occlusion stroke are identified retrospectively. Extent and temporal profile of collateral circulation is evaluated in the stroke patients. The temporal profile is calculated and graded as 'instant', 'early' and 'delayed'. The extent is measured and graded as 'good', 'moderate' and 'poor'. Comparison is made with the contralateral hemisphere and healthy subjects.

Results
There is variability in the extent and promptness of collaterals in both healthy subjects and stroke patients. The variation in the time-of-arrival of collaterals is higher in stroke patients than healthy subjects. The extent of collaterals correlates inversely with the area of ischemic tissue.

Conclusions
Presence of robust collaterals has been associated with better clinical outcome, smaller final infarct size and better recanalization results. Therefore evaluation of collaterals is important in stroke management. Our new imaging tool provides objective analysis in a reproducible manner, thus reducing the interobserver variability that many common collateral scores suffer.

KEYWORDS: Collateral Circulation, CT Perfusion, Stroke

EP-62
Phosphorus Nuclear Magnetic Spectroscopy in Multiple Sclerosis

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Purpose
To define the Phosphorus Nuclear Magnetic Resonance (NMR) spectroscopy profiles of multiple sclerosis (MS) patients according to disease severity

Materials and Methods
18 patients with MS (n=9 relapsing-remitting (RR-MS) patients with EDSS<6 and n=9 secondary progressive (SP-MS) patients with EDSS >6) and 10 controls were investigated by monovoxel 31-P MRS on a 3T imager with the following parameters:TR=450 ms, BW=3000 Hz, 128 acquisitions. The following metabolites were analyzed: Phosphocreatine (PCr), total Phosphoate (Pt), inorganic phosphate (Pi), glycerol-3-phosphoryl choline (GPC), glycerol-3-phosphoryl ethanolamine (GPE), Phospho-ethanolamine (PE), phospho-monoester compounds (PME), phosphodiester compounds, and the 3 peaks of ATP. the following ratios were calculated: PCr/Pt, Pi/Pt, alpha-ATP/Pt, beta-ATP/Pt, gamma-ATP/Pt, GPC/Pt, GPE/Pt, PME/PDE. Intra-cellular pH was also calculated.

Results
Compared with controls, patients had higher PCr/Pt (0.261 vs. 0.241, p=0.02) and PME/PDE (1.003 vs. 0.860, p=0.05) and lower GPC/Pt (0.084 vs. 0.100, p=0.01) ratios. Compared to controls, patients with EDSS<6 had lower Pi/PCr (0.230 vs. 0.279, p=0.01) and Pi/Pt (0.060 vs.
Compared to patients with an EDSS<6, those with EDSS>6 have elevated Pi/Pt ratio (0.068 vs 0.060, p=0.03) and PE/Pt (0.107 vs. 0.091, p=0.05) and decreased ratio beta;ATP/Pt (0.050 vs. 0.066, p=0.05).

Conclusions
Saltatory transmission of myelinated fibers required less energy than the continuous transmission of demyelinated fibers. Patients with RR-MS and an EDSS <6 have an increase of high energy phosphorus that could offset the increased energy demand associated with demyelination. This is no longer the case in the more severe forms (SP-MS with EDSS > 6) in which is observed a fall of beta-ATP. Phosphorus NMR spectroscopy is a tool for assessing encephalic energy capacities of patients with multiple sclerosis and differentiates low and high EDSS.

KEYWORDS: MR Spectroscopy, Multiple Sclerosis, Phosphorus Spectroscopy
Primary Intraosseous Venous Malformations of the Skull Base: Case Series and Review of the Literature

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Purpose
Primary intraosseous venous malformations (PIVM), previously known as intraosseous hemangiomas, are uncommon, benign skeletal vascular malformations, consisting of sinusoidal spaces with an endothelial lining. Normally found in the vertebral column, PIVM are relatively uncommon in the craniofacial skeleton, and are found only rarely in the skull base. Skull base PIVM may be assessed using a combination of CT and MRI. We present clinical and imaging findings in five patients with skull base PIVM and a review of the literature, including pathological features and management of PIVM.

Materials and Methods
We retrospectively reviewed demographics, clinical notes, CT and MRI findings in five patients with skull base PIVM presenting to a tertiary neurosciences and skull base institution.

Results
Three patients were female and two male, with an age range of 32 to 94 years. Four patients underwent both CT and MR imaging, and one patient had CT alone. The sphenoid bone was involved in three cases (Figure 1), with involvement of the clivus in one patient and the occipital bone, extending to the mastoid bone, in another. All lesions were incidental findings with radiologically benign appearances. Progressive filling between early and delayed postcontrast MR imaging was demonstrated in two cases. No cases had relevant associated findings, and all cases were asymptomatic, without compression of adjacent structures. In all cases, further follow-up imaging and clinical review were deemed unnecessary.

Conclusions
Skull base PIVM are rare, benign lesions, which may be found incidentally on cross-sectional imaging, with CT and MRI providing complementary diagnostic information. Lesions producing symptoms due to compression of local structures may be treated with surgery or radiotherapy. In our patients, all lesions were asymptomatic with benign appearances requiring no further clinical or imaging follow up.

KEYWORDS: Cavernous Malformation, Head And Neck, Hemangioma
Quantitative Flow Differences Between Multiple Sclerosis and Healthy Control Subjects

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Purpose
Previous research has reported reduced outflow through the internal jugular veins (IJV) in the Multiple Sclerosis (MS) population with large variability in the function of stenotic (ST) versus non-stenotic (NST) IJVs (1). The goal of this work is to provide a retrospective, statistical analysis on a group of healthy control (HC), ST-MS, and NST-MS subjects imaged using MRI to determine the optimum flow thresholds which differentiate HC from MS.

Materials and Methods
A group of 138 MS and 67 HC subjects were imaged on 3T Siemens scanners between two sites. Both 2D TOF MRV and 3D time resolved CE MRAV were used to determine if IJV stenosis was present, subdividing the MS group into ST-MS and NST-MS. The 2D PC was used to quantify flow through the major arteries and IJVs at both C2 and C6 levels. The ratio between the larger IJV flow (dJ) versus the smaller IJV flow (sdJ) was calculated as sdJ/dJ. IJV flow was then normalized to the total arterial flow (tA), providing two major criteria for both levels, the tIJV/tA, where tIJV is the sum of both IJV flows, and sdJ/tA. MANOVA and ROC curve analysis were done. Significance was determined at p=0.05.
Results
In the MS sample, 66 (48%) were NST-MS and 72 (52%) were ST-MS. Figure 1 shows the normalized flow measurements at both levels for right and left IJVs. The ST-MS demonstrated lower normalized flow (MANOVA, p<0.001) compared to HC for all calculations and optimum thresholds were determined to be: 0.62 for C6tIJV/tA, 0.66 for C2tIJV/tA, 0.16 for C6sdJ/tA, 0.10 for C2sdJ/tA, 0.31 for C6sdJ/dJ, and 0.14 for C2sdJ/dJ. The subjects that meet both: tIJV/tA criteria are 9% HC, 11% NST, and 61% of ST; sdJ/tA criteria are 13% HC, 6% NST-MS, and 60% ST-MS; and sdJ/dJ criteria are 13% HC, 7% NST, and 44% ST. Sensitivity ranged from 0.70 to 0.85 and specificity ranged from 0.57 to 0.81 with AUC being significant for all measurements (p<0.001).

Conclusions
The current sample of MS patients and HC indicates that there is a statistically significant difference in venous outflow through the IJV between the groups. These criteria may provide the means of assessing vascular abnormalities in MS subjects quickly using MRI.

KEYWORDS: Flow, Multiple Sclerosis, Venous Drainage
Rapid imaging protocol before reperfusion therapy in Acute Stroke by Area Detector CT

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Purpose
The wide area detector CT (ADCT) enables volume scanning (VS) for the whole brain within one rotation and can provide whole brain CT perfusion (CTP) and dynamic vascular analysis (3D/4D-CTA) in one examination with small volume of contrast medium. It is beneficial for ischemic stroke patients, because further contrast medium is required if endovascular reperfusion therapy is attempted. However, image reconstruction and transfer are too time-consuming in acute stroke setting, because of much volumetric data (VD). The aim of this study was to design the acute stroke protocol of ADCT scanning with short time of image reconstruction and transfer within acceptable limits of quality loss.

Materials and Methods
VS using the ADCT (Aquilion ONE, Toshiba) for CTA and CTP of the whole brain was performed with injecting non-ionic contrast medium 40ml (iopamidol 370,Fuji PHARMACEUTICAL) at a rate of 4mL/s. CTP used 1 s single rotation intermittent dataset scans acquired at 80kVp. Beginning 8 s after contrast medium injection, 18 intermittent volume scans at 100mA are acquired every other second for 34 s during the contrast medium arrival. Ten datasets were then acquired every 5 s for 45 s to complete a 28 volume dataset. Each volume consisted of 160 images of 1-mm thickness with z-axis coverage of 16-cm. After transferring VD to a workstation (Ziostation 2, AMIN/ZIO), CTA and CTP maps were generated with a macro-palette in 3 patients by 7 radiological technicians. Examination time and image quality were evaluated.

Results
VD was transferred to workstation in about 12 minutes 28 seconds since starting VS and both CTP and CTA was generated in mean 2 minutes 11 seconds. Total time until viewing images on PACS was about 14 minutes 39 seconds. Image quality of CTA and CTP maps was enough in acute stroke setting. Compared to initial protocol of a 0.5-mm thickness with z-axis, total operation time became about a half, because VD became a half.

Conclusions
Our protocol can provide the whole brain CTA and CTP images of ADCT with only 40ml contrast medium within 15 minutes in acute stroke setting.

KEYWORDS: CT Angiogram, Volumetric Analysis, Volumetric Perfusion CT
Purpose
Computed tomographic angiography (CTA) is commonly used for the noninvasive detection of cerebrovascular lesions responsible for subarachnoid hemorrhage, but rebleeding may occur during this procedure. We investigated imaging findings and related factors in patients who experienced rebleeding during CTA in our hospital.

Materials and Methods
Participants comprised 112 patients who underwent CTA for ruptured cerebral aneurysm in our hospital between January 2009 and December 2012. Computed tomographic angiography was performed using a 64-row detector system.

Results
Rebleeding occurred during CTA in 5 of 112 patients, representing a rebleeding rate of 4.5%. Mean time from initial onset of hemorrhage to CTA was shorter in patients with rebleeding (median, 92 minutes) than in patients without rebleeding (median, 256 minutes; P=0.051), and blood pressure at the time of initial treatment tended to be higher for patients with rebleeding. Patients with rebleeding showed either: a) spiral or wave-shaped hemorrhage into the cistern in which the aneurysm was located; or b) tear-drop-shaped hemorrhage within the hematoma. Patients with rebleeding were all grade 5 according to the World Federation of Neurological Surgeons (WFNS) and underwent CTA within 3 h of onset.

Conclusions
Computed tomographic angiography offers excellent performance for the diagnosis of cerebral aneurysm, but the use of intravenous contrast agent may carry some risk of rebleeding. History of recent severe subarachnoid hemorrhage also appears to represent a risk factor for rebleeding. As contrast agent injection may produce hemodynamic effects, management of fluctuations in blood pressure during CTA is crucial.

KEYWORDS: Aneurysm, CTA, SAH
Remote Microhemorrhages and Hematomas Are Common in Patients Treated for High Grade Glioma

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Purpose
High grade glioma affects patients of all ages. Over the past ten years, prognosis has considerably improved due to advances in surgery and adjuvant therapy. Patients with prolonged survival (greater than 5 years) are more numerous, and may experience delayed complications secondary to adjuvant therapy. Microhemorrhages or cavernous angiomas are recognized complications seen during the follow-up of central nervous system tumors in pediatric patients, but have not been well described during the surveillance of gliomas in the adult population. Our goal was to study the prevalence of remote microhemorrhages and larger hematomas using susceptibility weighted imaging among patients treated for high grade gliomas.

Materials and Methods
A retrospective study was performed of 57 patients with high grade glioma who underwent MR imaging between January 2009 and December 2010. Of these, 51 (89%) patients had been
treated with stereotactic radiation therapy (60 Gray). Over the course of follow-up each patient underwent from 2 to 16 1.5T MRI examinations, which included a susceptibility weighted sequence. All patients were followed until March 2013 or until demise; the average follow-up period was 569 days. A total of 430 examinations were reviewed by a senior neuroradiologist. We studied the prevalence of microhemorrhages and larger hematomas distant to the original tumor site and their potential relationship with previous stereotactic radiation therapy.

Results
31 patients (54%) had developed remote microhemorrhages, with 13 patients (23%) having more than 10 lesions. 7 patients (12%) presented during the course of their follow-up with a remote hematoma or a typical cavernous angioma with signs of multiple hemorrhages on all sequences. The prevalence of microhemorrhage among patients with previous radiation therapy was 61%, versus 0% without previous radiation therapy (p=0.0139). The patients who developed remote microhemorrhage (Mean age 47.0 +/- 13.0 versus 59.4 +/- 14.4; p=0.001) and hematomas (Mean age 39.7 +/- 12.9 versus 54.4 +/- 14.3; p=0.01) were younger.

Conclusions
Microhemorrhages and hematomas at locations remote from the primary tumor are frequent complications seen during the follow-up of treated high grade gliomas, and appear to be more common among patients treated with radiation therapy.

KEYWORDS: Glioma, Hemorrhage, Radiation Effects
Role of Echo-Planar Gradient-Recalled Echo (EPI-GRE) in Acute Stroke Patients: A Comparative Analysis with Conventional GRE
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Purpose
To evaluate the feasibility of implementing an EPI-GRE sequence into an acute MR stroke protocol with potential improved image quality and reduction in scan time and to compare the results with conventional GRE images.

Materials and Methods
Fifty patients with clinical suspicion of acute stroke (30 Male, age range: 45-99 y/o) were prospectively evaluated using an acute stroke MR protocol, which included both conventional GRE and EPI-GRE on a 3T MR scanner (Skyra, Siemens). The EPI-GRE was performed using a gradient-EPI sequence (TR/TE: 1860/48 msec, FA 90°, matrix 192 mm, voxel size 1.7 x 1.7 x 3 mm³). Generalized autocalibrating partially parallel acquisitions (GRAPPA) with acceleration factor of 2 was integrated to both GRE and EPI-GRE. The image acquisition time was 52 seconds for EPI-GRE and 3 minutes for conventional GRE. The image quality in terms of motion and susceptibility related artifact was assessed on both GRE and EPI-GRE studies independently by two neuroradiologists. The presence of intracranial hemorrhage (ICH) and clot within proximal arteries were evaluated on both GRE and EPI-GRE in separate reading session. Noncontrast CT studies were available for all patients and used as the standard of reference for detection of acute hemorrhage.

Results
All (100%) of EPI-GRE and 82% of GRE images were rated of diagnostic image quality by both observers, with interobserver agreements of k = 0.871, 95% CI 0.71-0.94 for EPI-GRE and k = 0.79, 95% CI 0.57-0.91 for GRE. A total of 13 patients had acute ICH detected on both GRE and EPI-GRE (See figure), confirmed on non-contrast CT. Four petechial hemorrhages associated with acute infarction not seen on non-contrast CT were detected on both GRE and EPI-GRE. There was no false negative for acute ICH for GRE and EPI-GRE in comparison to CT. Chronic micro hemorrhages went undetected on CT identified by on GRE (n=11) and EPI-GRE (n=6). In one patient proximal arterial blood clot was identified by both GRE and EPI-GRE.

Conclusions
In patients with acute stroke, EPI-GRE is feasible for detection of acute ICH with comparable or better qualitative results to conventional GRE and results in reduction in acquisition time.

KEYWORDS: Echo Planar Imaging, Hemorrhage, Infarct
Semiautomated Segmentation Techniques in Glioblastoma Multiforme: Interobserver Reproducibility Based On Training Level

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Purpose
The rising potential of quantitative imaging metrics in neuroimaging has fueled a growing demand for reliable and efficient lesion segmentation techniques. To this end various automated algorithms have been developed, increasingly favored over manual segmentation for improved reproducibility and speed of implementation. Widespread adoption of these automated techniques will require a clear understanding of the generalizability and limits of such
technology. In this study we aim to identify these potential difficulties by comparing segmentation results between users of various training levels.

Materials and Methods
Participants of various training levels were recruited for this study including a first year (PGY-2) radiology resident, a third year (PGY-4) radiology resident and two CAQ attending neuroradiologists. Each participant subsequently utilized an in house proprietary semiautomated segmentation algorithm to identify enhancing tumor in 25 cases of glioblastoma multiforme (GBM) and peritumor FLAIR signal abnormality in 28 cases of GBM. The tumor dataset was obtained from the previously deidentified Cancer Genome Atlas (TCGA). Total segmented volumes were compared using a two-tailed t-test.

Results
No significant difference was demonstrated in FLAIR hyperintensity volumes identified by residents of all training levels compared to attending neuroradiologist (p = 0.21). In addition, no significant difference was demonstrated in enhancing GBM volumes identified by attending neuroradiologists (p = 0.33) or by senior resident (PGY-4) and attending neuroradiologist (p = 0.78). However, a significant difference was demonstrated in enhancing GBM volumes identified by the most junior resident (PGY-2) compared to attending neuroradiologist (p = 0.0071).

Conclusions
The identification of peritumor FLAIR signal abnormality was highly reproducible across all training levels. By contrast, the identification of enhancing tumor appeared to be experience dependent, where modest training made a significant difference in segmented volumes. Further work in this area may involve identification of specific tumor components that are commonly mislabeled by novice users, in an effort to both improve segmentation algorithms and facilitate education in this area.

KEYWORDS: Diagnostic Accuracy, Glioblastoma, Semiquantitative

EP-21
6:30AM - 9:00PM

Sphenoid wing capillary hemangioma presenting as sudden unilateral vision loss

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Purpose
Calvarial Hemangiomas are uncommon primary tumors of the bone comprising only 1% of primary bone tumors. Classic appearance has been described and these are recognized easily. However, rarely Calvarial Hemangioma can have atypical presentation, and these can be mistaken for other etiologies. Majority are slow growing and asymptomatic. The atypical tumors can mimic other lesions on imaging and can present with vague symptoms including vision loss depending on location.

Materials and Methods
MR imaging (MRI) details the pathologically proven right sphenoid wing hemangioma resulting in compression of the orbital apex. Additionally, a full clinical work up of the patient is
presented to explore the presenting symptoms. Detailed history, complete ophthalmologic exam, and biopsy for pathologic diagnosis are reviewed. Postsurgical clinical progress also are presented.

Results
MR imaging in a young female demonstrates an intraosseous lesion in the right sphenoid wing with resultant mass effect on the lateral orbital wall, specifically on the optic nerve apex. Sphenoid wing meningioma commonly has been described in the literature; however pathology obtained by neurological surgery confirmed capillary type hemangioma.

Conclusions
We describe an unusual case of a right sphenoid wing capillary hemangioma, a presentation commonly associated with sphenoid meningioma.

KEYWORDS: Hemangioma, Neoplasm, Temporal Bone

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EP-83

6:30AM - 9:00PM

Spontaneous Retroclival Subdural Hematoma: A Perimesencephalic Hemorrhage Variant
Purpose
To describe unusual presentation of retroclival subdural hematomas in patients with subarachnoid hemorrhage.

Materials and Methods
Over a two year period, we collected data on all patients with spontaneous retroclival subdural hematomas at our institution. Data included clinical history, laboratory results, treatment, and review of all imaging studies performed.

Results
Four patients were identified demonstrating unusual presentation of retroclival subdural hematoma in the absence of trauma or anticoagulation/anti-platelet effect. These patients also demonstrated subarachnoid and fourth ventricular blood. All patients underwent noncontrast CT, CT angiography of the head, MRI of the head and spine, and conventional catheter angiography. No anatomic or structural cause of subarachnoid hemorrhage was identified. No vascular lesions were identified. CT and MR imaging confirmed the location of the retroclival collection to the subdural space crossing the basioccipital synchondrosis. An average of 12 month follow-up post discharge from initial hospitalization revealed a benign natural history similar to angiogram negative perimesencephalic subtype subarachnoid hemorrhage.

Conclusions
Retroclival hematomas are rare with limited description, mostly a post-traumatic phenomenon. Spontaneous retroclival subdural hematomas in the absence of trauma has few descriptions in the literature [1-3]. None of the reported clinical descriptions describe patients with a combination of spontaneous retroclival and perimesencephalic subarachnoid hemorrhage. Nevertheless, despite extensive description of idiopathic or angiogram-negative subarachnoid hemorrhage, including sub-categories such as perimesencephalic subarachnoid hemorrhage, the relationship between perimesencephalic hemorrhage and spontaneous retroclival hemorrhage remain unexamined. We report the first series of four patients with combination of spontaneous retroclival subdural hematoma and idiopathic subarachnoid hemorrhage.

KEYWORDS: Clivus, SAH, Subdural Hemorrhage
Stroke in Stoke - An Early experience of more than 100 cases.

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Purpose
Endovascular treatments have the potential to accelerate reperfusion in acute ischaemic stroke with large vessel occlusion. In the UK only a few stroke centres offer this interventional option. The University Hospital of North Staffordshire (UHNS) has treated the largest number of cases in the UK. Endovascular treatment (EVT) is offered to Revascularize in cases of large vessel occlusion. We present our initial experience of more than 100 cases of mechanical thrombectomy. We also present the Recanalization rate, outcome at 01 week and 90 day. in addition we present our complication rate for the mechanical thrombectomy cases.

Materials and Methods
All patients treated with EVT (intra-arterial thrombolysis (IAT), mechanical thrombectomy (MT) or both, or an attempt at intervention) for acute stroke at UHNS, Stoke-on-Trent, UK, were entered into a prospective register. Baseline demographic and clinical data, the National Institutes for Health Stroke Scale (NIHSS), imaging results including Thrombolysis In Cerebral Infarction (TICI) score, and complications were recorded. Mortality, and modified Rankin score (mRS) were assessed at 90 days.

Results
From December 2009 to January 2013 106 patients (mean age 64 years, median baseline NIHSS 18) were treated with EVT (thrombectomy ± IAT 83%, IAT alone 13%, neither 4%). Seventy-eight per cent of occlusions were in the anterior circulation. Intravenous bridging thrombolysis was performed in 81%. Revascularization was successful (TICI 2b/3) in 84%. The median time from stroke onset to the end of the procedure was 6 h 03 min. A good outcome (mRS≤2) at 90 days was achieved in 48% with a mortality of 15%. Fatal or nonfatal symptomatic intracranial haemorrhage (sICH) within 10 days occurred in 9%. The median length of stay was 14 days (31% discharged home ≤7 days).

Conclusions
Our initial experience suggests that Endovascular recanalization is a relatively safe procedure with 1.4 relative risk of better outcomes than thrombolysis alone in large vessel occlusions. EVT led to good clinical outcomes in almost 50% of patients with severe strokes.

KEYWORDS: Infarct, Intraluminal Thrombus
Superior parietal lobule connections of the temporoparietal white matter pathways of the human brain. A high resolution diffusion tensor tractography.

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Purpose
Inferior parietal lobule connections of the language pathways such as the middle longitudinal fasciculus (MdLF) and temporoparietal connections of the superior longitudinal fasciculus (TP SLF) have been described in the literature. Extensive crossing fibers at the corona radiata at the level of the lateral ventricles as well as lack of adequate imaging sensitivity and spatial resolution, so far, impeded depiction of superior parietal lobule connections of the temporoparietal language pathways in prior diffusion tensor imaging (DTI) studies. This work aimed to explore the acuity and feasibility of visualization of white matter pathways connecting the temporal lobe with the superior parietal lobule using a high resolution diffusion tensor imaging and deterministic tractography approach.

Materials and Methods
Subjects: Five healthy men (age range 24-37 years) were studied and written informed consent was obtained from all subjects. Conventional and DTI Acquisition: Data were acquired using a Philips 3.0 T Intera system using a SENSE receive head coil. Diffusion-weighted image (DWI) data were acquired axially using a single-shot multi-slice 2-D spin-echo diffusion with the balanced Icosa21 tensor encoding scheme. The b-factor = 500 sec mm⁻², TR/TE = 14460/60 msec, FOV = 256 mm x 256 mm and slice thickness/gap/#slices = 1 mm / 0 mm / 120. The EPI phase encoding used a SENSE k-space undersampling factor of two, with an effective k-space matrix of 112x112 and an image matrix after zero-filling of 256x256. Fiber Tracking: We used the FACT algorithm (DTIStudio) to reconstruct the superior parietal lobule connections of the temporoparietal white matter pathways of the human brain with a fractional anisotropy (FA) threshold of 0.22 and angle threshold of 60 degrees. Statistical comparisons were made using analysis of variance (Student t-test) and the Mann-Whitney tests.

Results
Using higher resolution combined with higher magnetic field reduced the partial volume effects and incoherency within the voxel. This allowed us to trace the superior parietal lobule connections of the temporoparietal pathways and reveal more anatomical details of the temporoparietal language pathways. In our experience these superior parietal lobule connections of the temporoparietal fibers are not traceable using slice thickness ~ 3 mm. This is attributable to mixing of fibers in different orientations within the voxel leading to lack of adequate anisotropy in larger voxel volume which was solved by using thinner slices and smaller voxel volume.

Conclusions
In this report we demonstrate for the first time the feasibility of in vivo tracing the superior parietal lobule connections of the temporoparietal white matter pathways using high resolution diffusion tensor tractography.

KEYWORDS: Diffusion Tensor Image, Language, Language Cortex
The superior longitudinal fasciculus components illustrated on one healthy young adult using the DTT at 1mm, 2mm and 3mm axial sections.

A. 1mm (120 slices)

**EP-84**

6:30AM - 9:00PM

**SURGICAL TREATMENT OF BRAIN TUMORS WITH USING DT-TRACTOGRAPHY**

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Purpose
Diffusion-tensor MR tractography - a diagnostic method to visualize the orientation and integrity of the pathways of the brain in vivo. State of pathways in the depths of the brain may be estimated at present, while only using diffusion-tensor MR tractography. The purpose of the study Evaluation of the results of surgical treatment of brain tumors are supratentorial localization method using DT-tractography, accompanied by intraoperative monitoring.

Materials and Methods
We analyzed the results of treatment of 112 patients who were hospitalized at the Republican Scientific Center of Neurosurgery, Ministry of Health and operated under identical conditions.

Results
Of the patients operated on our core group of marked regression of neurological deficit to 46.9%,
which contributed to the leakage of the postoperative period without complications and improve quality of life and its duration. For the noninvasive and more complete removal of the tumor with maximum preservation of pathways, we used data mechanogram to visualize increase of the amplitude of muscle potentials and the appearance of sharp peaks in the motor tract irritation, allowing surgeons to more accurately determine the angle of attack, the amount of tumor resection. Surgery was performed under the control of intraoperative monitoring in the form mechanogram using needle electrodes in m.bicepsbrachi, m.quadricepsbrachi and m. quadricepsfemoris, installed with geterolateralnoy side. We used a computer system with software SYNAPSIS "Neyrotex", Russia.

Conclusions
1. Data Analysis MR tractography allows you to select the optimal surgical approach to tumors, to identify areas available for the removal and disposal to adequately perform the volume preserving FVZ and white matter pathways in the brain. 2. Removal of intracranial tumors under the control of intraoperative monitoring mechanogram using data from MRI tractography, intraoperative ensure accuracy and safety of surgery to minimize surgical trauma, helps reduce the risk of neurological deficit, which determines the efficiency of operations and good quality of life of patients. 3. The method of MR tractography can noninvasively visualize the pathways of white matter and assess the extent of their defeat in tumors of the cerebral hemispheres.

KEYWORDS: Stroke

EP-48

The Hyperdense Artery Sign: How Dense is too Dense?

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Purpose
To determine a threshold computed tomographic attenuation ratio that can be used to increase the specificity of the hyperdense artery sign in predicting thrombus in patients with acute stroke.

Materials and Methods
We retrospectively analyzed non-contrast enhanced CT scans of the brain in 33 patients presenting with acute non-hemorrhagic infarction who demonstrated a hyperdense artery sign. The images were axially acquired at a slice thickness of 2.5 mm. Using an ovoid region of interest, the average CT density (in Hounsfield units) of the hyperdense arterial segment was measured. Density measurements of the contralateral middle cerebral artery (MCA) and superior sagittal sinus were also measured. Patients were excluded if there was evidence of intracranial hemorrhage, lack of a hyperdense artery sign or a hyperdense segment limited to the distal MCA (M3/M4) branches. Similar measurements were performed in 30 randomly selected control patients presenting with non-stroke symptoms. In the majority of stroke patients CT angiography of the Circle of Willis, performed immediately following uninfused CT, was reviewed to confirm the presence or absence of thrombus. For the stroke patients who did not undergo CT angiography, follow up imaging that demonstrated evidence of an evolving infarct was used to confirm the suspicion of intraluminal thrombus. Attenuation ratios of the denser artery over the contralateral MCA as well as the denser artery over the superior sagittal sinus were calculated in
both cases and controls. Receiver operating curve (ROC) analysis was used to compare case and control data. All measurements were taken independently by two observers and inter-observer agreement was evaluated using Cohen's kappa analysis.

Results
The area under the curve for the ROC analysis of the attenuation ratio of the denser artery over the contralateral MCA was 0.97 while the area under the curve for the attenuation ratio of the denser artery over the superior sagittal sinus was 0.93. Based on these values, a ratio greater than 1.3 using the contralateral MCA and a ratio greater than 0.9 using the superior sagittal sinus, have a 97% specificity for predicting thrombus.

Conclusions
Attenuation ratios greater than 1.3 and 0.9 for the hyperdense artery over the contralateral MCA and superior sagittal sinus respectively, have a specificity of 97% in predicting thrombus in acute stroke.

KEYWORDS: Hyperdense MCA, Stroke

(Filename: TCT_EP-48_ROCcurvesupdated.jpg)

EP-86
6:30AM - 3:00PM
The significance of lactate peak that predicts grade in primary neuroepithelial tumor
H Nakamura1, M Doi2, M Hoshikawa3, Y Nakajima3, M Takagi3, Y Tanaka3, Y Yoshida1, T Suzuki3, M Uchida4

1St, Marianna University of Medicine, Kawasaki, Kanagawa, 2St. Marianna University of Medicine, Kawasaki, Kanagawa, 3St. Marianna University of Medicine, Kawasaki, Kanagawa, 4St, Marianna University of Medicine, Kawasaki, Kanagawa

Purpose
Lactate is seen due to the various causes. These include hyperglucose metabolism, the reduced clearance of the necrotic area, the hypoxic state because of the tumor outgrow with inadequate blood supply. It is said that lactate peak is not a useful maker in predicting tumor grade. This study is to examine the significance of the lactate peak in the judgment of the grade of the neuroepithelial tumor.

Materials and Methods
Fifty-five patients (grade 1 (3 cases), grade 2 (11 cases), grade 3 (15 cases), grade 4 (26 cases)) with a pathological diagnosis of neuroepithelial tumors were enrolled. The biopsy cases were excluded. The magnetic resonance spectroscopy (MRS) was acquired using a 1.5T clinical scanner (Gyroscan, Intera, Philips Medical systems, Netherlands). Point-resolved spectroscopy (PRESS) (TR, 2000ms, TE, 144 ms, 128 acquisitions) spectra were acquired. The voxel was positioned at the solid tumor area avoiding the cysts. The size was 1.5×1.5×1.5 cm3. As controls for quantification, a voxel was also placed contralaterally or in a remote area. The lactate peak was defined as downward peak around 1.3ppm, whereas the lipid peak was upward. For the reference, lactate peak height / normal Creatine ratio was used (concurrent lipid cases were excluded)

Results
Results 1) The frequency of lactate is seen (Table1) Grade 2 is statistically different. 2) The frequency of lipid is grade 1 and 2( 0%), grade 3 (8.3%), grade 4 (44%). Grade 4 is statistically different among grades. 3) The height of lactate is not significantly different between grades.

Conclusions
When lactate peak is seen, we can consider grade1, 3 or 4 except 2. The etiology producing lactate peak is different between grade 1 and 3, 4. Grade 1 is due to hypermetabolism of glucose and grade 3 or 4 is due to the hypoxic state because of the tumor outgrow. In differentiating between 3 and 4, lipid peak may make us consider grade 4. Because grade 1 has a characteristic finding pathologically and radiologically, it is important to judge the routine imaging findings not to confuse with lactate peak. In conclusion, when we see the lactate peak, first of all we see the routine imaging findings to judge if the tumor is grade1 or not and secondary when we are unable to see the lipid peak, the grade 3 is more likely.

KEYWORDS: Glioma, Lactate
This calcification wasn’t supposed to be here! Series of 6 cases of intracranial calcified emboli

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Purpose
Calcified cerebral emboli is a rare disease and the literature on the subject is scarce. As far as we know, there is no series with more than four cases reported, and the prevalence in stroke patients has not been estimated yet. They can occur due to embolization from distant source, most commonly associated with aortic valve calcification, surgical manipulation of the carotid or even spontaneous and without a known source. In this poster we describe key findings that help neuroradiologist distinguishing calcified embolus from other physiological intracranial extra-axial calcifications, a usual finding on head CT.

Materials and Methods
Retrospective analysis of database in the past six years.

Results
We present six cases of patients attending our hospital in the last six years with acute neurological complaints, showing calcium foci in the subarachnoid space, matching the topography of cerebral arteries, some of them demonstrating areas of restricted diffusion in the correspondent arterial territories, documented through CT scans, MRI. These patients had performed brain exams shortly before with no evidence of calcification at the same area allowing the diagnosis of recent calcified emboli.

Conclusions
The finding of a calcium foci in cerebral circulation may explain acute neurological symptoms and help in the diagnosis of stroke. It is important to define the presence of calcium in the acute emboli, given that the approach to be taken by the attending physician as the indication of mechanical or chemical thrombolysis in these cases is still controversial. Calcified emboli should conduct prompt evaluation of carotid, aortic arch and heart for the most common sources of embolization. Although calcified emboli is a rare condition it is important to be familiarized with the imaging findings. They can be missed easily or mistaken by other benign intracranial calcifications, and the treatment of these cases is still controversial.

KEYWORDS: Calcifications, Emboli, Stroke

EP-51

Thrombolysis in Real-Time: Imaging Evidence of Early Arterial Recanalization During Administration of Intravenous Alteplase in the CT Scanner

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Purpose
The aim of this study was to demonstrate imaging findings of early recanalization. The imaging protocol for acute ischemic stroke at our institution includes noncontrast CT, followed by perfusion CT at two levels, and then CTA of the head and neck. Patients at our institution presenting with acute ischemic stroke are currently receiving intravenous recombinant tissue plasminogen activator (rt-PA) in the CT scanner. They may receive the rt-PA immediately after the noncontrast CT or immediately after the perfusion CT. This presents a unique circumstance whereby we can visualize recanalization in real time between different phases of imaging.
Materials and Methods
25 consecutive patients with signs and symptoms of acute ischemic stroke who received rt-pa on the CT scanner were included. The CT imaging at initial presentation was reviewed. Follow-up imaging performed within one week of initial presentation was also reviewed.

Results
Of the 25 patients, seven demonstrated evidence of early recanalization. Of these 7, three demonstrated early recanalization on the initial CT, and four demonstrated recanalization on follow-up imaging. In one patient, hyperdense clot was seen in the left M1 segment on noncontrast CT. CTA performed after rt -PA administration demonstrates distal migration of thrombus, into the left M2 segment. In another patient, noncontrast CT demonstrate hyperdense thrombus at the left M1-M2 junction. CTA performed after rt-PA administration demonstrates no narrowing or occlusion in the left middle cerebral artery (MCA) territory. A third patient who presented with acute left MCA syndrome demonstrates evidence of reperfusion on perfusion imaging, with diminished mean transit time, elevated cerebral blood flow, and elevated cerebral blood volume in the left MCA territory.

Conclusions
Intravenous rt-PA takes immediate effect in some patients, allowing us to see thrombolysis in real time. Some of the findings of early recanalization include decreased attenuation of thrombus, distal migration of clot, and elevated cerebral blood flow on perfusion CT. We will do further work to evaluate the incidence of early recanalization in patients who did not receive rt-PA.

KEYWORDS: Recanalization, Reperfusion Therapy, Stroke

EP-65
6:30AM - 9:00PM

Transverse Sinus Stenting for Pseudotumor Cerebri: 6-Month Follow-Up 320 CT Venography in 21 Patients

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1The Johns Hopkins Hospital, Baltimore, MD, 2Hôpital de Sion, Réseau Santé Valais, Sion, Switzerland, 3The Johns Hopkins University School of Medicine, Baltimore, MD

Purpose
Dural sinus stenting has recently emerged as a new treatment modality for patients with pseudotumor cerebri (PTC) caused by an underlying transverse sinus stenosis. However, stent patency in dural sinuses is not well documented. The purpose of this report was to evaluate the anatomic result of transverse sinus stenting at 6 months using 320 subtracted CT venography (CTV).

Materials and Methods
33 patients were treated with venous sinus stenting for underlying stenoses in the setting of PTC. All patients had exhausted conventional medical management and had progressive visual impairment. Six-month follow-up CTV was available in 21 of these patients. CTV was obtained with a standard protocol, including images in the native (Fig. 1A) and subtracted (Fig. 1B).
modes, with multiplanar reconstructions using a 320-row detector CT scanner (Aquilion One, Toshiba, Japan). The studies were retrospectively reviewed by two neuroradiologists.

Results
All 21 patients with 6-month follow up CTV had fully patent stents (100%), without evidence of neointimal hyperplasia or in-stent restenosis. Stent sizing was initially based upon maximal sinus diameter measurement. Two patients in that group developed new stenoses proximal to the patent stent, a phenomenon, which was believed to be secondary to deformation of the sinus by oversizing of the stent. All subsequent procedures were performed with smaller stents (5 or 6mm x 40 mm), without evidence of newly developed stenoses. 320 CTV images proved adequate to evaluate the stent integrity (native images) as well as the stent patency (subtracted images).

Conclusions
Venous sinus stenting is an effective and clinically durable modality for the treatment of PTC in an appropriately selected patient population. 320 subtracted CTV provides a high quality, noninvasive imaging method for the assessment of stent integrity and patency. At the 6-month follow-up evaluation, all the imaged stents were patent, without evidence of in-stent stenosis.

KEYWORDS: Endovascular Therapy, Pseudotumor Cerebrii, Venous Sinus Stenting
Usefulness of acute stroke imaging with wide area detector CT before endovascular reperfusion therapy in the anterior cerebral circulation

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Purpose
Background and purpose: The wide area detector CT (ADCT) enables volume scanning (VS) for the whole brain and can provide whole brain CT perfusion (CTP) and dynamic vascular analysis (3D/4D-CTA) in one examination. Whole brain 4D-CTA can dynamically display the affected
cerebral artery, other cerebral arteries and intracranial arterial communication like digital subtraction angiography (DSA). Therefore, 4D-CTA may allow us to perform reperfusion therapy directly to the target vessel without diagnostic whole brain angiography. The aim of this study was to investigate the usefulness of ADCT before endovascular reperfusion therapy in the anterior cerebral circulation (ACC).

Materials and Methods
Included in our retrospective analysis were patients 1) who were transferred to our institution from November 2010 to November 2013, 2) who underwent ADCT (Aquilion ONE, Toshiba) before endovascular reperfusion therapy (ERT) and 3) who underwent ERT for the affected artery in the ACC within 8 hours of the onset. Acute imaging protocol for stroke diagnosis and reperfusion therapy consists of pre-contrast CT and subsequent MRI set (DWI, MRA, T2WI, T2*WI) and subsequently helical 3D-CTA from the aorta to the distal neck arteries and whole brain VS for 3D-,4D-CTA and CTP. Each volume consisted of 160 images of 1-mm thickness with z-axis coverage of 16-cm. Evaluated were onset-to-puncture time (OPT), door-to-puncture time (DPT) and successful ERT. Successful ERT was defined as TICI of 2b or 3.

Results
During the study period, 17 patients matched to our inclusive criteria. Aortocervical 3D-CTA helped endovascular therapists to decide which approach was suitable to patients, transfemoral or transbrachial. Intracranial 4D-CTA gave them useful information to perform a direct access to the target artery without diagnostic whole brain angiography. Median OPT and DPT were 3.5 and 2.1 hours, respectively. Successful ERT rate was 76% (14/17).

Conclusions
Our acute stroke imaging protocol using ADCT can provide endovascular therapists with useful information rapidly just before ERT in acute stroke setting.

KEYWORDS: CT And Stroke, CT Angiogram, CT Brain Perfusion

**EP-82**

**Utility of Gadoxetate Disodium as a Craniospinal and MR angiographic Contrast Agent: Preliminary Experience**

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Purpose
Nephrogenic systemic fibrosis (NSF) is a rare, but potentially debilitating condition in patients with renal insufficiency who receive intravenous gadolinium-based contrast agents (GBCA's), particularly in FDA-approved Group 1 "non-ionic linear" agents (gadodiamide, gadopentetate dimeglumine, and gadoversetamide). As of yet, there have been no cases of NSF reported in the newly approved Group 3 agents including gadofosveset and gadoxetate disodium (aka Eovist, Bayer Healthcare Pharmaceuticals). Gadoxetate disodium is the only FDA-approved GBCA with a 50-50% renal-biliary excretion, and has the highest thermodynamic and conditional stability and has been utilized extensively for body imaging, but not well studied with regards to
neuroimaging. A prior study showed that gadoxetate disodium adequately depicts normal enhancing structures that lack a blood-brain barrier, as well as vasculature (1). The purpose of our study was to preliminarily evaluate the utility of gadoxetate disodium as a craniospinal and MR angiographic contrast agent in imaging abnormalities.

Materials and Methods

IRB approval was obtained. Over a 3 year period, intravenous gadoxetate disodium was administered in 24 patients in whom enhanced neuroimaging was a medical necessity since the use of routinely administered group 1 agents was contraindicated due to renal dysfunction or sensitivity to other gadolinium agents. Patient consent was obtained in those with a GFR of <30. A 10cc dosage (one half of the recommended maximum dosage utilized in body imaging) was administered intravenously and imaging was performed after a 5 minute delay. A review of imaging studies of these patients was performed by 3 neuroradiologists, with respect to detection of pathology, which included brain MRI (n=21), skull base/neck MRI (n=4), head/neck MRA (n=3), head MRV (n=1) and spine imaging (n=4); notably, several patients had more than one of the aforementioned regions evaluated. The studies were performed on both 1.5T (n=13) and 3T (n=11) magnets with spin echo (n=13) and gradient echo (n=11) T1WI's, and dynamic CEMRA (n=4).

Results

The mean age of the 24 patients was 63.5 years (range 29-85 years). The GFR range of the patients with renal impairment was 10-48 (mean=31.1, SD=±8.8 ; n=22). The indications for contrast and the corresponding findings in patients were as follows: 2 patients with normal renal function with sensitivity to other GBCA's (negative for metastatic disease), 9 patients with systemic malignancy (7 were negative and 2 positive for metastatic disease), 6 patients for stroke (5 were negative, with one patient having pontine myelinolysis, and one with a meningioma), 1 patient for 6th nerve palsy (negative), 2 with severe headache (one with glioblastoma, the other with pseudotumor cerebri), 1 with pharyngitis (phlegmon without abscess), and 1 for vertigo (>80% stenosis of the internal carotid on MRA). Regarding the 4 patients with spine imaging, all 4 were positive, one having a meningioma causing severe cord edema, two patients with bone metastases to the spine, and one with osteomyelitis from an adjacent large peritonsillar abscess.

Conclusions

Gadoxetate disodium, at one-half of the dose utilized in body imaging, may serve as an alternative contrast agent for craniospinal and angiographic MR imaging, especially in patients with moderate-severe renal impairment. The risk of NSF may be decreased, although this needs to be proven prospectively. This preliminary study, and our prior study (1), demonstrate that abnormalities of the blood-brain barrier, vasculature, and spine can be adequately depicted.

KEYWORDS: Brain Abnormalities, Contrast Agents
EP-90
6:30AM - 3:00PM

Utility of of follow-up imaging in Isolated Perimesencephalic Subarachnoid Hemorrhage

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Purpose
To determine the utility of follow-up imaging in isolated perimesencephalic subarachnoid hemorrhage as assessed on initial CTA.

Materials and Methods
Retrospective review of patients with perimesencephalic hemorrhage was performed over the last 5 years in our large academic center. Search was performed through the radiology database for the words "perimesencephalic hemorrhage" at a single, large academic institution for cases in the past five years, after obtaining IRB approval. Perimesencephalic subarachnoid hemorrhage
was defined as hemorrhage centered in the anterior mesencephalon without greater than trace blood in the interhemispheric and/or proximal Sylvian fissures. Studies were excluded if there was a history of trauma or imaging findings showed extensive/diffuse subarachnoid hemorrhage. The keyword search resulted in 213 CTAs. All studies were retrospectively reviewed by a Neuroradiology fellow and a CAQ certified Neuroradiologist with over 5 years experience. 17 patients met the inclusion criteria. Patients ranged in age from 26 to 75 years (mean 50.4, SD 12.6) with 10 men and 7 women. Number of follow-up imaging studies, including CT/CTAs, MRI/MRAs, DSAs, and transcranial dopplers, were tabulated.

Results

17 patients with isolated perimesencephalic subarachnoid hemorrhage were identified on initial non contrast CT with negative initial CTA. Of these 17 patients, follow-up imaging was obtained in 15 patients. All follow-up studies including CTAs, MRI/MRAs, and DSAs were negative in all patients. There were a total of 41 follow-up CT/CTAs, 40 MRI/MRAs, and 15 DSAs, resulting in an average of 2.41 CT/CTAs, 2.35 MRI/MRAs, and 0.88 DSAs per patient. A total of 15 follow-up transcranial dopplers were performed, which showed unexplained left MCA vasospasm in three patients, with all spontaneously resolving without intervention.

Conclusions

Imaging follow-up in patients who meet the strict radiographic criteria for isolated perimesencephalic subarachnoid hemorrhage with no source identified on initial CTA has been described as unnecessary in a previously published study from two large academic centers of 28 patients that showed completely negative DSAs and other follow-up imaging (Agid et al AJNR 31: 696-705). The authors concluded that DSA and subsequent imaging is not needed in these patients. We retrospectively reviewed patients with perimesencephalic hemorrhage at our institution over the last 5 years to determine efficacy of follow up imaging in patients who meet strict radiographic criteria on initial CTA. All 15 patients in our study had multiple negative follow-up imaging studies. Our data further supports that follow-up imaging is not necessary if the initial CTA is negative when strict radiographic criteria for isolated perimesencephalic subarachnoid hemorrhage are being followed. Interobserver and Intraobserver disagreement in CT Characterization of Nonaneurysmal perimesencephalic SAH has been reported (Brinjikji et al AJNR 31:1103-05.) However, the disagreement was all in cases which were called as not being NAPH (nonaneurysmal perimesencephalic hemorrhage). There was complete agreement in cases which met strict radiographic criteria of NAPH. We hope this will stimulate a debate and challenge the practise pattern in these subgroup of patients.

KEYWORDS: SAH

EP-53

Utility of whole-brain 4D-CTA using a 320-detector row CT scanner in the evaluation of cerebral arteriovenous malformations

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Purpose

Higher Spetzler-Martin grade (SMG) cerebral arteriovenous malformations (cAVMs) are known
to be associated with more severe postoperative deficits and poorer clinical outcomes. Recently, the 320-detector row CT scanner has offered a new and promising method in the diagnosis of patients with cardiovascular disease, but few reports concerning cerebrovascular disease have been described. The purpose of this retrospective study was to investigate the utility of whole-brain four-dimensional computed tomography angiography (4D-CTA) for evaluating cAVMs compared with cerebral angiography (CAG) as the gold standard reference.

Materials and Methods
Patients with cAVMs who underwent both 4D-CTA and CAG during hospitalization from November 2010 to October 2013 were enrolled. AVM detection rate, diagnostic quality, and SMG were investigated. Each component of the AVM (feeders, nidi, drainers) was scored using a 4-point grading scale (excellent=3, good=2, fair=1, poor=0). Two experienced neuroradiologists evaluated the examinations dependently and reached a final diagnosis by consensus.

Results
During the study period, 20 consecutive patients met our criteria (16 men, 4 women; mean age, 59.0 ± 17.9 years; range, 26–84 years). The 4D-CTA was able to detect all AVMs. Average scores for feeders, nidi, and drainers were 2.2, 2.4, and 2.5 on 4D-CTA and 2.5, 2.5, and 2.6 on CAG (P<.005), respectively. Visibilities of small cAVMs were slightly but not significantly lower with 4D-CTA than with CAG. AVM scores of all components assessed using 4D-CTA showed good interobserver agreement (kappa values ranging from 0.68 to 0.80). Median SMG score was 2.0 for both, and results from both modalities were in complete accord.

Conclusions
Although 4D-CTA shows limitations in terms of lower temporal and spatial resolution, 4D-CTA using 320-detector row CT showed complete agreement with CAG in terms of SMG and thus appears reliable for evaluating cAVMs.

KEYWORDS: Arteriovenous Malformation, CT Angiogram
Utilizing Dual Energy CT to Improve CT Diagnosis of Posterior Fossa Ischemia

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Purpose
Noncontrast head CT sensitivity to posterior fossa infarcts is notoriously limited because of artifacts from the petrous temporal bones and dental amalgam. The goal of this study was to determine if virtual monochromatic images reconstructed from dual energy head CT would improve image quality and the detection of posterior fossa infarcts compared to standard polychromatic CT.

Materials and Methods
30 consecutive patients were retrospectively identified during the time period from March through October of 2012 who presented with symptoms suggestive of a possible posterior fossa infarct and received unenhanced head CTs on a single scanner and a brain MRI within 24 hours of the head CT as part of their standard of care. The MRI DWI findings were used as reference standard for the presence or absence of infarct. Monochromatic images were reconstructed from the routine noncontrast head CT studies at 60, 80, 100, 120 keV and the original polychromatic CT were interpreted independently by two blinded radiologists for the presence and location of infarct and for the image quality (overall effects from artifacts, homogeneity of the pons, and ability to see the cerebellar folia, the vermis, and the basilar artery quantified on a Likert scale). Statistical analysis was then performed using McNemar test and GEE logistic regression.

Results
Sensitivity, specificity, negative and positive predictive, and accuracy values of the monochromatic and standard CT datasets are presented in the attached table. No p-values for these metrics measured <0.05, but there was a trend toward significance at 100 keV for specificity (p=0.096) and a marginal trend toward significance at 80 keV for sensitivity (p=0.157). Overall effects from artifacts were significantly improved at 80, 100, and 120 keV (p<0.001, p=0.001, and p=0.027), homogeneity of the pons was significantly greater at 80 and 100 keV (p<0.001 for both), and the ability to see the basilar artery was significantly improved at 80 and 100 keV (p=0.004 and 0.02). The sum of all the quality metrics and also a more homogenous pons were significantly associated with a higher rate of detection of posterior fossa infarcts (p=0.022 and 0.015).

Conclusions
Virtual monochromatic head CT reconstruction at 80 and 100 keV significantly reduces artifacts and increases the perceived quality of the posterior fossa on head CT. A higher perceived quality is associated with a higher detection of posterior fossa infarcts. There is a trend toward higher specificity with monochromatic reconstructions at 100 keV and a less significant trend toward an increase in sensitivity at 80 keV. However, a negative 80 or 100 keV monochromatic head CT still warrants obtaining a brain MRI if clinical suspicion for posterior fossa ischemia is sufficient.

KEYWORDS: Dual-Energy CT, Posterior Fossa, Stroke

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<th>Polychromatic CT</th>
<th>60 keV</th>
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CT Reconstruction methods versus MRI as the reference standard with respect to posterior fossa infarcts (95% confidence intervals in brackets).

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<th>Polychromatic CT</th>
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<th>80 keV</th>
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<td>[40.7-82.8]</td>
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EP-05

**Value of Noncontrast Time-resolved MR Angiography Using Arterial Spin Labeling in the Diagnosis of Moyamoya Disease**

K Tsuchiya¹, M Gomyo², A Ohara²

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**Purpose**

Our purpose was to assess the value of noncontrast time-resolved MR angiography developed based on the arterial spin labeling technique in the evaluation of the hemodynamic status of moyamoya disease.

**Materials and Methods**

The study group comprised a total of 20 patients (6 men and 14 women; age range, 15-76 years; mean age, 51.6 years) with established diagnosis of moyamoya disease by conventional digital subtraction angiography (DSA). Among them, 10 patients were in the status of post bypass surgery. Noncontrast time-resolved MR angiography was performed on a 3 T system using a 3D fast field-echo sequence with parameters as follows: TR/TE/FA, 4.5 ms/2.1 ms/15 deg; FOV, 230×256 mm; imaging matrix, 256×256; slab thickness, 96 mm; and section thickness, 3 mm. As to magnetically label the blood as a tracer, we placed a tag pulse band of 200 mm thickness inferior to the scan slab placing an interval of 17 mm. No cardiac or peripheral pulse gating was used. Changing a labeling delay time by 300-500 ms, we performed 3-5 scans in the axial plane. Visual assessment regarding the visualization of the steno-occlusive lesion and collateral vessels was performed comparing with 3D time-of-flight (TOF) MR angiograms in all patients using a four-point grading system. Comparison also was done with DSA in 12 patients and brain perfusion single photon emission tomography (SPECT) in 17 patients.

**Results**

Noncontrast time-resolved MR angiography better depicted the steno-occlusive lesion and collateral vessels than 3D-TOF MR angiography in 16 patients (80%) achieving a better result in the assessment by scoring (Wilcoxon rank-sum test, P<0.01). Its findings were comparable with digital subtraction angiography in all of the 12 patients and with SPECT in 14 of the 17 patients.
Conclusions
In assessing the hemodynamic status of occlusive diseases of the major intracranial arteries, noncontrast time-resolved MR angiography by using the arterial spin labeling technique is superior to 3D TOF MR angiography, while it is equivalent to conventional digital subtraction angiography and SPECT.

KEYWORDS: Moyamoya, MRA Techniques

(Filename: TCT_EP-05_moyaASLMRA.jpg)

EP-23
6:30AM - 9:00PM

Value of the contrast material in the CT diagnosis of carotid artery dissection

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Purpose
The purpose of this work was to evaluate if the use of contrast material in the MDCTA study of carotid artery dissection (CAD) modify the diagnostic performance.

Materials and Methods
One hundred patients (61 men, 39 women; mean age, 51 years; range, 25 – 78 years) 40 with and 60 without CAD, that underwent MDCTA for suspected CAD formed the study cohort. In this study patients from three different groups were included (patients with MR confirmation of CAD, n = 40; patients with MR confirmation of CAD absence, n = 20; patients that underwent MDCTA of carotid arteries for atherosclerosis analysis, n = 40). Three blinded observers with different level of expertise analyzed the randomized basal scan and after three months the observers evaluated the same datasets by using basal scans (BS) and after administration of
Results
The ROC curve analysis showed that for the three observers the use of BS versus BS and CM produced an improvement of the diagnostic confidence with AUC values from 0.894 to 0.926 (p value = 0.91); from 0.856 to 0.879 (p value = 0.365); and from 0.819 to 0.982 (p value = 0.01). The Cohen kappa analysis showed no significant difference in concordance with the use of BS versus BS and CM. The prevalence of uncertain findings was in 16%, 20.5% and 33% in the BS and 15%, 17.5% and 29% in BS and CM for observer one, two and three respectively.

Conclusions
Results of our study suggest that the use of BS instead the classic BS and CM determines a small reduction in the diagnostic confidence of the readers, that is statistically significant in only the junior one. Therefore the use of the only BS in the suspect of CAD may help in reducing cost and risk related to the administration of contrast material.

KEYWORDS: Carotid Dissection
Visual Deficits and Pituitary Adenomas: The Myth of Bitemporal Hemianopia

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Purpose
Our goals in this project were to test the hypothesis that bitemporal hemianopsia is the most common visual field deficit in patients with pituitary adenomas, to assess the degree of optic chiasm compression necessary to produce such a deficit, and to determine the frequency by which asymmetric visual deficits are associated with pituitary adenomas that impact the pre-chiasmal optic nerves or post-chiasmal optic tracts.

Materials and Methods
We retrospectively reviewed the imaging findings and medical records of 86 consecutive patients with pathologically proven pituitary macroadenoma or presumed pituitary macroadenoma between September 2009 and October 2012. We reviewed the clinical findings and ophthalmologic records which included documentation of visual field defects, reported vision disturbances by the patient, visual evoked potentials and optical coherence tomography in all patients. We evaluated the degree of displacement of pre-chiasmal optic nerve, optic chiasm, and post-chiasmal optic tract with sellar, suprasellar and parasellar masses attributed to pituitary macroadenoma in all patients. We also evaluated the degree of optic pathway displacement from the unaffected side or expected normal location, the changes on T2 or FLAIR signal intensity, atrophy or enhancement anywhere along the optic pathway, and the presence of hemorrhage in the masses. We correlated the clinical findings with these MR imaging findings.

Results
Patient's symptoms ranged from nonspecific ocular symptoms to bitemporal hemianopsia. 56 patients had no visual symptoms. Bitemporal hemianopsia (n=21) was the most common symptom, followed by unilateral temporal defect (n=2), homonymous hemianopsia (n=2), and miscellaneous (n=5). The relationship between the masses and optic chiasm showed compression (n=18), elevation (n=27), and no contact (n=41). Although 5 patients with chiasmal compression showed visual symptoms and 3 patients with chiasmal elevation did not show any visual symptoms, most ocular symptoms were caused by chiasmal elevation due to masses. The displacement of the optic pathway by the mass ranged from 0.2 cm to 1 cm. There was atrophy of optic chiasm in 3 cases and hemorrhage in the mass in ten. We did not find any signal change on T2WI or enhancement along the optic pathway compromised by the pituitary adenoma.

Conclusions
As our hypothesis, the bitemporal hemianopsia is the most common visual field deficit in patients with pituitary macroadenoma. The smallest displacement to produce such a deficit was 4 mm in the patients with chiasmal elevation.

KEYWORDS: Optic Chiasm, Pituitary Adenoma, Visual Pathways
Visualization of carotid artery stenosis using 3D fast spin-echo T1 black blood imaging techniques with and without improved motion-sensitized driven-equilibrium (iMSDE): preliminary experience

M Maeda\(^1\), M Umino\(^1\), H Sakuma\(^1\)
\(^1\)Mie University School of Medicine, Tsu, Japan

Purpose

Recently, 3D fast spin-echo (FSE) T1 black blood imaging (BBI) has become available, allowing full coverage of cervical carotid arteries with high spatial resolution and multiplanar reformation. Despite its inherent flow-void capability, 3D FSE T1BBI might exhibit plaque-mimicking artifacts because of insufficient blood suppression at the carotid bifurcation. Consequently, further improvement in blood signal suppression is desired for 3D FSE T1BBI. To improve blood suppression, several reports have been proposed and described, such as flow-dephasing BBI with improved motion-sensitized driven-equilibrium (iMSDE). However, its efficiency has not been studied sufficiently in patients with cervical carotid stenosis in a clinical setting. This study was designed to compare 3D FSE T1BBI with iMSDE prepared 3D FSE T1BBI for the evaluation of carotid artery stenosis.

Materials and Methods

Twenty-eight patients (mean 75 years; 22 men, 6 women) with cervical carotid artery stenosis were studied consecutively. 3D FSE T1BBI sequences with and without iMSDE were performed using 3 T MRI (Achieva, Quasar Dual; Philips) with a 16 channel NV array coil. The respective voxel sizes and scanning times for 3D FSE T1BBI and iMSDE were 0.9 × 0.9 × 0.9 mm and 0.93 × 0.93 × 1 mm, 3 min and 48 s and 4 min and 7 s. Visual assessment was made of the two sequence images by two radiologists in consensus. Blood signal suppression was rated for opposite normal vessels as well as stenotic vessels using four-point scoring where 4 = no artifact, 3 = partial or mild artifact, 2 = substantial artifact, and 1 = impossible to differentiate between the lumen and wall because of the flow artifact. Signal ratios of the plaque to the sternocleidomastoid muscle were obtained for quantitative analyses.

Results

Four vessels were excluded from this study because of post-carotid stenting vessels. Visual assessment showed that assigned scores were significantly higher for iMSDE prepared 3D FSE T1BBI than those for 3D FSE T1BBI (3.35 +/- 0.65 vs. 3.06 +/- 0.66, p=0.018). The 3D FSE T1BBI prepared with iMSDE was particularly effective for the visualization of ulcer plaque caused by blood signal suppression (Figure 1). However, 3D FSE T1BBI prepared with iMSDE showed blurring of images in seven vessels, which degraded the vessel wall visualization. Signal ratios were obtained from 22 vessels with plaque. The values were not significantly different between the two sequences (1.7 +/- 0.58 and 1.81 +/- 0.81, p=0.19).

Conclusions

Our preliminary results suggest that 3D FSE T1BBI prepared with iMSDE improves blood signal suppression, yielding better visualization of plaque morphology. This result was also true for a normal carotid artery, improving the interpretation of carotid plaque. However, blurring of images occasionally was apparent in 3D FSE T1BBI prepared with iMSDE, which can present difficulties. Further investigations should be conducted with more clinical cases.

KEYWORDS: Black-Blood Technique, Plaque Imaging
EP-93

6:30AM - 3:00PM

Visualization of Cerebrospinal Fluid Dynamics in the Response to Driving Force by Arterial Spin labeling Real Time Imaging.

S Yamada¹, S Matsumoto², M Miyazaki³, T Yamaoto⁴, M YUi⁴, T Shiodera⁵, T Takeguchi⁵
¹Toshiba Rinkan Hospital, Sagamihara, Kanagawa, ²Sales Division, Otawara, Tochigi, ³Toshiba Medical Research Institute, Vernon Hills, IL, ⁴Toshiba Medical Systems Corporation, Otawara, Tochigi, ⁵Toshiba Corporation, Kawasaki, Japan
Purpose
CSF movement associated with cardiac pulsation and respiration can be seen in the external ventricular drainage tube as well as during neurosurgical operation. Purpose of this study is visualized CSF movement in the response to cardiac pulsation, respiration and head inertia in undisturbed normal physiological condition using an MRI time spatial labeling inversion pulse (Time-SLIP) technique with single-shot fast spin echo (SS FSE) and real time balanced steady-state free precession (bSSFP) imaging.

Materials and Methods
A series of 2D images with incremental inversion recovery times were acquired by 1.5T MRI scanner using Time-SLIP sequence with SS FSE and bSSFP real time imaging. The bSSFP scanning conditions were FOV = 24.0 x 26.3 cm, matrix = 64 x 192, slice thickness = 7 mm, TR/TE = 4.2/2.1, FA = 90, initial inversion time (TI) = 0.6 s and TI step = 0.101 s. All images were acquired on normal volunteers using a head coil. Volunteers were asked to hold breath (cardiac pulsation), to deep breath (deep inspiration and expiration) and to move head (inertia) during the examination.

Results
Real time CSF dynamics were observed using the MRI Time-SLIP sequence with FSE and bSSFP. Cerebrospinal fluid dynamics in response to CSF driving force were demonstrated using MRI Time-SLIP with FSE and real time bSSFP imaging technique.

Conclusions
Significant amount CSF was moved by cardiac pulsation, respiration and head inertia.

KEYWORDS: Arterial Spin-Labeling, Cerebrospinal Fluid

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Poster - Anatomy
EP-99

6:30AM - 9:00PM

Age- and disease-related changes in signal intensity in the superior cerebellar peduncles on 3 dimensional T2-weighted FLAIR

K Toyoda¹, H Oba¹, J Kotoku², T Kanda¹, M Osawa¹, R Hiraoka¹, S Furui¹
¹Teikyo University School of Medicine, Tokyo, Japan, ²Teikyo University, Tokyo, Japan

Purpose
In the three-dimensional T2-weighted fluid-attenuated inversion recovery (3D T2 FLAIR) technique, contrast imaging of the normal brain stem demonstrates higher signal intensity in the superior cerebellar peduncles, decussation of the superior cerebellar peduncles, middle cerebellar peduncle, and corticospinal and central tegmental tracts compared with surrounding regions, and it displays greater contrast than 2D FLAIR or 2D T2-weighted images. The present study investigated whether signal intensity in the region from the superior cerebellar peduncles to the decussation of the superior cerebellar peduncles increases with age in subjects who had no lesion
of the brain stem nor cerebellum, as well as signal intensity changes associated with progressive supranuclear palsy and multiple system atrophy.

Materials and Methods
3D T2 FLAIR images from 305 subjects with a normal brain stem and cerebellum were reviewed retrospectively. Using a 3 T MR imaging (MRI) unit, the imaging protocol was as follows: 8000/105/2260 (TR/TE/TI); ETL, 140 or 150; slice thickness, 1.4 mm; matrix, 256 × 244; and NEX, 1. Signal intensity in the superior cerebellar peduncles was evaluated visually and classified into the following three categories: grade 0, no high signal intensity; grade I, high signal intensity in comparison with surrounding white matter (pons, cerebellum); and grade II, fan-shaped distribution of high intensity covering the brainstem tegmentum. Three hundred five subjects were grouped based on age as follows: 0–29 years (n=40), 30–49 years (n=50), 50–59 years (n=50), 60–69 years (n=60), 70–79 years (n=65), and 80 years (n=40). Significant differences among the age groups were investigated based on the comparative incidence of grades 0–II. Grades of signal intensity in the superior cerebellar peduncles also were investigated in images from 19 patients with progressive supranuclear palsy and 10 patients with multiple system atrophy. The FLAIR protocol for these diseases was the same as for normal subjects.

Results
In normal subjects, a greater incidence of grade II signal intensity in the superior cerebellar peduncles and an increase in the area of high signal intensity were observed visually and statistically with age. Incidence of grade II was 56.7% in 60-69 years and 66.2% in 70-79 years, respectively. In multiple system atrophy patients, the mean age was 62.1 years, and 60% showed grade II signal intensity in the superior cerebellar peduncles, indicating that signal intensity was preserved. Conversely, in progressive supranuclear palsy patients, the mean age was 73.8 years, but only 15.8% had grade II signal intensity (grade I incidence, 73.7%), and atrophy of the superior cerebellar peduncles themselves was observed.

Conclusions
On 3D T2 FLAIR, marked high signal intensity was observed in the superior cerebellar peduncles with age. Meanwhile, signal intensity decreased in progressive supranuclear palsy, which affects the superior cerebellar peduncles. The present findings suggest that decreased signal intensity in the superior cerebellar peduncles on 3DT2 FLAIR in elderly patients may constitute an abnormal imaging finding indicative of disease.

KEYWORDS: Aging, Degenerative, Fluid-Attenuated Inversion Recovery

EP-103
6:30AM - 9:00PM

Application of Dynamic Contrast Enhanced MR Imaging in Head and Neck Squamous Cell Carcinoma: A Correlation study of DCE Parameters with Clinicopathologic Characteristics by Histogram Analysis

J Kim\textsuperscript{1}, S Lee\textsuperscript{1}, A Lerner\textsuperscript{2}, C Liu\textsuperscript{3}, M Park\textsuperscript{1}, M Shiroishi\textsuperscript{2}, J Go\textsuperscript{4}, M Law\textsuperscript{5}
\textsuperscript{1}Yonsei University College of Medicine, Seoul, Korea, \textsuperscript{2}University of Southern California Keck School of Medicine, Los Angeles, CA, \textsuperscript{3}University of Southern California, Los Angeles, CA, \textsuperscript{4}LAC/University of Southern California Medical Center, Los Angeles, CA, \textsuperscript{5}Keck Medical Center of University of Southern California, Los Angeles, CA
Purpose
The purpose of this study was to investigate the usefulness of histogram analysis of dynamic contrast-enhanced MR imaging (DCE-MRI) parameters for assessing the clinicopathologic characteristics in the patients with head and neck squamous cell carcinoma (HNSCC).

Materials and Methods
Dynamic contrast-enhanced MRI was performed in a total of 18 consecutive patients with pathologically confirmed head and neck SCC, and DCE-MRI parameter maps including Ktrans (microvascular permeability), Ve (extravascular-extracellular space volume), and Vp (plasma volume) were obtained. Enhancing tumors were segmented manually on each slice of parameter maps and data were collected to obtain a histogram for the entire tumor volume. Mean, median, skewness, and kurtosis of the parameters were calculated and they were correlated with the clinicopathologic characteristics including tumor differentiation, T stage, N stage, TNM stage, presence of lymphovascular and perineural invasion.

Results
From the histogram analysis of Ktrans maps, mean, median, and kurtosis of the tumors with poor or moderate differentiation, higher stage, presence of lymphovascular and perineural invasion were lower than those of the tumors with well differentiation, lower stage, absence of lymphovascular and perineural invasion, but no significant difference was observed among them. Only the skewness of Ktrans value was significantly different between the tumors according to tumor differentiation (P = 0.005), tumor stage (P = 0.018), and presence of perineural invasion (P = 0.046). Other DCE parameters including Ve and Vp, did not significantly differ between the groups.

Conclusions
Our preliminary evidence using histogram analysis of DCE-MRI parameters (Ktrans) based on whole tumor volume suggests that it may be useful to predict clinicopathologic characteristics of HNSCC.

KEYWORDS: Head And Neck, MR Permeability, Squamous Cell Carcinoma

EP-102

Chordoid Meningioma: Differentiating this atypical WHO grade II tumor from other meningioma histologic subtypes by standard MRI imaging

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Purpose
The chordoid meningioma is an atypical WHO grade II tumor with a reportedly more aggressive clinical course and greater propensity for recurrence. Attempts to distinguish benign from atypical and malignant meningiomas on MR imaging (MRI) have been undertaken with variable results though no data analysis specifically examining the chordoid morphologic variant has been performed. A retrospective review was performed of preoperative MR examinations of intracranial chordoid meningiomas at our institution in an effort to determine if distinguishing MR characteristics exist that can aid in differentiating this atypical variant from other histologic subtypes.
Materials and Methods
Ten cases of WHO grade II chordoid meningiomas were diagnosed at our institution over an 11-year span, eight of which had preoperative MR exams available for review and were included in our analysis. Chordoid meningioma imaging characteristics were compared to 80 consecutive cases of WHO grade I, 21 consecutive cases of nonchordoid WHO grade II, and one WHO grade III meningioma from our institution in which preoperative MR imaging was available. Studies were analyzed for tumor location, size, signal characteristics, peritumoral edema, enhancement characteristics, cystic necrosis, bone changes, restricted diffusion, ADC value and normalized ADC (NADC) ratio. Statistical analysis of absolute ADC and NADC ratios was performed using a generalized linear model and the Tukey-Kramer method.

Results
Preoperative MR imaging in our study cohort revealed no significant differences in size, location, signal characteristics and contrast enhancement of chordoid meningiomas compared to other meningiomas. There was variable presence and degree of peritumoral edema and involvement/invasion of the adjacent calvarium, not allowing for reliable differentiation between the histologic subtypes. There were, however, clear differences in ADC values and NADC ratios with a mean absolute ADC value of 1.62 ± 0.33 x10-3 mm2/s and a mean NADC ratio of 2.22 ± 0.47 x10-3 mm2/s in chordoid meningiomas compared to mean ADC and NADC values of 0.88 ± 0.13 x10-3 mm2/s and 1.17 ± 0.16 x10-3 mm2/s in benign WHO grade I meningiomas, 0.84 ± 0.11 x10-3 mm2/s and 1.11 ± 0.15 x10-3 mm2/s in non-chordoid WHO grade II meningiomas, and 0.57 x10-3 mm2/s and 0.75 x10-3 mm2/s in the case of WHO grade III meningioma. Analysis of these values demonstrated a statistically significant difference in ADC values and NADC ratios of chordoid meningiomas compared to all other WHO grade I, II and III subtypes (all pair-wise p values < 0.01).

Conclusions
Pre-operative identification of the atypical meningioma variant chordoid meningioma would be beneficial for neurosurgical treatment planning and follow-up surveillance. Our review revealed a statistically significant elevation of ADC and NADC values in chordoid meningiomas when compared to all other WHO grade I, II and III subtypes allowing for a reliable prediction of this atypical histopathologic diagnosis.

KEYWORDS: Diffusion MR Imaging, Meningioma
Clinical applications of Dynamic CT of the Cervical Spine.

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Purpose
Spinal instability is defined as the loss of ability of the spine to limit displacement so as to not damage or irritate the spinal cord and nerve roots and, in addition, to prevent incapacitating deformity or pain due to structural changes. Flexion-extension radiographs so far have been the gold standard for evaluating instability of the cervical spine. Conventional CT scans, although superior to radiographs for defining bone anatomy and providing details on disk, ligaments and soft tissues have limited benefits due to the lack of information regarding abnormal spinal movements. Recently, 320-row multidetector computed tomography (CT) was introduced, allowing low-dose volumetric in vivo image acquisition while the joints are in motion. The aim of this study is to assess the diagnostic performance of low-dose 320-row CT in the evaluation of cervical spine instability. Dynamic x-ray films serve as the standard of reference.

Materials and Methods
The patients referred to our institution for suspect cervical instability are examined using
dynamic CT of the cervical spine. Clinically the patients present with neck pain with or without radiculopathy. The subjects included in the study undergo both dynamic x-ray films and flexion-extension CT scanning. CT examinations are performed using the 320-row Aquilion ONE scanner (Toshiba), using four or five volumetric acquisitions while the patient moves from the extension to the flexion position. Each volume is acquired with the following parameters: 320 detector of 0.5mm each, covering 16cm with120Kv, mA modulated from scout views, rotation time one sec, scan field of view 240mm, display field of view 200-240mm. Then time resolved 4D flexion and extension cine loops, axial and sagittal soft tissues and bone algorithms reformatted images are obtained. CT images then are evaluated, using the x-ray films as a reference, in order to assess the normal and abnormal range of motion.

Results
Multidetector CT scanning has tremendous advantages particularly when a large volume can be covered. The advantage of CT scan in comparison with plain x-ray is related to the amount of the additional information concerning mainly soft tissues, intervertebral disks and facets that can be obtained. In particular changes in disk height, facets subluxation and vertebral bodies’ instability are better detected and depicted with dynamic CT. This technique enables a panoramic view of the cervical spine with excellent anatomical detail, which of course is useful in case fusion is indicated. The aim of our presentation is to illustrate the advantages of dynamic CT of the cervical spine to assess stability and evaluate vertebral bodies, disks and facets movements during flexion and extension.

Conclusions
Dynamic CT of the cervical spine was found extremely useful in the dynamic evaluation of the cervical spine since the quality of the information and the spatial resolution is superior to that of conventional plain x-ray. CT proved to be very useful for the assessment of facets subluxation, spondyloysis and disk changes as the patients passes from the extended to the flexion position. In consideration of the multiple information provided by CT with excellent display of the soft tissues, disks and vertebrae dynamic CT of the spine seems a promising imaging technique for the evaluation of the cervical spine in patients with degenerative disk disease. The dose of exposure of this type of examination when compared with conventional x-ray does not represent a significant limit to this exam particularly because it is a more complete and accurate imaging evaluation. This is particularly true in those cases requiring fusion due to the instability.

KEYWORDS: CT, Spinal Imaging, Spondylarthropathy
Cord Compression due to Extramedullary Hematopoiesis: A Rare Presentation in Patient with Beta Thalassemia Major

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Purpose
To describe the role of magnetic resonance imaging (MRI) in a patient with β thalassemia major and mid thoracic pain and abnormal gait due to extra medullary hematopoiesis, a rare complication in these patient.

Materials and Methods
A 32-year-old male with β thalassemia major and mid thoracic pain and abnormal gait. He is on chronic blood transfusion with very stable hemoglobin and low serum ferreting level due to optimal treatment with chelation agents. He has not major organ failure due to thalassemia and recurrent blood transfusion such diabetes, or liver fibrosis. Thoracic and lumbar spine MR imaging (MRI) demonstrated hematopoietic marrow throughout the spine, para-spinal soft tissue masses and epidural masses causing cord compression consistent with extramedullary hematopoiesis. These masses showed positive uptake on nano sulphur colloid scan. He received radiation therapy and steroid which resulted in marked improvement of the symptoms. However the para-spinal masses showed no significant change in size on the follow-up MRI.

Results
Extramedullary hematopoiesis causing cord compression in patient with thalassemia major with well maintained hemoglobin and serum ferritin is very rare. The imaging finding with MRI and sulfur colloid scan have well recognized imaging features for which patient with similar presentation, the diagnosis should be considered and invasive procedure, such as surgery or biopsy, could be avoided to confirm the diagnosis.

Conclusions
In clinical setting thalassemia, major patient with no apparent thalassemia complications due to chronic anemia and repeat blood transfusion and characteristic appearance of the extramedullary hematopoiesis, MRI could play a major role in diagnosis and treatment of these patients.

KEYWORDS: MR Imaging Spine, Spinal Cord

EP-105

CT and MR Appearance of Rathke’s Cleft Cyst and its Radiologic Mimickers

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Purpose
To review and identify distinguishing imaging findings of Rathke's cleft cyst and its common radiologic mimickers.

Materials and Methods
A total of twenty one cases of cystic like intrasellar and suprasellar masses imaged from 2006 to 2013 are presented. Followup pathologic identification was obtained when available. Sixteen cases are imaged with contrast enhanced MRI, utilizing sagittal and coronal T1 and T2 imaging, axial Flair sequence. Two cases include both enhanced CT and MRI and two cases were performed with unenhanced CT and enhanced MRI. One case was imaged with unenhanced CT and MRI. CT scan protocol is acquired in 1.25 mm axial slices with coronal and sagittal reformatted images.
Results
Nineteen cases proceeded to surgical intervention. Pathological examination reveals fifteen Rathke's cleft cysts, two craniopharyngiomas and two pituitary adenomas. The other two cases are identified radiologically as arachnoid cyst and empty sella. On T1 weighted imaging, 7 cases (50%) display increased signal intensity, 3 (20%) cases are isointense, 4 cases (26%) display low signal intensity and 1 (4%) case exhibits mixed signal intensity. On T2 weighted imaging, 9 cases exhibit high signal intensity (60%), 2 cases display low signal (13%) intensity, 2 cases (13%) are isointense and 2 cases have mixed signal. All fifteen cases show lack of central contrast enhancement and lesion with epicenter in the sella. Arachnoid cyst and empty sella are identified by their typical simple cerebrospinal fluid signal. Craniopharyngioma is identified by its heterogenous signal and enhancement pattern. Pituitary cystic adenoma provides a diagnostic challenge, frequently mimicking Rathke's Cleft cyst.

Conclusions
Imaging findings of Rathke's cleft cyst and its radiologic mimickers, including pituitary cystic adenoma and craniopharyngioma are evaluated in attempt to identify differentiating findings. In our study, arachnoid cyst and empty sella can be easily differentiated by their MR cerebrospinal fluid signal intensity. Enhancement pattern is helpful in identifying neoplasms such as craniopharyngioma. Pituitary cystic adenoma remains a diagnostic challenge. Rathke's cleft cysts are benign, epithelium-lined intrasellar cysts which originate from remnants of Rathke's pouch. Rathke's pouch arises from the primitive oral cavity and migrates rostrally to form the anterior pituitary lobe and the pars intermedia. This developmental pattern constitutes the basis for the consistent intrasellar epicenter of Rathke's cleft cysts. Rathke's cleft cysts display a wide array of signal characteristics, which reflects their varied chemical composition. In our study, 60% of cases exhibit increased T2 signal. About 50% of cyst are represented by high signal intensity on T1 weighted imaging. This reflects components of hemorrhage and cholesterol. Only about 26% of cases display both high T1 and T2 signal. High T1 signal intensity and lesion within the sella are typical features helpful in identifying Rathke's cleft cysts in our study.

KEYWORDS: Rathke Cleft Cyst, Sella, Suprasellar Mass

EP-100
6:30AM - 9:00PM

How Dark is too Dark? : Age-related Quantitative Analysis of Normal T2 Hypointensity of Central Gray Matter Structures on 3T

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1Indiana University School of Medicine, Indianapolis, IN

Purpose
Due to the inherent increase in magnetic susceptibility on 3 T imaging, differentiation between normal T2 hypointensity of central gray matter structures versus pathologic metal or mineral deposition can be a challenge. Previous studies have demonstrated that iron deposition is a normal function of aging. We present a set of normal brain MR imaging (MRI) T2 sequences from birth to the seventh decade of life as a template for clinical imaging on 3 T.

Materials and Methods
Brain MRI with standard T2 clinical sequences were obtained restrospectively from a PACS
database performed on 3 T scanners (Magnetom Trio and Verio, Siemens, Malvern, PA, USA). Inclusion criteria required a normal result from the scan. Patients with central nervous system (CNS) pathology and pathology known to cause iron and mineral deposition to the brain were excluded after a search through a clinical patient database. The central gray structures were evaluated subjectively for hypointensity compared to the surrounding structures. Regions of interests (ROI) were drawn around the bilateral putamen, globus pallidus (GP), red nucleus (RN), and dentate nucleus (DN). A 30mm2 ROI also was obtained in the white matter (WM) of the centrum semiovale. Signal intensity values of all central gray structures were compared to the putamen as well as the white matter as ratios. Pearson's Rho correlation was performed between age and signal intensity ratios.

Results
Ninety patients (0.05–67 years, mean 25.6 years) with at least five per decade of life were obtained. Pearson's Rho correlation were significant (p<0.0001) for GP/Putamen (r=-0.69), GP/WM (r=-0.85), RN/WM (r=-0.65) and Putamen/WM (r=-0.55). Subjectively, the GP appears darker than the putamen as early as seven years, but is consistent in the second decade of life. The DN is consistently darker than the adjacent cerebellar white matter by the third decade. Conversely, the RN is visualized after the first year of life.

Conclusions
Our results correlate well to previous 1.5 T radiographic and histologic studies of brain iron accumulation by age and represent a normal quantitative template for clinical 3 T imaging.

KEYWORDS: Globus Pallidus, Gray Matter

![Globus Pallidus to Putamen Ratio Graph](TCT_EP-100_Graph.jpg)
Imaging of Idiopathic Intracranial Hypertension (IIH) Pre and Post Venous Stenting

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Purpose
Hypothesis: Non-invasive imaging can predict and identify dural sinus stent responders in idiopathic intracranial hypertension. Idiopathic intracranial hypertension (IIH) is characterized by headache, tinnitus and visual changes. Clinically these patients demonstrate papilledema and elevated opening pressures on lumbar puncture. The pathophysiology of the disease is controversial but recent literature has suggested dural venous sinus stenosis as an underlying mechanism for the increased pressure and lack of CSF reabsorption. Venous sinus angioplasty and stenting has emerged as a treatment strategy. A small number of case studies have evaluated patient symptomatology and response to therapy based on clinical data including papilledema and headache but the effects of stenting on the radiological signs of increased intracranial pressure has not been well demonstrated. In our study, we utilized MRI/MRV and CT/CTV to assess for changes in radiological signs of IIH post-stenting.

Materials and Methods
Materials and Methods: 6 patients (5 females and 1 male) aged 16-32 were diagnosed with IIH based on the Dandy criteria. Using CT or MR, the presence of radiologic papilledema, perioptic space dilation, empty sella, and dural venous sinus stenosis was recorded pre and post venous stenting. Prior to stenting the diagnosis was confirmed invasively with OP on LP and measurement of the intravenous pressure gradient across the stenosis.

Results
Results: Headache and MRI/CT findings of papilledema, perioptic space dilation, empty sella, and dural venous sinus stenosis < 2mm (in the dominant transverse sinus or bilateral in codominant sinuses) were found in all 6. All 6 had OP > 30 cm of H20 and pressure gradients > 14 mm of Hg across the stenosis. Post stenting, all 6 patients experienced resolution of headache, and imaging demonstrated resolution or improvement of papilledema, perioptic space dilation, empty sella, and dural venous sinus stenosis.

Conclusions
Conclusion: Venous stenting of transverse sinus stenosis in IIH leads to resolution of radiological features of intracranial hypertension including empty sella and perioptic space dilation. A prospective trial of venous stenting verses ventriculoperitoneal shunting for medically refractory patients is proposed.

KEYWORDS: Idiopathic Intracranial Hypotension, Venous Sinus Stenting, Venous Stenosis

Midsagittal Pituitary Measurement Exaggerates Pituitary Height when compared to Coronal Measurement with 3 Tesla Magnet.
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Purpose
Measurement of the pituitary height on MR studies plays an important role in multiple occasions including borderline pituitary abnormalities such as physiological hypertrophy, inflammatory disease, and masses. The measurement is traditionally measured on midsagittal T1 sequence. On the other hand, the coronal plane offers the best single view for evaluating the sellar structures. We sought to assess and compare pituitary height on midsagittal and coronal images.

Materials and Methods
Thirty three healthy adults (3 females; age ranging 35-55) with thin slice isovolumetric sagittal and coronal T1 sequence scanned between 2010 and 2013 were included. The isovolumetric T1 sequences were performed with 1 mm voxel size on a 3T MR scanner (Verio, Siemens, Germany) in direct sagittal, coronal reformatted images were obtained to correlate. The sagittal and coronal images were analyzed by an experienced neuroradiologist independently. The pituitary heights were measured on midsagittal and also on coronal images at the level of the stalk.

Results
The pituitary height was 4.6 ± 0.28 mm (mean ± SEM) on midsagittal images and measured 3.7 ± 0.27 mm (mean ± SEM) on coronal image. Both measurements were within the previously reported normal limits for age and sex. Pituitary height measured at midsagittal image is significantly longer than those on coronal images (p=0.0001).

Conclusions
MR imaging is the optimal imaging technique for evaluating the pituitary gland. Measurement of the pituitary height is important in many borderline pathologies, which is traditionally performed on midsagittal images. Our study showed that the midsagittal measurements significantly exaggerate the pituitary height by approximately 0.9 mm on average when compared to coronal images. Thin slice coronal views may provide a more accurate quantitative evaluation of the pituitary gland.

KEYWORDS: Pituitary Gland

EP-101

MR imaging of the superior cervical ganglion: Anatomical features and distance from the common carotid artery bifurcation

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Purpose
The superior cervical ganglion (SG) is the largest ganglion of the cervical sympathetic trunk. Nerve block for SG is performed as treatments for vasospasm and neuralgia. Some reports have described the location and structural features of the SG by autopsy; however there are few reports about imaging anatomy. We describe imaging findings of the SG and analyze the
distance from its inferior pole to the common carotid artery bifurcation (CCAB), which is considered a good landmark for anesthetic block.

Materials and Methods
Eighteen cases (mean age, 43.3; range, 17-74 years) without obvious sympathetic symptoms were included. They underwent MR neurography (Philips 1.5 T Achieva, 3D-STIR VISTA, coronal acquisition, TR1600, TE200, TI180, thickness 2.4mm, overlap 1.2mm). The MR images corresponded with anatomical reports of SG. Additionally, ordinary least-squares multiple regression analysis was performed using gender, height, side and level of the CCAB to predict the SG-CCAB distance.

Results
Thirty-six SGs of all 18 cases could be visualized. The SG presented spindle shape and hyperintense on STIR and lay on the longus capitis muscle within the range from C1 to C4 level. The mean long axis was 29.1 ± 6.6mm and mean short axis was 5.3 ± 1.6mm. The model significantly predicted the SG-CCAB distance (R2=0.389, p=0.003). Gender, height and the level of CCAB contributed significantly to the variance in this model.

Conclusions
3D-STIR can visualize the SG and evaluate anatomical feature. The CCAB is a good landmark for localizing the SG.

KEYWORDS: Anatomy, Neurography

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Normal Variants of Paranasal Sinuses and Nasal Cavity on CT

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Purpose
Normal variants of the paranasal sinuses and nasal cavity are very common. Some of these variants such as bilateral concha bullosa, Haller cells and hypertrophic ethmoid bulla have been found to be associated with chronic rhinosinusitis. Other variants such as Onodi cells are of importance to functional endoscopic sinus surgeons as their presence is associated with an increased risk of injury to optic nerves or carotid arteries. The purpose of this educational exhibit is to discuss the prevalence of anatomical variants of the paranasal sinuses and nasal cavity and to present multiple computed tomography (CT) images of different variants as a pictorial essay.

Materials and Methods
We retrospectively analyzed 214 CTs of the sinuses performed at our institution between 5/8/2013 and 11/5/2013. None of the patients underwent prior sinus surgery. Each CT was analyzed for the presence of the following normal variants: Agger nasi cells, Haller cells, Onodi cells, prominent ethmoid bulla, sphenoid sinuses extending into the posterior nasal septum, dehiscent lamina papyracea, pneumatized anterior clinoid, pneumatized pterygoid process, pneumatized hard palate, pneumatized floor of the sella turcica, pneumatized uncinate process, supraorbital cells, pneumatized crista galli, pneumatized superior turbinates, paradoxically bent middle turbinates, pneumatized lamina of middle turbinates, concha bullosa, pneumatized inferior turbinates, nasal septal deviation and nasal septal spur. Prevalence of the above variants was calculated.

Results
The most common anatomical variant in our study was deviation of the nasal septum, present in 98% of patients although in 37% it was minimal. The second most common variant was Agger nasi cells, present in 83% of patients. Other common variants were extension of sphenoid sinuses into the posterior nasal septum (78%), pneumatization of the floor of the sella turcica (68%), prominent ethmoid bulla (62%), Haller cells (46%) and pneumatized lamina of middle turbinates (36%). Onodi cells were found in 32% of our patients. Concha bullosa was present in 25% and was bilateral in 10%.

Conclusions
There is a wide variety of normal anatomical variants of the paranasal sinuses and nasal cavity, some of which occur very frequently. The most prevalent variants in our study were deviation of the nasal septum and presence of Agger nasi cells. It is important to be aware of normal variants as some may be associated with chronic rhinosinusitis and others with a higher rate of complications from functional endoscopic sinus surgery.

KEYWORDS: Normal Variant, Paranasal, Sinonasal Disease
Radiological changes in irradiation of mandible bone with increasing irradiation doses in minipigs: detection of osteoradionecrosis with MR-imaging and CT.

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Purpose
To investigate radiological changes in mandibular bone after irradiation in various doses with and without surgery to identify the imaging characteristics of osteoradionecrosis.
Materials and Methods
Sixteen Göttingen minipigs were divided into four groups and were irradiated with equivalent doses of 0, 25, 50 and 70 Gy. Three months after irradiation, mandibular premolars and molars on the left side were removed and four dental implants were placed. A CT-scan and MRI-scan were obtained before irradiation. Six months after irradiation and implantation - CT and MRI-scans were repeated under general anaesthesia. Immediately after imaging the animals were sacrificed. Macroscopic and microscopic pathologic evaluation was done. The MR-imaging protocol consisted of coronal T1, T2-TSE and T2-SPIR, transverse STIR images and post-gadolinium T1-weighted images of the mandible. Signal intensities on all sequences of MR were scored by two head-neck radiologists independently and in consensus, as well as enhancement and cortical destruction. Cortical destruction and location and presence of implants was recorded from the CT-scan. A final decision of detection of osteoradionecrosis on MR and CT-scans was given separately. Gold standard for the diagnosis of osteoradionecrosis was clinical examination revealing persistent intra-oral exposed bone.

Results
Two animals had clinical signs of osteoradionecrosis; one animal in the 50 Gy and one in the 70 Gy group (fig 1). Increasing scores of signal changes were recorded with increasing radiation dose in the operated and non-operated mandible at MR. The T1-weighted images with gadolinium showed the highest signal intensity in the two pigs with suggested osteoradionecrosis. Other sequences showed more variable signal changes of the bone marrow. Cortical destruction based on MR after irradiation was noted in 3 animals, CT scan revealed clear cortical destruction in same three animals and some minor cortical changes in some other animals. The radiologists addressed two animals with osteoradionecrosis: in one animal the radiological findings matched the clinical diagnosis; in the other animal with a smaller intraoral area of exposed bone the radiological imaging failed to detect osteoradionecrosis. Another animal was radiologically diagnosed with osteoradionecrosis, but did not show any clinical signs – and therefore did not meet the diagnostic criteria of osteoradionecrosis. Preliminary histological evaluation, however, showed extensive radiation damage in this animal.

Conclusions
MR imaging showed increasing signal alterations in mandibles irradiated with higher dosages. The clinical diagnosis of osteoradionecrosis does not parallel the diagnosis of osteoradionecrosis on imaging, intramedullary changes are better visualized on MR.

KEYWORDS: Animal Model, Mandible, Radiation Necrosis
EP-108

Signal intensity of perirolandic white matter on phase difference enhanced imaging

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Purpose
The phase difference enhanced (PADRE) imaging was developed to enhance the contrast between the target tissue and surrounding tissue by choosing the appropriate phase difference. On PADRE images, the signal-intensity (SI) of a certain WM may reflect its myelin content. Our purpose is to evaluate relative SI of the superficial white matter (SWM) in the precentral and postcentral gyri on PADRE.

Materials and Methods
All studies were performed at 3T MR. First, the echo time (TE) was optimized for the PADRE; TE of 58.3 msec was selected analyzing the best depiction of the optic radiations. The study population consisted of 44 normal subjects (29 women, 15 men: mean age 52.9 years: range 22-90 years). By consensus of two observers, the precentral gyri, postcentral gyri and superior frontal cortex (SFC) was identified based on the previously established anatomic methods. The SI of the SWM in the precentral and postcentral gyri on PADRE images was divided into three grades in comparison with that of the SFC; grade I: isointense, grade II: slightly hypointense, and grade III: markedly hypointense.

Results
The SWM in the precentral and postcentral gyri showed hypointense on PADRE images (Figure). For the SI analyses on PADRE images, the grade I, grade II, and grade III appearances were found in 1 (1%), 21 (24%), and 66 (75%) of 88 precentral gyri (44 subjects), respectively, and in 1 (1%), 25 (28%), and 62 (70%) of 88 postcentral gyri, respectively. Figure. PADRE image of a 29-year-old female. The superficial white matters in the bilateral precentral (arrows) and postcentral (arrowhead) gyri show marked hypointense (grade III).

Conclusions
On PADRE images, the perirolandic SWM showed hypointense to other cerebral cortices, which probably reflects differences in the concentration of the nerve fibers as well as the higher myelin content. PADRE may be useful for identification of the central sulcus by assessing the SI of the SWM.

KEYWORDS: Anatomy, Motor Cortex, Phase Contrast Imaging
Figure. PADRE image of a 29-year-old female. The superficial white matters in the bilateral precentral (arrows) and postcentral (arrowhead) gyri show marked hypointense (grade III).
Strategies for Reducing Ionizing Radiation Dose during Parathyroid 4DCT in Patients with Primary Hyperparathyroidism

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Purpose
Evaluate strategies to reduce radiation dose in patients undergoing Parathyroid 4DCT in patients with Primary Hyperparathyroidism

Materials and Methods
4DCT was performed using a 16 (20 mm beam collimation) and a 64 (40 mm beam collimation) detector row GE CT scanner in one non- and 2 or 3 post-contrast phases at 1.25 mm slice thickness from the angle of the mandible to the tracheal carina. The scanning protocol underwent several subsequent adjustments with the purpose of reducing the radiation dose without compromising the diagnostic quality of the studies such as: use of a lower tube voltage, acquisition of fewer phases, use of automated tube current modulation instead of fixed mA. The patient radiation dose was estimated using the ImPACT (Imaging Performance Assessment of CT Scanners) calculator and expressed as absorbed dose in various organs. The effective dose was calculated from the organ specific doses using tissue weighting factors according to the recommendations of the ICRP (International Commission on Radiological Protection) 103.

Results
For the 64-slice scanner, lowering the x-ray tube voltage from 140 to 120 kV in a 4 phase scan reduced the calculated patient effective dose from 18 to 8.8 mSv. The effective dose estimated for a similar 4 phase acquisition protocol (120 kV, 200 mA, 0.8 sec rotation time and pitch of 0.968 for all the phases) performed on the 16-slice scanner was 10.4 mSv, 18% higher than for the 64-slice scanner. Further, reducing the number of phases from 4 to 3 resulted in a decrease to 6.6 mSv. Combining these alterations to the protocol lowered the thyroid dose from a 4DCT study from 172 to 66 mGy. Based on the age and gender-dependent risk factors from the multiplicative model from the Biological Effects of Ionizing Radiation Committee VII (BEIR VII), the calculated risk of thyroid cancer for a 20 year old female patient from 4DCT would be reduced by 62% (from 1944 cases/million persons exposed to 746 cases/million persons exposed) by the altered protocol. Using automated tube current modulation (with the maximum tube current set at the fixed mA scan value of 180 mA) instead of fixed mA, resulted in a further decrease of the radiation dose by varying percentage, depending on the patient body habitus.

Conclusions
4DCT is associated with a high thyroid radiation dose. By reducing the X ray tube voltage and the number of phases used, the thyroid dose can be significantly reduced. This may lead to a lower risk of thyroid cancer formation, especially in young individuals.

KEYWORDS: Parathyroid, Radiation Dosage
The Adult Face of PHACES.

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¹Lenox Hill Hospital, New York, NY

Purpose
In PHACES syndrome, infantile hemangioma is accompanied by multisystem malformations that include brain, cardiac and eye anomalies. While this syndrome frequently is diagnosed in early childhood due to the presence of a typical segmental facial hemangioma, we have encountered several cases that have been identified later in life. This delayed diagnosis typically occurs when one of the associated malformations is identified on an imaging study performed for an unrelated indication, with the accompanying facial lesion long forgotten.

Materials and Methods
This poster will include three case presentations, utilizing clinical photographs and images from radiologic examinations, as well as a comprehensive review of clinical and imaging findings in PHACES syndrome.

Results
Subject one is a 20-year-old male presenting with dizziness while exercising. On CT he was found to have an absent right internal carotid artery as well as ipsilateral aberrant subclavian artery and cerebellar hypoplasia. Subject two is a 25-year-old female with left-sided hearing loss since infancy. On CT a persistent stapedial artery and ipsilateral cerebellar hypoplasia were noted as well as a wide internal auditory canal and cochlear dysplasia. Subject three is a 33-year-old female with history of trauma found to have multiple anomalies of the intracranial vasculature with ipsilateral cerebellar hypoplasia. All subjects had a remote history of a facial hemangioma.

Conclusions
When PHACES-related anomalies are encountered in the absence of history of facial hemangioma, findings such as absent or ectatic cerebral vessels may be a cause of significant clinical concern, and inappropriate work up may be initiated. With the knowledge of the typical patterns of PHACES-related anomalies, the diagnosis may be suggested and confirmed with history.

KEYWORDS: Adult Brain, PHACES

EP-107

The Human Foramen Magnum - Normal Anatomy of the Cisterna Magna in Adults.

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Purpose
The goal of this study was to radiologically describe the anatomical characteristics of the cistern magna (CM) with regard to presence, dimension, and configuration.
Materials and Methods
In this retrospective study, 523 records were reviewed. We defined five CM types, the range of which covered all normal variants found in the study population. Characteristics of the CM were recorded and correlations between various posterior fossa dimensions and CM volume determined.

Results
There were 268 female (mean age 50.9 ± 16.9 years) and 255 male (mean age 54.1 ± 15.8 years) patients. CM volume was smaller in females than in males and correlated with age (Pearson correlation, r=0.1494, p=0.0006) and gender (unpaired t test, r²=0.0608, p<0.0001). Clivus length correlated with CM volume (Pearson correlation, r=0.211, p<0.0001) and gender (unpaired t test, r²=0.0163, p<0.0035). The anterior-posterior dimension of cerebrospinal fluid anterior to the brainstem correlated with CM volume (Pearson correlation, r=0.181, p<0.0001) and gender (unpaired t test, r²=0.0205, p=0.001).

Conclusions
The anatomical description and simple classification system we define allows for a more precise description of posterior fossa anatomy and could potentially contribute to the understanding of Chiari malformation anatomy and management.

KEYWORDS: Anatomy, Foramen, Posterior Fossa

Fig. 1 T1-weighted mid-sagittal MR image showing study measurements as follows: A the height of the cisterna magna (CM); (B not shown) the maximum width of the CM measured on an axial T2 image; C the maximum depth of the CM perpendicular to the occipital dura, volume of the CM calculated as A × B × C/6, (D McRae’s line) the foramen magnum diameter; E the CSF depth between the brainstem and the dura, anterior to the brainstem along McRae's line; F the clivus length measured from the posterior clinoid process to the basion; and G the tentorial angle measured as the largest angle between Twining's line and the tentorium

(Filename: TCT_EP-107_Figure1.jpg)

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d
Chemical exchange saturation transfer imaging of Choline

Z Dai, T Zhang, G Yan, R Wu
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Purpose
We aim to detect the choline using chemical exchange saturation transfer imaging.

Materials and Methods
MRI experiments were conducted under an Agilent 7T small hole MRI system with a standard volume coil for RF transmission and reception. Choline phantoms were prepared to reach concentrations of 5, 10 and 20 mM, and their pH was titrated to 7.0. Choline imaging was obtained by the standard CW-CEST sequence. Parameters were used: offset frequency at 0.5 ppm and -0.5 ppm, pre-saturation time=5000 ms, TR/TE=6000/2.5 ms, slices=1, slice thickness=2mm, NEX=4, FOV=60*60 mm2, imaging matrix=64*64 and bandwidth=50 kHz. The pre-saturation power was 6 μT. Z-spectra were obtained in phantoms. All data were processed in Matlab.

Results
We could see clearly the choline effect at about 0.5 ppm in the Z-spectra. The Choline imaging signal increased with its concentration.

Conclusions
Our study demonstrates the specific choline imaging can be obtained using chemical exchange saturation transfer technic, which offset frequency is at about 0.5 ppm.

KEYWORDS: Choline
MR study of the brain. The purpose of this educational exhibit is to demonstrate normal anatomy of the orbit, common pathologies and incidental lesions occurring in the orbit. "Do not miss lesions" in the orbit also will be highlighted. The target audience is radiology residents and general radiologists.

Materials and Methods
After a brief review of the normal orbital structures seen on CT and MRI, high resolution and detailed images of the various orbital lesions will be presented, with pertinent clinical/pathological correlation and ancillary imaging findings, wherever applicable.

Results
1. Recognize the incidental findings of venous varix, vascular malformations, optic nerve drusen, scleral and trochlear calcification. 2. Distinguish retinal or choroidal detachment. 3. Learn the expected imaging appearance of cataract surgery, lens implants, retinal and choroidal reattachment procedures. 4. Gain knowledge of systemic conditions affecting the orbits such as Graves' ophthalmopathy, idiopathic orbital inflammatory syndrome, optic neuritis, lymphoma, sarcoidosis. 5. Be aware of the do not miss lesions of the orbit such as post septal cellulitis, subperiosteal abscess, subtle primary tumors in children and adults as well as subtle metastasis.

Conclusions
The orbits can be affected with a number of local or systemic pathologies. There are several imaging features and patterns that distinguish physiological calcifications and other incidental findings within the orbits from other conditions that may require emergent intervention. When utilizing a template for voice recognition dictation, we recommend a separate field with specific comments on the orbital contents as it encourages the resident to review the orbits systematically and decreases the chance of missing lesions especially early in the training.

KEYWORDS: Orbital Hemangioma, Orbital Tumor, Orbits

EP-134
6:30AM - 3:00PM

Detection of 99mTc-Sestamibi Negative Parathyroid Adenomas with Multi-Phase CT: Preliminary Experience

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¹University of Arkansas for Medical Sciences, Little Rock, AR

Purpose
Pre-operative parathyroid adenoma localization in patients with primary hyperparathyroidism facilitates minimally invasive parathyroidectomy. Many practices rely on congruent localization by two modalities, typically 99mTc-sestamibi (MIBI) scintigraphy with or without single photon-emission computed tomography/computer tomography (SPECT/CT) and cervical ultrasound prior. In patients whose adenomas are not localizable by 99mTc-MIBI imaging and/or ultrasound, bilateral neck exploration may be required. Multi-phase CT (MPCT) has been recognized as a complimentary modality for the detection of parathyroid adenomas. We investigated the utility of MPCT for the detection of adenomas that are non-localizing on 99mTc-MIBI imaging.
Materials and Methods
MPCT was performed on a Phillips 64-slice CT scanner (mA 180-200, kV 120) with acquisitions prior to and following injection of 75ml non-ionic contrast at 3 mL/s at 30, 60, and 90 seconds. Images were reviewed by a subspecialty-certified neuroradiologist and otolaryngology surgeon. Enhancement kinetics of identified lesions were compared to those of non-pathological lymph node in each patient. Accuracy of MPCT localization was correlated with findings at surgery.

Results
Two patients with primary hyperparathyroidism were included, one with 2 negative 99mTc-MIBI planar exams, 1 negative 99mTc-MIBI single photon-emission computed tomography/computer tomography (SPECT/CT) exam, and 1 negative ultrasound exam and the other with 1 negative 99mTc-MIBI planar exam and a positive ultrasound. Adenoma localization was accomplished in both patients with MPCT and confirmed at surgical resection. Parathyroid adenomas showed early enhancement followed by contrast washout compared with continuous contrast accumulation in lymph nodes.

Conclusions
MPCT detects parathyroid adenomas that are non-localizing by 99mTc-MIBI scintigraphy. Given the implications of pre-operative localization for minimization of surgical morbidity, further investigation into the utility of MPCT in this population is warranted.

KEYWORDS: CT, Parathyroid
Diffusion-weighted MR imaging in lymph node metastases of squamous cell carcinoma: Does discrimination of the carcinomas possible with apparent diffusion coefficient values?

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Purpose
We aim to compare apparent diffusion coefficient (ADC) values of nodal metastases in head and neck squamous cell carcinoma (SCC).

Materials and Methods
Ethics committee approval and informed consent were obtained. Patients with nodal metastases underwent 1.5 Tesla MR imaging, including diffusion weighted echo planar imaging performed with b values of 0 and 1000 sec/mm². ADC values of the histologically proven nodal metastases (1 cm or greater in short-axis diameter) of head and neck SCC retrospectively evaluated. A
region of interest was drawn around the malignant node on ADC maps. Mean ADC values were compared using Kruskal-Wallis test. Receiver operating characteristic analysis was employed to investigate whether ADC-based differentiation is possible among squamous cell carcinomas depending on their histologic characteristics.

Results
Twenty-seven patients (24 men, three women; mean age, 60.7 years) with 42 nodes underwent imaging. Mean ADC values for nodal metastases of the nasopharyngeal carcinoma (n:15), oropharyngeal carcinoma (n:12), laryngeal carcinoma (n:10) and hypopharyngeal carcinoma (n:5) were (0.710 ± 0.160 [standard deviation]) x 10-3 mm2/s, (0.960±0.190) x 10-3 mm2/s, (0.900±0.250) x 10-3 mm2/s, and (1.060±0.150) x 10-3 mm2/s, respectively. Significant differences were found between the nasopharyngeal and other SCC metastases. There were no significant differences among the other groups. By selecting 0.850 x 10-3 mm2/s as an ADC threshold value, we can differentiate nasopharyngeal carcinoma metastases from other carcinomas metastases with sensitivity of 80% and specificity of 85% (area under the curve, 0.890).

Conclusions
The present study demonstrates that ADC values of the nodal metastases in head and neck squamous cell carcinomas are similar other than the nasopharyngeal carcinoma. Diffusion weighted imaging may help distinguish nasopharyngeal carcinoma metastases from other SCC metastases.

KEYWORDS: Apparent Diffusion Coefficient, Diffusion-Weighted Imaging, Nasopharyngeal Carcinoma (NPC)
Does the ‘Taller-than-Wide’ Sign Apply to Metastases to the Thyroid?

(Debnam¹, M Kwon², B Edeiken-Monroe¹, B Fornage³)

¹ Debnam, ² M Kwon, ³ B Edeiken-Monroe, ⁴ B Fornage
The University of Texas MD Anderson Cancer Center, Houston, TX, The University of Texas MD Anderson Cancer Center, Houston, TX, The University of Texas MD Anderson Cancer Center, Houston, TX

Purpose
An anteroposterior (AP)/transverse (TV) ratio of thyroid nodules greater than 1 (the so-called "taller-than-wide sign") has been reported as a sign of malignancy in primary thyroid cancer. The purpose of this study was to determine if this sign also applies to metastases to the thyroid from extrathyroid primary.

Materials and Methods
Thirty-three patients with a solitary nodule, or a dominant/suspicious nodule as part of a multinodular thyroid, and a cytological diagnosis of metastasis to the thyroid gland were included. The AP and TV dimensions of the nodules were measured in both the transverse and longitudinal planes and the AP/TV ratio was calculated in both planes.

Results
The thirty-three nodular metastases appeared as a solitary nodule (n=14) or a dominant/suspicious nodule in a multinodular thyroid (n=19). For the solitary nodules, the AP/TV ratio in the either the transverse or longitudinal plane was > 1 in 5 of 14 (36%) lesions. The AP/TV ratio in the either plane was > 1 in 8 of 19 (42%) dominant/suspicious nodules in a multinodular thyroid. In total, 13 of 33 (39%) lesions demonstrated an AP/TV ratio > 1.

Conclusions
The taller-than-wide sign is not a reliable sonographic sign of metastasis to the thyroid gland from an extrathyroid malignancy.

KEYWORDS: Metastases, Thyroid, Ultrasonography

EP-114
6:30AM - 9:00PM

Dynamic Contrast-Enhanced MRI (DCE-MRI) in Head and Neck Squamous Cell Carcinoma and Nodal Metastases: Correlation with 18F-FDG PET/CT Changes and Clinical Response

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1City of Hope Medical Center, Duarte, CA, 2iCAD, Nashua, NH

Purpose
To evaluate the usefulness of pretreatment quantitative dynamic contrast-enhanced MR imaging (MRI) DCE-MRI analysis in predicting chemoradiation response as assessed by 18F-FDG PET/CT changes and clinical response in head and neck squamous cell carcinoma (HNSCC) primary sites and nodal metastases.

Materials and Methods
Twelve patients underwent pretreatment DCE-MRI. All patients had both pretreatment and three-month post-treatment 18F-FDG PET/CT. Regions of interest (ROI) were placed on the primary tumor and nodal metastases. Dynamic contrast-enhanced MRI scans were postprocessed with iCAD software. Seven parameters: ROI volume, the transfer constant (Ktrans), extracellular extravascular volume fraction (Ve), fractional plasma volume (Vp), precontrast tissue relaxation
rate (T10), efflux rate (Kep) and initial area under gadolinium curve for 60 sec (iAUGC) were recorded. 18F-FDG PET/CT analysis was performed with Advanced Workstation and the Maximal Standard Uptake Value (SUVmax) was obtained. Dynamic contrast-enhanced MRI studies were divided into responders (Rs) and nonresponders (NRs) based on clinical assessment and/or PET/CT changes.

Results
In the 10 HNSCC cases with primary site assessed, five were deemed responders and five nonresponders. The average tumor volume was 22.75cc in the Rs and 34cc in the NRs. Ktrans(1/min) was higher in the Rs with average of 2.57 compared to 0.58 in the NRs. Kep(1/min) was also higher in Rs with average of 6.1 compared to 1.23 in the NRs. Ve showed increase in NRs, while iAUGC and T10 were higher in Rs. In the 11 exams with DCE-MRI available and nodal metastases assessed, seven were deemed Rs and four NRs. The average node volume was higher in the Rs with 7cc compared to 5.43cc in NRs. Ktrans was higher in Rs with average of 1.4 compared to 0.99 of NRs. iAUGC (mMsec) was higher in Rs 18.64 compared to 8.86 in NRs. Kep and T10 also were elevated in the Rs group, while Ve and Vp did not show much difference between two groups. 18F-FDG PET/CT findings showed resolution of FDG activity in the Rs and greater reduction of SUVmax values than the NRs.

Conclusions
The pretreatment DCE-MRI parameters of both HNSCC primary sites and nodal metastases may correlate with 18F-FDG PET/CT changes and clinical response. Multimodality imaging with both DCE-MRI and 18F-FDG PET/CT may be a helpful imaging biomarker to predict treatment response to chemoradiation in HNSCC.

KEYWORDS: Head And Neck

EP-125
6:30AM - 9:00PM
Effects of ROI Measurement Technique on the Quantitative Assessment of Recurrent Thyroid Cancer During Multiphasic Multidetector CT

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1University of Texas M. D. Anderson Cancer Center, Houston, TX, 2MD Anderson Cancer Center, Houston, TX, 3University of Texas MD Anderson Cancer Center, Houston, TX, 4UT MD Anderson Cancer Center, Houston, TX

Purpose
Multi-phase multidetector dynamic CT studies (4D-MDCT) allow the assessment of complex contrast enhancement patterns. The quantitative assessment of these patterns is complex, and highly dependent on ROI selection. We compare the results of three different ROI techniques in the setting of recurrent thyroid carcinoma.

Materials and Methods
Twenty-four patients (with 29 nodules) with pathologically-proven recurrent thyroid carcinoma underwent 4D-MDCT imaging of the neck prior to surgical resection or biopsy. Our 4D-MDCT protocol has 4 phases: initial non-contrast, 25 seconds after injection (arterial phase), and 55 seconds (venous phase) and 85 seconds (delayed phase). Regions of interest (ROI) analysis was done in three different ways: a) a small hand drawn ROI was placed over the area of highest
enhancement in the lesion (Max Enhancement), b) a freeform ROI was contoured to the outline of the lesion through different phases of enhancement, with no requirement for the ROI size to remain constant (Contouring), and c) the ROI was drawn freehand around the lesion on the phase of highest conspicuity, and then copied over to the other phases, with size being held constant (Size Constant). Average Hounsfield density was recorded for each ROI for each phase in each patient. Linear mixed model was used to estimate and compare densities between phases and ROI drawing methods.

Results
At baseline the Hounsfeld densities (HU) for Max Enhance, Contouring and Size Constant methodologies HU were 40+/-18, 37 +/-18 and 40+/-16 (Mean+/-SD). Arterial phase was 112 +/-38, 100 +/-38 and 116 +/-43. Venous phase was 102 +/-26, 91 +/-32, and 106 +/-26. Delayed phase was 98 +/-27, 88 +/-29 and 99 +/-27. Coefficient of variation were 44%, 34%, 26% and 28% for Max Enhance, 48%, 38%, 35% and 33% for Contouring, and 41%, 37%, 25% and 27% for Size Constant measurements for each phase respectively. (See figure comparing mean +/-standard deviations for these three measurement techniques). Based on linear mixed model estimates, Contouring method obtained significantly lower densities compared to Max Enhancing (mean difference = -11, 95% CI: -16 - -7, adjusted p < 0.0001) and Size Constant ROIs (mean difference = -9, 95% CI: -14 - -5 adjusted p < 0.0001). There was no difference between Size Constant and Max Enhancing (adjusted p = 0.45).

Conclusions
The way an ROI is placed is very important, and can influence the results of quantitative analysis. Coefficients of variation were smallest for the Size Constant method, suggesting it to be the more repeatable methodology, but further research based on diagnostic accuracy is needed. Research into ROI technique and analysis is necessary, and important for standardizing quantitative methods.

KEYWORDS: CT, Neoplasm, Thyroid
Evaluation of Histogram Parameters of ADC Values in Oropharyngeal Carcinomas: Correlation with Human Papilloma Virus Status

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1Saitama International Medical Center, Saitama Medical University, Hidaka, Saitama, Japan, 2Philips Electronics Japan, Minato-ku, Tokyo, Japan, 3Boston Medical Center, Boston University School of Medicine, Boston, MA

Purpose
Predicting the human papilloma virus (HPV) status of oropharyngeal squamous cell carcinoma (SCC) based on conventional imaging is challenging, however recent studies have reported the utility of CT perfusion parameters and mean apparent diffusion coefficient (ADC) value in determining HPV status. Apparent diffusion coefficient histogram analysis could provide a better assessment of tumors by quantifying tissue heterogeneity characteristics. The purpose of this study was to assess the ability of ADC histogram analysis to identify HPV status in oropharyngeal SCCs.

Materials and Methods
Clinical and imaging data of 19 patients with oropharyngeal SCC who underwent MR imaging prior to biopsy between April 2011 and November 2013 were retrospectively evaluated. MR imaging including diffusion weighted imaging was performed on each patient using a 3T MR scanner. Apparent diffusion coefficient map was generated by using 2 b-values (0 and 1000 s/
The regions of interest were drawn manually around the entire tumor on each slice to generate ADC histogram. Peak ADC value, skewness, and kurtosis were extracted from the histograms. These parameters were compared with HPV status using p16 immunohistochemistry as a surrogate marker for HPV infection. The histogram parameters were correlated with HPV status and evaluated by Mann-Whitney u test.

Results
Apparent diffusion coefficient histograms of representative cases are demonstrated in the figure. Significant differences were noted between HPV-positive SCC and HPV-negative SCC in peak ADC value (0.68 × 10⁻³ mm²/s versus 0.94 × 10⁻³ mm²/s, p=0.008). There were no significant differences in HPV status and skewness (p=0.48) or kurtosis (p=0.72).

Conclusions
Oropharyngeal SCCs show a distinct ADC histogram feature with peak ADC values in HPV-positive SCCs being significantly lower compared to HPV-negative SCCs. Apparent diffusion coefficient histogram analysis may be useful in determining HPV status in patients with oropharyngeal SCCs.

KEYWORDS: ADC, Oropharynx, Squamous Cell Carcinoma

(Filename: TCT_EP-121_Figurehistogram.jpg)

EP-130
Evaluation of Tracheal Size with Changes in Body Mass Index (BMI).

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Purpose
Enlarged thyroid gland is a potential cause of Positional Dyspnea. If there is substantial narrowing of the trachea near the thoracic inlet, patients are treated with partial thyroidectomy. However, it is not clear whether other factors, such as obesity, may influence baseline tracheal diameters and mimic tracheal compression, resulting in unnecessary surgery. This is especially important because Positional Dyspnea is linked with obstructive sleep apnea, which itself is associated with obesity. Our aim was to evaluate whether the baseline diameter of the trachea is influenced by patients' body mass index (BMI).

Materials and Methods
After institutional review board approval, 179 patients, 18 to 70 years old, who underwent CT angiography or CT of the cervical spine in the emergency room were randomly selected and their imaging was retrospectively evaluated. The BMI was calculated from weight and height, or taken directly from the clinical notes. The diameter of the trachea in anteroposterior (AP) and transverse (Trans) dimensions, as well as the cross-sectional area (using free hand region of interest tool), was measured at the first tracheal ring and in the sub sternal region. Pearson correlation coefficients along with the 95% confidence interval (CI) were computed to compare BMI and tracheal dimensions. Two-sample t-tests were used to compare male and female patients. All tests were two-tailed and deemed statistical significant when p<.05. All our analyses were conducted using SAS 9.3 statistical software, Copyright, SAS Institute Inc.

Results
No statistically significant association was found between BMI and any other variable. (Table 1). Statistically significant differences were found between the mean of males and mean of females for each of the tracheal dimensions. All p-values were <.0001 with males having larger tracheas than females.

Conclusions
No association was found between BMI and tracheal size. Tracheal compression in patients with goiter can be safely attributed to glandular enlargement, regardless of obesity status.

KEYWORDS: Anatomical Variation

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**EP-126**

**IDIOPATHIC TRIGEMINAL NEUROPATHY: CLINICORADIOLOGICAL ASPECTS IN TWO CASES**

C Agostinis¹, G Bonaldi², L MOSCHINI³, g pezzetti⁴

¹Ospedale Papa Giovanni XXIII, Alzano Lombardo, Italy, ²Ospedale Papa Giovanni XXIII, Bergamo, Italy, ³POLICLINICO SAN MARCO ZINGONIA, Bergamo, Italy, ⁴ospedale san raffaele Milano, Bergamo, Italy

**Purpose**

To present two cases of idiopathic gasserian ganglion enhancement.

**Materials and Methods**

Two male patients aged 50 and 43 years, respectively, with uneventful medical histories were evaluated because of subacute onset of subcontinous headache with neuralgic attacks and unilateral facial numbness. Neurologic examination revealed global hypoesthesia in the second and third division of the trigeminal nerve of the symptomatic side in both cases.

**Results**

Both patients had MRI showing enhancement of the gasserian ganglion on the symptomatic side extending to the mandibular nerve in both and to the cisternal segment of the trigeminal nerve in one case. In both cases the adjacent meninges of middle cranial fossa and parasellar region were also involved. Laboratory testing showed normal values for all routine measurements in both patients. They were treated with steroids over 10 days; one patient also received acyclovir for one week. In both cases symptoms progressively improved during the following weeks, with persistence of mild hypoesthesia at a 6-month clinical follow up. MRI with gadolinium 3 and 5 months later, respectively, demonstrated resolution of abnormal findings.

**Conclusions**

These cases can be considered as idiopathic inflammatory trigeminal sensory neuropathy. Few cases of this condition have been reported. Radiologist should be aware of this benign entity, which usually resolves within weeks and must be differentiated from other conditions such as perineural spread of head and neck neoplasms, lymphoma, sarcoidosis and bacterial and fungal infections. The similarity of MRI findings and clinical evolution with Bell's palsy suggests a similar etiology.
Imaging characteristics of nodal metastasis in HPV-positive HNSCC: Does extracapsular spread influence the prognosis?

A Fujita¹, K Buch², S Jalisi³, M Truong³, G Mercier³, O Sakai¹
¹Boston Medical Center, Boston University School of Medicine, Boston, MA, ²Boston University Medical Center, Boston, MA, ³Boston Medical Center, Boston University, Boston, MA

Purpose
Human papillomavirus (HPV)-positive head and neck cancers have been recognized as a distinct subtype of head and neck squamous cell carcinoma (HNSCC). Certain imaging features specific to HPV-positive lymph nodes have been described such as a cystic appearance. While nodal metastasis with extracapsular spread has been associated with a poorer prognosis in HNSCC, this feature has not been established as a poor prognostic feature in HPV-positive HNSCC patients. The purpose of this study was to evaluate imaging features distinguishing the nodal metastasis of HPV-positive from HPV-negative HNSCC. Additionally, these imaging features and HPV status of HNSCC were correlated with short term clinical outcomes and prognosis.

Materials and Methods
Following IRB approval, 142 patients with HNSCC (65 oropharynx, 40 oral cavity, 22 larynx, 9 hypopharynx, and 6 others) with known HPV status between December 2009 and October 2013 were reviewed retrospectively. Several imaging features of the nodal metastasis including internal consistency (solid, necrotic, or cystic), number, size, and presence extracapsular spread were assessed on pretreatment contrast-enhanced CT or MR exams. The TNM stage and treatment methods were recorded to correlate with the one-year short term outcomes. Basic descriptive statistics including a Student's t-test and Fischer's exact test were performed. P values less than 0.05 were considered statistically significant.

Results
Of 142 patients with HNSCC, 59 patients were HPV-positive (42 oropharynx, 6 oral cavity, 8 larynx, and 3 others) and 83 patients were HPV-negative (23 oropharynx, 34 oral cavity, 14 larynx, 9 hypopharynx, and 3 others). Nodal metastasis were more common in HPV-positive HNSCC with 44 patients (75%) compared to 45 patients with HPV-negative HNSCC (54%) (P = 0.01). There was no significant difference in the TNM stage and treatment method between patients with HPV-positive and HPV-negative HNSCCs. There was no significant difference in the prevalence of necrotic nodal metastasis between HPV-positive patients [26/44 (59%)] and HPV-negative patients [26/45 (58%)]. Cystic changes were noted exclusively in 7/44 (16%) HPV-positive patients with six of the seven (86%) HNSCC occurring in the oropharynx (one patient was unknown primary). Three patients with HPV-positive HNSCC had both necrotic and cystic changes. HPV-positive patients [34/44 (77%)] tended to demonstrate a higher prevalence of extracapsular spread of nodal metastasis compared to HPV-negative patients [26/45 (58%)]. Although the number and size of nodal metastasis were larger in HPV-positive patients, these results were not statistically significant. These features also did not correlate with presence of necrotic/cystic internal change or extracapsular spread. A total of 49 patients with nodal
metastasis completed a one-year follow-up evaluation after initial treatment with significant differences in disease free survival rates of 90% (19/21) in HPV-positive HNSCC and 46% (13/28) in HPV-negative HNSCC (P = 0.002).

Conclusions
While cystic nodal metastases were seen exclusively in HPV-positive HNSCC, there were no statistically significant differences in the presence of necrotic nodes and extracapsular extension in HPV-positive versus HPV-negative HNSCC. Nodal metastases were significantly more common in HPV-positive HNSCC while the prevalence of disease recurrence was significantly more common in HPV-negative HNSCC. Even though extracapsular spread was noted in the majority of the HPV-positive patients with nodal metastasis, the one-year disease recurrence rates were better compared to HPV-negative patients, which suggest that extracapsular spread of nodal metastasis may not be a poor prognostic factor for HPV-positive HNSCC.

KEYWORDS: Head And Neck, Lymph Node Metastasis, Squamous Cell Carcinoma

EP-113
6:30AM - 9:00PM

**Imaging of Phosphaturic Mesenchymal Tumors of the Head and Neck: Rare Tumors in Rare Places**

T Howard¹, C Hunt¹, A Kotsenas¹, C Giannini¹, J Morris¹
¹Mayo Clinic, Rochester, MN

**Purpose**
Phosphaturic mesenchymal tumors (PMT) are rare tumors of the soft tissues and skeleton that often present with oncogenic osteomalacia, a paraneoplastic process due to production of fibroblast growth factor-23 (FGF23). The purpose of this study is to describe the typical imaging features of these rare tumors when they occur in the head and neck.

**Materials and Methods**
A retrospective review of all pathologically confirmed PMT was performed at our institution occurring in the head and neck. Clinical presentation, serum laboratory values, and all available imaging were reviewed. Available MR imaging (MRI) and CT images were reviewed for typical features in consensus by two fellowship trained neuroradiologists.

**Results**
A total of four PMT were identified involving the head and neck, representing 24% of the PMT previously identified at our institution. While oncogenic osteomalacia is the classic paraneoplastic presentation for PMT, none of our patients with head and neck involvement presented with this finding, even though all had evidence of amplification of the FGF23 gene. The tumors with head and neck involvement were centered in the paranasal sinuses (n=2), skull base (n=1), and a frontal lobe mass with extraaxial extension (n=1). Imaging features were fairly uniform throughout our tumors. All tumors were heterogeneous but mostly iso- to hypointense on T1 and hyperintense on T2-weighted sequences. Cystic changes were common (2 of 4). Intense gadolinium enhancement was seen in all tumors, corresponding with hypervascular changes on conventional angiography. Involved bones were expanded with preserved morphology. Vascular encasement also was seen without evidence for luminal narrowing. Matrix
calcification production was not typical (1 of 4). Macroscopic fat was demonstrated in the frontal lobe mass with extraaxial extension (1 of 4).

Conclusions
PMT are rare tumors, but, when present, tumor involvement of the head and neck is not uncommon. Typical imaging features include expansion of the involved bone, intense enhancement, and vascular encasement without evidence for luminal narrowing. These imaging features, especially in the presence of an elevated FGF23, should strongly suggest the diagnosis of phosphaturic mesenchymal tumor.

KEYWORDS: Paraneoplastic, Skull Base Neoplasms

EP-123

Incidental Paranasal Sinusitis on Routine Brain MRI - Exploring a potential biomarker for links to Co-Morbidities of Periodontal Disease.

P Rosenthal¹, K Lundy¹, D Massoglia¹, M Gebregziabher², E Payne², G Gilbert³
¹Ralph H Johnson VA Medical Center, Charleston, SC, ²Medical University of South Carolina, Charleston, SC, ³Health Care Simulation South Carolina, Charleston, SC

Purpose
Incidental Paranasal Sinusitis (IPS) is common on imaging for unrelated disorders and thought not to be clinically significant in asymptomatic subjects (1,2,3). Recent Cone-Beam CT studies (4,5) have shown strong correlations of Periodontal Disease (PD) to IPS at the base of the maxillary sinuses, where, in our experience (6), IPS is most often seen on Brain MRs. Since PD is a risk factor for atherosclerosis (7) and is linked to other inflammatory disorders (8), our study tests if IPS may serve as a clinically relevant biomarker for underlying PD.

Materials and Methods
Expedited review and waiver obtained. Subjects random, the first 15 MR Brain scans here by month Jan - Dec 2009, excluding duplicate scans. Two MR and 1 EMR reviewers, each blinded to the others' findings. All MR scans from 1.5 Tesla Magnet, Siemens Avanto, with primary Sagittal T2 weighted Fast Spin Echo scan (5.0 / 5.5 mm), Matrix 384sq; TR4390.0–5150.0/TE97.0; view 230 mm. Other sequences were also available. IPS was scored as 0 normal, 1 mild, 2 moderate, 3 severe for each non-maxillary sinus. Maxillary sinuses, being larger, were scored from 0 - 6 in a similar way. The IPS scores by subject were summed for total out of 30. Significant IPS was summed score >/=6, equivalent to at least 1 fully inflamed maxillary sinus. Number of posterior maxillary teeth on MR also read. Reader 1 read all 180 MRs, reader 2 read only 115 contrast scans, to check IPS score accuracy. EMR review by subject drawn from Vista-CPRS, the Veterans Health Administration EMR. History of Cerebrovascular Disease, Coronary Artery Disease, Aortic Aneurysm, Peripheral Arterial Disease, erectile dysfunction; smoking, diabetes, hypertension, obesity, hyperlipidemia, statin use, rhinosinusitis, ENT surgery and treatment for allergies noted. Other entities possibly linked to PD also noted. Raw Odds Ratios (OR) correlating significant IPS to demographics, PD co-morbidities and risk factors were calculated. Modified ORs were then calculated to assess for effect modifiers or confounders.

Results
Of 180 exams, 7 excluded for nasal tubes, large dental artifacts, recent ENT surgery. 173
subjects analyzed, M:F:156:17, age 23.3 - 97.7 yrs (Means - all 62.4, M 64.1, F 46.3), Race 104 white, 69 non-white. Indications for MR - table. IPS scores: 0/30, sinuses all clear, N=48(27.7%); 0.5/30, sinuses clear except for tiny mural foci, N=29(16.8%); 1-2/30, minimal IPS up to 5mm thick, N=47(27.2%); 3-5/30, mild IPS, >5mm thickening, N=29(16.8%); >/=6/30, significant IPS, N=20(11.5%). Reader comparison - no significant difference (mean difference of IPS score by exam 0.46/30; SD 0.60). Significant correlations of IPS score >/=6 were most marked for: history of Cerebrovascular Disease - (stroke, transient cerebral ischemia (TIA) and carotid disease), (N 57, OR 5.969; p<.001); hypothyroidism (N 13, OR 6.042; p<0.005) and race, OR 7.011, more common in whites than non-whites (p=.0107). Milder significant IPS correlations were to: smoking, hypertension, statin use, rhinosinusitis and Grave's disease. None of the other atherosclerotic diseases or proxies showed correlations to IPS >/=6. There were Nonsignificant trends to IPS >/= 6: males at 5 times risk to females (p<.2), temporal arteritis (OR 7.993, p<.2) and history of autoimmune disease (OR 2.693, p<.2) Of scenarios controlling for age, race, smoking, hypertension, rhinosinusitis, statin use, Grave's and hypothyroidism, only hypothyroidism had a significant modifying effect on the IPS correlation to carotid disease and sequelae, OR 10.142, p<0.0007

Conclusions
Our study has several implications. It suggests that IPS may serve as a biomarker for chronic PD, with correlations to several entities previously linked to PD. In the absence of ostial or nasal passage obstruction on MR, IPS may be reported as likely due to underlying PD. Further, significant IPS on MR may signify almost a 6-fold increased risk for carotid artery disease and its cerebral ischemic sequelae, as compared with subjects with sub-significant or no IPS. The study results support prior studies favoring a causal link between PD and carotid intimal thickening (9) and basal maxillary sinus thickening (3,4,10) respectively. The passage of inflammatory agents via small veins and lymphatics has been suggested as a mechanism for IPS causation from PD (10). While not in equal proximity to the gums as the maxillary sinuses, our results suggest that a similar pathway may purvey inflammatory agents from the gums to the carotid arteries.

KEYWORDS: Periodontal, Sinonasal Disease, Stroke

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<td>Tumor, primary or metastatic</td>
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<td>Headache, Migraine</td>
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* some subjects had more than 1 indication > 100%
Measurements of Normal Inner ear in Children with Congenital Sensorineural Hearing Loss and a “Normal Temporal Bone CT Scan”.

F Bahador¹, J Nabi¹, L Lewin², M Darke², J Connors¹, A Fallahian¹
¹University of Missouri Health Care, Columbia, MO, ²University of Missouri School of Medicine, Columbia, MO

Purpose
The purpose of this study was to use standardized measurements of the inner ear to see whether there are subtle bony malformations in children with congenital sensorineural hearing loss whose temporal bone computed tomography are normal based on the current criteria.

Materials and Methods
IRB approval was obtained. Medical records and the pure-tone audiometric results of 339 patients, diagnosed with sensorineural hearing loss in our tertiary referral center were reviewed. Children with perinatal infections were excluded from the study. The high resolution temporal bone CT scans of the remaining 112 patients were reviewed retrospectively by two reviewers independently. Patients with cochlear, labyrinthine, aqueductal or IAC anomalies also were excluded. Fifty-six patients with 90 ears met the eligibility criteria. The control subjects, who included 55 patients with 90 ears, had undergone CT for the evaluation of cholesteatoma, mastoiditis, external ear disease or trauma. The CT scans of the SNHL and the control groups were performed between June 2004 and September 2011, and between September 2005 and August 2011, respectively. Two readers including a mid-level radiology resident and a radiologist with 11 years experience who did not have any knowledge of the other reader’s interpretations or audiometric results reviewed all CT scans independently. Standardized measurements including maximal height and length of cochlea and vestibule, canal lumen width and bony island width of superior semicircular canal (SSCC) and lateral semicircular canal (LSCC), canal lumen width and inferior limb length of posterior semicircular canal (PSCC) were made on axial and coronal CT images. Correlation was made with short and long axes to avoid error in measurements.

Results
Student’s t test was performed to compare the measurements of the two groups. No significant difference in the measurements of the inner ear structures was found in children with SNHL and without SNHL for both readers.

Conclusions
Prior studies demonstrated mixed results with regard to meaningful differences in inner ear structures between the patients with SNHL and control group, however the results of our study do not support those findings and we believe studies with larger sample groups are required to elucidate any meaningful difference. On the other hand, while measurements of the inner ear demonstrate good reproducibility, however, given to the susceptibility to systematic errors in measurement, they could be difficult to interpret. Audiometric evaluation remains the main component of evaluation in patients with sensorineural hearing loss and radiologic evaluation of the inner ear is more helpful in identifying vestibulocochlear dysplasias and should be considered to complement audiometric analysis, until more data is available.
### Microanatomy of the Chorda Tympani: Normal Variations on HRCT Temporal Bone Study

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(Filename: TCT_eP-134b_Results.jpg)
D Singh, S Bhuta, C Hsu, G Kwan

Gold Coast University Hospital, Gold Coast, Australia

Purpose
Iatrogenic injury of the chorda tympani nerve is a recognized complication of otologic surgery. The aim of the study is to define the normal anatomical variation of the chordae tympani through the posterior canaliculus of the mastoid temporal bone on high resolution CT (HRCT).

Materials and Methods
Retrospective review of 13 consecutive normal HRCT temporal bones study (8 males and 5 females, mean age 41 years) was performed. Scanning protocol included Ultra Hi-res algorithm on a Siemens Flash dual source CT scanner with parameters of 120KvP, 230 mAs. Images were obtained at 0.3 mm thickness and reconstructed at 0.4 mm for interpretation was reviewed by two independent authors (DS and CC-TH) using a standardized approach to enable reproducible measurements of two distances: a) origin of chorda tympani from posterior genu of facial nerve and b) lateral most position of the chorda tympani from the mastoid segment of facial nerve. Right- and left-sided comparison to assess symmetry was analyzed with paired t-test.

Results
The chorda tympani nerve was identified in all patients. The mean distance of the chorda tympani origin form the mastoid segment of the facial nerve was 11.6 mm (standard deviation, SD=3.4, 95% CI: 10.2-13.0). This distance was 10.8±3.3 mm on the right side and 12.4±3.5 mm on the left (mean±SD), with no statistical significance between each side (p=0.27). The most lateral position of the chorda tympani from the facial nerve extended to a mean distance of 1.3 mm (SD of 0.6, 95% CI: 1.2-1.7), range 0 to 2.5 mm and was 1.3±0.6 mm 1.3±0.8 mm on the right side (mean±SD). No statistical significance between each side was observed (p = 0.11). In all patients chorda tympani entered the middle ear cleft immediately posterior to the tympanic membrane.

Conclusions
Chorda tympani can be identified reliably on HRCT temporal bone studies on 0.4 mm thickness images. Reproducible measurements demonstrate variability in both origin from the mastoid segment of the facial nerve and its lateral most course. No significant right- versus left-sided asymmetry was found. Precise description of the course of the chorda tympani with HRCT study may be useful for planning of otologic surgery to limit inadvertent injury to the nerve during surgery.

KEYWORDS: Temporal Bone

EP-115

NEW APPLICATION OF ULTRASOUND FOR THE ASSESSMENT OF ORAL CAVITY CANCER – PILOT STUDY

S Foster, Y Anzai, J Dillon

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Purpose
Oral cavity cancer (OCC) imposes particular challenges to radiologists. Clinical examination may underestimate the depth of tumor involvement and CT or MR imaging (MRI) evaluation
often is limited by artifact secondary to dental work. The accurate assessment of the size and extent of OCC is critical for treatment planning especially in regards to decisions for surgery versus chemotherapy and radiotherapy. Ultrasound (US) is a minimally invasive imaging modality to characterize OCC without ionizing radiation. The goal of this pilot study is to apply US for evaluation of OCC to compare size and extent with CT/MR as well as surgical specimen.

Materials and Methods

Patients with newly diagnosed OCC from the Oral Surgery Clinic in our institution were recruited prospectively for this study. Written informed consent was obtained from all patients. These patients undergo a standard clinical assessment as well as MRI or CT as part of their routine staging. The ultrasound was performed within one to two weeks of the MRI or CT. The ultrasound was performed using both an intra-oral and submental approach. The intra-oral scan was performed using a 7-15MHz hockey stick probe and the external submental scan was performed using a linear 7-25MHz probe. The tumors were assessed for size in AP, transverse, and cranial caudal dimensions. Both intra-oral and submental scans were obtained in coronal and para-sagittal planes. Additionally, invasion of neurovascular structures within the sublingual space, involvement of extrinsic tongue muscles and distance from the midline raphe of the tongue were assessed when applicable. The size and extent of the tumors was compared between preoperative clinical assessment by the surgeon, MRI, ultrasound and with the pathological report from the surgical resection when available.

Results

Ultrasound adequately visualized the tumors in five out of seven patients. While the tumors were not clearly visualized with MRI/CT due to significant dental hardware artifact in two out of seven patients, ultrasound was successful in visualizing the lesions. In the five patients that went on to surgical resection, the ultrasound measurements correlated closely with the actual lesion size in three of the patients, minimally underestimated the size in one patient and minimally overestimated size in one patient. Ultrasound measurement closely correlated with estimated clinical size in six out of seven patients. Compared with the MRI measurements of the lesions, ultrasound correlated well in all comparable cases except one in which, neither MRI, ultrasound or clinical estimate of tumor size were comparable with the actual tumor size on pathological specimen.

Conclusions

Ultrasound is a useful adjunct imaging technique for assessment of oral cavity tumors, in particular when CT or MR is limited due to dental hardware. The assessment of tumor size on ultrasound appears to correlate well with the measurements of the lesions based on clinical assessment, MRI and pathological size in the majority of cases. The potential clinical application of ultrasound for evaluation of OCC is assessment of depth in relatively superficial tongue cancer or evaluation of deep extension to the neurovascular bundles.

KEYWORDS: Cancer, Head And Neck, Ultrasonography

Comparisson of the maximal dimension of the oral cavity tumors between clinical preoperative assessment, MRI measurement, US measurement and surgical specimen when available.

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Optimization and Diagnostic Utility of Dual Energy Multi-detector CT in Non-contrast CT Examination of the Head

Purpose
Dual Energy CT (DECT) allows for user-defined contributions from 80kVp and 140kVp weighting within the image. The diagnostic utility and optimal parameters of DECT for brain imaging have not been fully addressed in the literature. The aim of this study is to assess for the...
optimal parameters of DECT in evaluation of routine non-contrast head CT, by prescribing precise percentile contributions of the two different energy spectra and to compare image quality between routine non-contrast DECT versus conventional single energy CT (SECT).

**Materials and Methods**

Thirty patients underwent DECT of the head (Somatom Flash dual source CT, Siemens, Forcheim, Germany) using tube voltages of 80 and 140kVp. All patients had identical CT acquisition parameters. Studies were prospectively collected. Raw data were reconstructed using a soft convolution kernel and fused images were post-processed using a range of weighting factors which by convention are described as the percentage contribution of the 80kVp tube (0.1, 0.3, 0.5, 0.7, 0.9). Five sets of images were generated for each case. Three neuroradiologists blinded to the weighting factor and patient demographics evaluated these images independently based on 7 criteria: 1. pons visualization with regard to beam-hardening artifact; 2. clarity of the temporal lobes at the level of the ventricular horns; 3. distinctness of the insular cortex; 4. sharpness of the boundaries between the different components of basal ganglia; 5. centrum semiovale gray-white differentiation; 6. cortical sulcal clarity; and 7. overall image quality. The 7 criteria were assessed independently to avoid intra-observer bias. The reviewers selected the best and worst image for each criterion. Rank analysis was performed. In four patients, a previous non-contrast SECT of the head was performed utilizing the same scanner. Redacted SECT images were presented alongside 0.3 and 0.7 DECT images and ranked based on pontine artifact; deep nuclei visualization, gray-white matter distinction, cortical sulcal visualization and overall image quality.

**Results**

For pontine and cortical sulcal evaluation a low weighting factor (average of ~0.2) was considered to yield the optimal diagnostic image, whereas a high weighting factor was deemed the worst. For basal ganglia, gray-white differentiation and insular cortex evaluation, a high weighting factor (> 0.6) was considered to yield better diagnostic images. The categories of temporal lobe visualization and overall image quality showed high variance and no weighting factor was clearly superior. Radiation dose between DECT and SECT groups did not differ. DECT image quality consistently ranked higher than SECT for all criteria.

**Conclusions**

This study demonstrates that kV weighting factor renders a dramatic influence on the diagnostic quality of DECT brain imaging. Generally, a low weighting factor (0.2) is optimal for beam hardening artifact reduction and structural definition, whereas a high weighting factor (>0.6) is optimal for tissue contrast and conspicuity. Our findings indicate that two different weighting factors should routinely be included in DECT exam of the head to provide best diagnostic quality. Furthermore, our results suggest that DECT is superior to SECT for routine evaluation of the brain.

**KEYWORDS:** CT

**EP-122**

6:30AM - 9:00PM

Prevalence of venous sinus stenosis in pseudo tumor cerebra using digital subtraction angiography

M Ibrahim¹
Purpose: To Study the prevalence of intracranial venous stenosis in Pseudo cerebra patients.

Materials and Methods
Patients and methods: Thirty patients diagnosed as pseudo cerebra according to Dandy criteria. All underwent general and neurological assessment. Radiological assessment included CT scan brain +/- MRI brain without contrast, MRV. All underwent digital subtraction cerebral Angiography (DSA) (venous phase) to confirm the validity of filing gaps seen at the level of MRV.

Results

Results: MRV brain showed that 24 patients (80%) showed filling gaps. Digital subtraction cerebral angiography (venous phase) showed 9 patients (30%) had stenosis in their dural sinuses. MRV showed to be a good screening tool since it had 100% sensitivity and negative predictive value. However, since it has a moderate specificity (62%) with a positive predictive value (PPV) of only 35%, then lesions detected should be confirmed with digital subtraction cerebral angiography (venous phase) particularly those involving the transverse and sigmoid sinus.

Conclusions
Confirm with digital subtraction cerebral angiography (venous phase) particularly those involving the transverse and sigmoid sinus.

KEYWORDS: Sinonasal Disease

EP-118

Progression of Optic Nerve Ischemia on MR Imaging after Spinal Surgery

L Robinson1, J Yi2
1Bryn Mawr Hospital, Philadelphia, PA, 2Bryn Mawr Hospital, Bryn Mawr, PA

Purpose
Spine surgery is a risk factor for the development of optic nerve ischemia. While the ischemic pattern of the brain has been well documented with MR imaging (MRI), there are very few cases that show evolution of optic nerve ischemia with MRI. The MRI characteristics of posterior ischemic optic neuropathy has similar imaging characteristics and evolution to brain ischemia. MR imaging may be of benefit in identifying early cases of posterior ischemic optic neuropathy.

Materials and Methods
MR images of the orbits and brain were obtained over a three-week period.

Results
This case shows evolution of optic nerve ischemia similar to what is seen with brain ischemia, a finding that has not been described completely in the literature. Initial imaging showed restricted diffusion without significant enhancement. Imaging two weeks later showed resolution of restricted diffusion with development of bilateral optic nerve enhancement. These findings coincided with the patient's timing and clinical presentation of loss of vision and bilateral optic nerve infarcts. There have not been any articles published showing the progression of an optic
nerve infarct using DWI to confirm lack of diffusion with progression to optic nerve enhancement.

Conclusions
The MR imaging characteristics of stroke have been described very well in the brain, findings that also are seen in optic nerve ischemia. In the acute phase of ischemia increased signal can be seen on the diffusion-weighted images within 30 minutes of onset and lasts up to 10 to 14 days. Enhancement can be seen in the subacute phase starting between days four to seven and can last up to eight weeks. There are several types of visual loss that can occur following nonocular surgery including anterior ischemic optic neuropathy (AION), posterior ischemic optic neuropathy (PION), central retinal artery occlusion (CRAO), pituitary apoplexy and cortical blindness. Of these subtypes PION is the most frequent to occur following spinal surgery. The rate of postoperative vision loss varies in the literature between 0.1% to 0.2%. Risk factors from back surgery includes prone surgery, long operative time, massive hemorrhage and anemia. The patient had several risk factors for ischemic neuropathy of the optic nerve including obesity, position from back surgery and diabetes mellitus. The pathogenesis of postoperative PION is currently unknown. Several possible causes of postoperative PION include hypotension, patient positioning and anemia serve as a possible explanation. One possible explanation for ischemia is that patient positioning may lead to venous congestion which causes decreased intraocular pressure and leads to optic nerve ischemia. The posterior optic nerve is supplied by pial branches that originate from the ophthalmic artery, arteries that may not have the capabilities to autoregulate in conditions of severe hypotension. Although PION is important to recognize in its early stages, there is no standardized treatment at this moment. In the future MRI may be of benefit with early identification of patients with PION. Perhaps optimizing control of risk factors, limiting operative time and avoiding intraoperative hypotension may help avoid what can be a devastating disease.

KEYWORDS: Iatrogenic, Ischemia, Optic Nerve
Role of diffusion weighted MR imaging in differentiation Graves’ disease from painless thyroiditis

A Abdel Razek¹
¹Mansoura University, Mansoura, Egypt

Purpose
To assess the role of diffusion-weighted MR imaging in differentiating Graves' disease from painless thyroiditis.

Materials and Methods
Thirty-seven consecutive patients with thyrotoxicosis underwent diffusion MR imaging of the thyroid gland and thyroid function tests. Diffusion-weighted MR images were acquired with a b-factor of 0.250 & 500 sec/mm² using a single shot echo planar imaging. The scanning parameters were: TR= 10000 ms, TE=108ms, bandwidth=125 kHz, slice thickness =4 mm. The apparent diffusion coefficient (ADC) value of the thyroid gland correlated with thyroid function tests. Twenty healthy subjects served as a control underwent the same MR study.

Results
There was significant difference in the ADC value between patients with thyrotoxicosis and volunteers (P=0.003). The mean ADC value of thyroid gland in patients with Graves' disease was 0.66 ±0.22X 10⁻³ mm²/sec in patients with painless thyroiditis was 0.81 ±0.17X 10⁻³ mm²/sec. There was significant difference in the ADC values of patients with Graves' disease and painless thyroiditis (P<0.002). When ADC value of 0.72 X10⁻³ mm²/sec was used as a threshold value for differentiating of Graves' disease from painless thyroiditis, the best result was obtained with an accuracy of 90%, sensitivity 92%, specificity 91%, positive predictive value 85% and negative predictive value of 86%. The mean ADC value correlated with serum free T3 (r =0.85) and TSH (r=0.84).

Conclusions
We concluded that ADC value of thyroid gland can be used for diagnosis of thyrotoxicosis and to differentiate Grave's disease from painless thyroiditis.

KEYWORDS: Thyroid

Role of diffusion weighted MR imaging in differentiation of Sjogrene disease from IgG4-related dacryoadenitis and sialadenitis

A Abdel Razek¹
¹Mansoura University, Mansoura, Egypt
Purpose
To assess role of diffusion MR imaging in differentiation of Sjögren's disease from IgG4-related dacryoadenitis and sialadenitis.

Materials and Methods
This study was conducted upon 24 consecutive patients (8 male and 14 female aged 15-29 years) with bilateral diffuse lacrimal and or parotid enlargement. They underwent single shot echo planar diffusion-weighted MR imaging of head and neck with b-factors of 0, 500 and 1000 sec/mm2. Apparent diffusion coefficient (ADC) maps were reconstructed. The ADC value of the lacrimal gland was calculated.

Results
The mean ADC value in Sjogren's disease (0.98±0.12X10⁻³ mm²/sec) was significantly lower (P<0.001) than that of IgG4-related dacryoadenitis and sialadenitis (1.12±0.11X10⁻³ mm²/sec). When apparent diffusion coefficient value of 1.02X10⁻³ mm²/sec was used as a threshold value for differentiating Sjogren's disease from IgG4-related dacryoadenitis and sialadenitis, the best results were obtained with an accuracy of 89%, sensitivity of 94%, specificity of 82%, negative predictive value of 91% and positive predictive value of 93%.

Conclusions
Apparent diffusion coefficient value is a noninvasive promising imaging modality that can be used for differentiation of Sjogren's disease from IgG4-related dacryoadenitis and sialadenitis.

KEYWORDS: Lacrimal Apparatus, Parotid Gland

Stationary Digital Tomosynthesis for Neuroradiology Applications

Y Lee¹, L Burk², J Lu², J Shan², O Zhou²

¹The University of North Carolina at Chapel Hill, Chapel Hill, NC, ²The University of North Carolina at Chapel Hill, CHAPEL HILL, NC

Purpose
Linear tomography was invented to visualize planes of structures within the body soon after the discovery of x-rays. However, after computed tomography (CT) was invented, linear tomography's use declined. More recently, there has been significant renewed interest in digital x-ray tomosynthesis, which utilizes limited angle acquisition and reconstruction to generate a pseudo 3-D volume. The current clinical applications for x-ray tomosynthesis have focused on breast and chest imaging, however, the physical translation of the x-ray tube has limited both resolution and imaging speed. The carbon nanotube (CNT) based x-ray source enables the creation of completely stationary tomosynthesis systems with both linear and non-linear geometries. This allows faster imaging with no associated focal spot blur. The goal of the study was to explore these novel stationary tomosynthesis systems for neuroradiology applications.

Materials and Methods
A stationary tomosynthesis setup was implemented with prototype linear and non-linear geometry multi-beam CNT based x-ray sources. Additional non-linear geometries were also simulated using physical translation of the CNT x-ray tubes. Images were acquired with a conventional digital flat panel detector and reconstructed with a filtered back-projection based
reconstruction algorithm (Real Time Tomography, Villanova, PA). A pseudo 3-D volume was created for each acquisition, reconstructed to 1 mm slice thicknesses. Imaging was performed on both phantom and cadaveric specimens using body part specific protocols. Specific areas of interest included the face, sinuses, and the cervical, thoracic and lumbar spine. A reader study was performed with board-certified neuroradiologists and trainees to evaluate the utility of the images for visualizing the osseous structures in the areas of interest. Readers were asked to document their confidence in localization of structures and the degree of osseous detail in the tomosynthesis image stack. Readers were also asked to identify the presence of artifacts, and the interpretability of the images in the presence of the artifacts.

Results
Stationary digital tomosynthesis images were successfully acquired of each of the regions of interest. Average scan times were approximately 10 to 15 seconds (linear acquisition) and primarily limited by detector readout times. In-plane image quality was felt to be high, and effective for localization and the evaluation of osseous detail. Spatial localization in the through plane was more limited, as anticipated with the tomosynthesis acquisition approach. Artifacts were greatest when there was significant bone overlap, such as in the sinuses. Wider angles of acquisition were more effective at removing these overlap artifacts, at the expense of requiring a wider angle of x-ray acquisition. Soft tissue evaluation was severely limited, as expected. Radiation dose was measured to be approximately 20% of conventional CT acquisitions.

Conclusions
Stationary digital tomosynthesis has the potential to provide high resolution in-plane imaging for neuroradiology applications. Though conventional CT has advantages in true 3-D imaging and multi-planar reconstruction, the ability to acquire 3-D images using a system with no moving parts has significant potential in mobile, trauma, and battlefield type applications. Furthermore, the potential radiation dose reduction compared to CT would further enhance applications in radiation sensitive populations. Work is ongoing to develop a full clinical prototype system.

KEYWORDS: C-Arm Cone Beam, C-Arm CT Imaging, Spinal Imaging

**EP-129**

*6:30AM - 9:00PM*

**Ultrasound Guided Thyroid Nodule Biopsy and Correlation with Imaging Features**

Z Junwei\(^1\), A Gopinathan\(^1\)

\(^1\)National University Hospital, Singapore, Singapore

Purpose
To evaluate sonographic features predictive of malignancy or benignity in thyroid nodules.

Materials and Methods
From a registry of 559 ultrasound guided fine-needle aspiration biopsies (FNABs) performed at a single tertiary institution between January 2010 and April 2013, 388 thyroid nodules in 325 patients (M:F 61:264; mean age: 52.5 years) which had a pathological diagnosis and pre-biopsy diagnostic ultrasound study were identified. The pre-biopsy ultrasound images were reviewed by a radiologist blinded to the pathological diagnosis. The sonographic features of the thyroid nodules were assessed with respect to their echotexture, shape, margins, size, multiplicity, vascularity, calcifications, extrathyroid extension and cervical lymphadenopathy. A Fisher's
exact test was performed. Sensitivity, specificity, and positive and negative predictive values were obtained.

Results
Malignancy was noted in 7% of the nodules. The presence of microcalcifications (sensitivity, 44.4%; specificity, 98.9%), irregular margins (sensitivity, 59.3%; specificity, 97.8%), marked hypoechogenicity (sensitivity, 38.5%; specificity, 98.5%) and a taller-than-wide shape (sensitivity, 22.2%; specificity, 94.5%) were features consistently seen in malignant nodules while benign nodules were isoechogetic (sensitivity, 56.8%; specificity, 88.5%), had comet tail artifacts (sensitivity, 31.9%; specificity, 96.2%), had a hypoechoic halo (sensitivity, 67.6%; specificity, 88.0%) and were purely or predominantly cystic (sensitivity, 21.6%; specificity, 96.3%). The association between these sonographic features and malignancy or benignity of the nodule was statistically significant (p<0.05). All 5 nodules associated with cervical lymphadenopathy were malignant. The presence of at least one malignant finding had a sensitivity of 85.2%, a specificity of 91.1% and a diagnostic accuracy of 90.7%.

Conclusions
Sonographic features are useful in differentiating between malignant and benign thyroid nodules. High sensitivity, specificity and diagnostic accuracy for malignancy can be achieved using a combination of features.

KEYWORDS: Fine Needle Aspiration, Thyroid, Ultrasound-Guided FNA

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Poster - Interventional
EP-159

Adjunctive C-arm CT Imaging with Mechanical Thrombectomy Using Solitaire Stent Retriever for Endovascular Recanalization in Acute Ischemic Stroke.

B Mitchell¹, P Chinnadurai², G Chintalapani³, H Morsi⁴, H Shaltoni⁴, M Mawad⁵
¹Baylor College of Medicine, Houston, TX, ²Siemens Medical Solutions USA Inc., Hoffman Estates, IL, ³Siemens Medical Solutions USA Inc, Hoffman Estates, IL, ⁴St. Luke’s Hospital, Houston, TX, ⁵Baylor College Of Medicine, Houston, TX

Purpose
Rapid treatment of acute stroke with endovascular methods frequently depends on acquiring as much information as possible regarding vessel blockage and distribution of any thrombi in order to effectively deploy retrievable stent thrombectomy devices. We describe the use of C-arm CT in conjunction with mechanical thrombectomy during treatment of acute stroke to aid vascular recanalization efforts.

Materials and Methods
Intra-procedural C-arm Computed Tomography was used in a series of 18 consecutive patients undergoing endovascular treatment to determine areas of maximal stent distortion during thrombectomy for treatment of an acute stroke. Patient outcomes were then analyzed including
extent of reperfusion, post-treatment changes in NIH Stroke Scale, patient survival, and the presence of post-treatment hemorrhage.

Results
Eighteen consecutive cases of acute stroke treatment using Solitaire Retriever devices were included in this study. Intra-procedural C-arm CT allowed for clear visualization of stent distortion in areas of arterial blockage, indicating accurate stent placement. Clot removal with successful recanalization of occluded cerebral arteries was achieved in 15/18 cases (83.3%) with TICI scores of 2B/3 all patients with initial recanalization, using combined C-arm CT and retrievable stent thrombectomy, NIH stroke scale improved on average from 19 pre-treatment, to 11 post-treatment, and 72% of patients survived. Post treatment hemorrhage was observed in 28% of patients (5/18), with 4 of those 5 patients having achieved recanalization during treatment.

Conclusions
Use of C-arm CT may aide the positioning of stroke treatment devices for more rapid treatment and maximally efficient device placement, maximizing the possibility of rapid arterial recanalization following acute embolic stroke. Our data indicates that the severity of strokes can be reduced rapidly by using this method of mechanical thrombectomy.

KEYWORDS: Stents, Stroke, Thrombectomy

Treatment with retrievable stent placement across thrombosed MCA. (A) A-P fluoroscopic view of deployed Solitaire stent device on the first pass across the thrombus. Visualization of the device is poor; arrows indicate approximate location of the stent. (B) C-arm CT of the deployed stent across thrombus – note the narrow diameter of the stent, indicating presence of surrounding thrombus, preventing the stent from full expansion (C) A-P fluoroscopic view of second-pass of the Solitaire device. (D) C-arm CT of the second-pass of the solitaire device - now the stent is able to more fully expand within the artery, although there is still thrombus present. (E, F) 3-D reconstructions of first-pass (gray) and second-pass (red) showing interval expansion of the stent once a large portion of the thrombus had been removed. (G) Retrieved thrombus from the first and second passes in the MCA.
An Analysis of Intraoperative Adverse Events for Interventional Therapy of Intracranial Aneurysms Based on Ruptured Status

S Mangla¹, Y Karim¹, A Eldib¹
¹SUNY Downstate Health Science Center, Brooklyn, NY

Purpose
Interventional therapy has become the primary treatment modality for cerebral aneurysms in most cerebrovascular centers. A growing volume of experience has demonstrated increased capability to successfully treat a larger variety of morphologies and presentations. We analyzed our single operator experience including primary success, retreatment rates, use of adjunct devices, and adverse events with respect to presentation, unruptured cerebral aneurysms (UIAs) vs. SAH/ICH associated aneurysms (SAHa).

Materials and Methods
We performed a retrospective review of clinical records and imaging of a prospectively maintained database of aneurysm therapies performed from 3/01/04 to 6/30/13. Data gathered included presentation (SAHa/UIA), primary success of treatment, retreatment, adjunct devices (stents/balloons), intra-operative adverse events (embolic/hemorrhagic), and immediate clinical outcome (<24 hours).

Results
A total of 131 aneurysms were treated in 107 patients in 123 operations (66 UIA and 65 SAHa). Treatment was successfully achieved in 124/131 (94.7%), and 9/131 (6.9%) represented retreatments or staged operations. Stents were employed in 15/131 (11.5%), and Balloon remodeling in 47/131 (35.9%). In the SAHa group, we experienced 7 (10.8%) intraoperative perforations of the aneurysm with no neurological deficit/change, disabling stroke, or death in 2(3.1%), 2(3.1%), 3(4.6%) patients respectively. Embolic events (including coil migration) were experienced in 2(3.0%) operations: 1(1.5%) with no deficit, 1(1.5%) disabling stroke, 0 deaths. In the SAHa group, overall intraoperative mortality(<24hrs) was experienced in 3(4.6%), with disabling stroke in 3(4.6%). In the UIAs, we experienced 2(3.0%) intraoperative perforations of the aneurysm with no neurological deficit/change, disabling stroke, or death in 2(3.0%), 0(0%), 0(0%) patients respectively (Table). Embolic events (including coil migration) were experienced in 3(4.5%) operations: 1(1.5%) with no deficit, 2(3.0%) disabling stroke, 0 deaths. In the UIAs group, overall intraoperative mortality was 0 with disabling stroke in 2(3.0%).

Conclusions
Cerebral Aneurysms presenting with SAH/ICH are at significantly higher risk of experiencing aneurysm perforation when compared with UIAs. Embolic event rates are similar between the groups. Overall intra-operative disabling morbidity and mortality rates for aneurysm therapy are higher with ruptured presentation (9.2%) vs. (3.0%).

KEYWORDS: Aneurysm Embolization, Aneurysm Treatment, Complications
Analysis of radiation dose trends and practices during diagnostic cerebral angiography before and after the implementation of dose reduction strategies

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Purpose
Despite the increased utilization of noninvasive imaging, cerebral digital subtraction angiography (DSA) remains the gold standard technique for the evaluation of many cerebrovascular disorders. This study analyzes the radiation dose trends and practices during diagnostic cerebral angiography before and after the implementation of radiation dose reduction strategies.

Materials and Methods
This study was approved by our Institutional Review Board. A retrospective review of a single operator's prospectively collected cerebral angiograms from 2010 to 2013 was performed. Inclusion criteria included adult and pediatric patients undergoing a diagnostic cerebral angiogram from January to June 2010 to 2013. Embolization procedures were excluded as well as those patients in whom the radiation dose reports were unavailable. A maximum number of 50 adult cases per year were considered. All angiograms were performed using a biplane angiography system (Artis Zee, Siemens, Germany). Cerebral angiograms and procedure exam protocols were reviewed for patient age, gender, diagnosis, angiography techniques (DSA frame rate, number of exposures, inclusion of aortic arch evaluation, 3D-DSA, or DynaCT), and radiation dose expressed as fluoroscopy time, reference point air kerma (K\(_{a,r}\) in mGy), and kerma-area product (PKA in µGym²).

Results
From January 2010 to June 2013, a total of 231 diagnostic cerebral angiograms were reviewed including 200 adults and 31 children. Adult patients ranged from 19 to 94 years (median 54 years) and included 77 men and 123 women. Pediatric patients ranged from 2 to 18 years (median 10 years) and included 11 boys and 20 girls. The most common diagnoses in adult patients were unruptured intracranial aneurysm (36%) and subarachnoid hemorrhage (18.5%), whereas in children, moyamoya vasculopathy (35.5%) and arteriovenous malformation (22.6%) predominated. The median K\(_{a,r}\) and PKA per adult patient significantly decreased from 2010 (1867 mGy, 21,231 µGym²) to 2013 (653 mGy, 7,860 µGym²), (p < 0.001). The same trend was observed in pediatric patients: 2010 (644 mGy, 6,495 µGym²) and 2013 (138 mGy, 1,465 µGym²). The average DSA frame rate per year decreased for both adults from 3.94 f/s (2010) to 2.04 f/s (2013) and children, 4.22 f/s (2010) to 2.07 f/s (2013). Figure 1. The boxplots show a continuous decline in the median patient radiation doses, expressed as K\(_{a,r}\) (left image) and PKA (right image), since 2010.

Conclusions
Increased radiation awareness and implementation of radiation dose reduction strategies resulted in decreased radiation doses both in adult and pediatric patients. The use of lower and variable DSA frame rates as well as tailored examinations contributed significantly to the reduced radiation doses observed during diagnostic cerebral angiography without a perceived reduction in imaging quality or clinical value.
Anterior Cerebral Artery Embolism as a Complication of Mechanical Thrombectomy of Middle Cerebral Artery Occlusion

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Purpose
Mechanical thrombectomy is an effective procedure in acute stroke caused by large vessel occlusions. Clot fragmentation and migration can occur as an adverse event, and potentially be a source of embolism to other arteries. Anterior Cerebral Artery (ACA) embolism after Middle Cerebral Artery (MCA) thrombectomy has been reported and studied. The aim of our study was to assess its frequency and clinical impact in a single centre experience.

Materials and Methods
We analyzed our prospective acute stroke registry and identified 77 patients with isolated M1 occlusions treated by mechanical thrombectomy between May 2009 and December 2012. We reviewed clinical data on admission and after thrombectomy, angiographic images, technical aspects on the thrombectomy procedures, and follow-up imaging to document for ACA infarcts.

Results
11 patients were excluded by insufficient data. A total of 66 patients with M1 thrombectomy
procedures were analyzed. In 77.2% of cases a stent retriever was used. Concerning the total number of patients, the mean TICI score was 2.2. All procedures included proximal occlusion with balloon-guide catheter and distal aspiration. 5 patients (7.6%) had documented embolism to the ipsilateral ACA (one bilateral). ACA recanalization (chemical and/or mechanical) was attempted in all cases, and was successful in 4 with a final TICI score of 2b. On the follow-up imaging, 3 patients (4.5%) had acute ACA infarcts but without significant increase in NIHSS score after the procedure.

Conclusions
ACA embolism is a known complication of MCA thrombectomy. This study reported an incidence of 7.6% of this complication, less when compared to other similar studies. The routine use of proximal occlusion and distal aspiration while performing thrombectomy probably reduced the possibility of clot migration in our series of cases. ACA infarcts on imaging studies occurred in 3 of the 5 patients that had ACA embolism but there was not a significant clinical impact.

KEYWORDS: Acute Stroke, Emboli, Thrombectomy

EP-150

Calcium Polyphosphate: A New Radio-opaque Liquid Embolic Agent

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Purpose
Current liquid embolic agents for vascular embolization are not inherently radio-opaque. These materials require the addition of a contrast agent for radio-opacity. Calcium polyphosphate (CPP) is a novel, inherently radio-opaque two-part embolic agent that forms a gel in situ when a sodium polyphosphate solution and a calcium solution are injected simultaneously, with the divalent calcium ions creating crosslinks between the polyphosphate chains. This work examines the in vivo biocompatibility, setting and occlusion ability of this new liquid embolic agent in a rabbit model.

Materials and Methods
Three New Zealand white female rabbits (4-5 kg) were subcutaneously implanted in the back with pre-formed CPP gels, Surgifoam® gelatin sponge controls (soaked for 2 h in 50% iodated contrast), Onyx18® controls (soaked for 2 h in phosphate buffer solution) and sham surgery sites for 1 and 2 weeks. Just before euthanasia, the central artery of each rabbit ear was embolized by 0.25 mL of polyphosphate solution (0.933 mol L−1 PO3, 2.2 mol% Sr, 9 mol% Ba and 3.8 mol% Ca) and an equal volume of 0.33 M CaCl2. The solutions were simultaneously injected through a concentric needle device to model a dual lumen catheter. Formation of gel in the vessel and occlusion was confirmed by x-ray and histology. Tissues were explanted, sectioned while frozen (10 µm), stained with H&E and examined by light microscopy (magnification x40).
Results
Biocompatibility tests showed no signs of adverse reaction, inflammation, swelling or macroscopic changes in the tissue surrounding the subcutaneous implants after 1 and 2 weeks. On histology, a new reaction layer of cells had formed around the implants by 1 week but not in the sham surgery sites (Fig. 1). This layer had a similar morphology for all implants and was thinnest surrounding Onyx®, and thickest surrounding the gelatin sponge (as indicated by arrows). The gelatin sponge also had the greatest resorption at two weeks when cell ingrowth into the porous gelatin matrix was observed. CPP embolic agent successfully occluded the auricular artery in a controlled fashion over several minutes and distal penetration of contiguous small arteries was demonstrated (Fig. 2a). Histological cross-sections of the central artery of the ear confirmed complete cross-sectional filling (d=0.48 mm) (Fig. 2b).

Conclusions
A novel CPP based radio-opaque liquid embolic agent demonstrates initial biocompatibility and forms a gel in vivo which successfully occluded a rabbit auricular artery.

KEYWORDS: Embolization
Carotid Elongation Does not Affect Angiographic Results of Mechanical Thrombectomy in Acute Stroke

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Purpose
New techniques have substantially raised recanalization rates of mechanical thrombectomy in acute ischemic stroke in the last few years with initial prospective trials reporting good neurological outcomes in up to 58% of the cases. However some recent highly disputed reports questioning the benefit of endovascular therapy have boosted the discussion about the importance of patient-selection. The purpose of this study was to investigate whether an elongation of the carotid artery affects the angiographic outcome of the recanalization procedure in MCA-occlusions.

Materials and Methods
The data of 54 patients with occlusions of the M1-segment who underwent mechanical thrombectomy was included. The lengths of the carotid arteries were measured using preinterventional CT-angiograms. To take individual patient height into account these lengths were divided by the length of the spine from the tip of the dens to the bottom of the th3 vertebral body (referred to as CS-Ratio). Angiographic results were scored according to the mTICI-score.

Results
Recanalization with mTICI ≥ 2b was achieved in 83.3%. The mean CS-Ratio was 1.32 ± 0.13. There was a significant correlation between the CS-Ratio and the age of the patients. There were no significant differences in the CS-Ratios of occlusions that were successfully recanalized and those that were not. Neither were there significant correlations of the CS-Ratio and the length of procedure or the number of deployments of the stentretrievers.

Conclusions
In this retrospective analysis we report that carotid elongation does not affect angiographic results of mechanical thrombectomy in acute stroke.

KEYWORDS: MCA Occlusion, Mechanical Thrombectomy, Stroke

Clinical Outcome in Acute Embolic Stroke With High Clot Burden: Comparison of Neurothrombectomy and Systemic Thrombolysis

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Purpose
To evaluate the efficacy and safety of neurothrombectomy in the treatment of acute embolic stroke in patients selected by a thrombus length of >= 8 mm using the stent-retriever Trevo Pro device.

Materials and Methods
Forty patients (mean age 66.7±14 years; 27 females) with acute artery occlusion in the anterior circulation with a thrombus length of >= 8 mm as measured on non contrast-enhanced cranial CTs were treated with neurothrombectomy additionally to standard stroke treatment between January 2011 and March 2012 (mean NIHSS on admission 15.3). Twenty-five patients were treated with mechanical thrombectomy alone, the remaining patients were treated with additional i.v.-thrombolysis (bridging concept). We compared the outcome to a historical group of 42 patients (mean age 71.5±11.6; 21 females) with a thrombus length of >= 8 mm that received systemic thrombolytic therapy only (mean duration of symptoms 74.3±27 minutes, mean NIHSS on admission 13.1). Clinical outcome (modified Rankin scale) was assessed on admission, at discharge and at day 90.

Results
Thrombectomy group and control group data on admission did not differ except for time from symptom onset until time of admission (156.2 min vs. 74.4 min; p=0.001). The mean duration from admission to start of angiographic interventions (including time to establish general anaesthesia) was 75.8±37.1 minutes (range 29 to 189 minutes). Artery recanalization (Thrombolysis In Cerebral Infarction Score 2b or 3) was achieved in 33 patients (83%). The mean time from symptom onset to recanalization was 319.9±99 minutes. Treatment-related complications occurred in 3 patients (8%). Mean modified Rankin scale score on admission was 4.6±0.6 (thrombectomy) vs. 4.38±0.8 (control), at discharge 3.00±1.8 vs. 4.7±1.3, (p<0.01) and at day 90 2.6±1.8 vs. 4.8±1.2 (p<0.01), respectively. On Day 90, 7 vs. 24 patients experienced no improvement on the modified Rankin scale. Symptomatic intracranial hemorrhage occurred in 3 vs. 7 patients, 3 vs. 17 patients died within 90 days (thrombectomy vs. control each).

Conclusions
This study in patients with high clot burden found that thrombectomy with the Trevo Pro device has an acceptable risk and was superior to iv-thrombolysis alone. This suggests that stratifying treatment for clot length by 8 mm might be a powerful approach to improve the outcome of mechanical thrombectomy.

KEYWORDS: Stroke, Thrombectomy, Thrombolysis
unruptured intracranial aneurysms from January 2010 to May 2012 in Halifax Infirmary Hospital. The coil protrusion was divided into: mass, loop, tail or no protrusion. These patients were followed up both clinically and by imaging. The use of anti-platelet and any thromboembolic events during the procedure and in the follow up visits were documented.

Results
We had 90 patients and 93 aneurysms. Ruptured aneurysms were 53 (57%) and unruptured aneurysms were 40 (43%). Thirteen aneurysms (14%) of unruptured aneurysms were treated using SILK flow diverter. Anterior circulation aneurysms account for 62.4% and posterior circulation account for 37.6% of total aneurysms. Balloon remodeling was used in 9 patients, stent was used in 4 patients and double microcatheter technique in one patient. Most of the coiling were not protruding into the parent vessel (54.2%). Loop protrusion is seen in 25%, mass protrusion in 18% and tail protrusion in 2.8%. Antiplatelet was prescribed to 36.4 % of patients with coil protrusion. Thromboembolic events were noted in one patient with no protrusion, one patient with loop protrusion on Antiplatelet and in one patient with loop protrusion who did not receive Antiplatelet. Seven patients died within 30 days of coiling, all of them presented with SAH.

Conclusions
There is small risk of thromboembolic events if part of the coiling protrudes into the parent vessel.

KEYWORDS: Aneurysym, Aneurysm Treatment

EP-142

Development and Validation of an Endovascular Chemotherapy Filter Device for Removing High-Dose Doxorubicin from the Blood: In Vivo Porcine Study

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Purpose
A novel disposable endovascular chemotherapy filter (CF) device was developed to remove excess doxorubicin (Dox) from the blood during intra-arterial chemotherapy delivery to prevent systemic toxicities. Previous proof-of-concept established the capacity of the filter to bind Dox in swine serum in vitro. In this study, CF navigation, deployment and in vivo Dox binding was evaluated in the porcine inferior vena cava (IVC).

Materials and Methods
An 18 Fr CF device was constructed with an ion-exchange membrane attached to an expandable 28 mm diameter Nitinol frame. Under X-ray fluoroscopy and contrast venography, the CF was percutaneously introduced via the internal jugular vein and deployed in the porcine infrarenal IVC. 50 mg of Dox (2 mg/ml) was injected over 10 min in the IVC below the CF device. Venous catheters with tips proximal and distal to the CF device in the infrarenal IVC obtained pressures and blood samples for Dox concentrations over 90 min across the CF device membrane.

Results
The CF device was successfully introduced and deployed in the infrarenal IVC in vivo. Visualization under X-ray fluoroscopy verified the proper placement and mechanical expansion
of the Nitinol framework. In a 90 min study, the device was biocompatible, not leading to hemodynamic disturbances: pressure measurements taken throughout the experiment yielded a max gradient of 17 mmHg across the CF membrane. Venography demonstrated non-flow-limiting thrombus associated with the CF device after 90 min of deployment (swine were not heparinized). Significant Dox binding was noted with an 85%, 74%, and 83% decrease in relative pre- versus post-filter Dox concentrations at times 3, 10, and 30 min, respectively after Dox injection.

Conclusions
We developed a biocompatible CF device that can be safely introduced, deployed, and removed from the IVC in vivo. The CF device demonstrated significant Dox binding, and could serve as a platform technology in drug therapy to allow for higher regional doses of drug while limiting systemic toxicity. This technology may be readily adaptable to primary cancers of the head and neck, brain, and spine, with deployment in the relevant vein(s) draining those organs. Future work will modify the filter and its binding capacity to address particular chemotherapeutics of interest for a given diseased organ.

KEYWORDS: Chemotherapy, Devices
Do Arch and Carotid Characteristics on CT Angiography Predict Delay in Puncture to Device Deployment Time in Acute Ischemic Strokes?

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Purpose
Time to successful reperfusion is a significant predictor of a good clinical outcome in acute ischemic stroke. We aimed to identify whether certain anatomical characteristics of the aortic arch and carotid artery on CT Angiography (CTA) predicted delays in the time interval from groin puncture to first device deployment during endovascular stroke treatment.

Materials and Methods
We included patients with clinically-disabling stroke and an anterior circulation proximal occlusion that had CTA and underwent endovascular therapy from January 2011 to February 2013. We explored 10 anatomical characteristics pertaining to the anatomy of descending aorta, aortic arch, cervical, and intracranial carotid arteries (table 1). The time interval from groin puncture to first device deployment (PD time) was the primary end point. We first evaluated the impact of these individual characteristics on delays in PD time and then collectively investigated these characteristics to identify the predictors of PD time delay of 30 mins or more using logistic regression models.

Results
Among 125 patients identified, males were 55.2% and median age was 69 years (inter-quartile range: 16). Median time for puncture to first run was 5 mins (7), puncture to first device deployment was 20 mins (15) and puncture to recanalization was 43 mins (48) (Figure 1). Successful recanalization (TICI 2b or 3) was seen in 78.4 % (98/125) patients. A non-conventional origin of great vessels from the arch (category 1 or 2, table 1) predicted delay in median PD time (p=0.02). The presence of common carotid tortuosity and cervical ICA loops increased PD time. Presence of 2 or more cervical ICA loops increased the time significantly. Other characteristics including types of arch (1 - 3), carotid stenosis or thrombus and intracranial ICA tortuosity did not show significant PD time delays. Logistic regression analysis showed that presence of any one of these characteristics viz. non-conventional origin of great vessels from the arch, tortuosity of common carotid artery and cervical ICA loops increased the odds ratio for PD time delay of more than 30 mins by 2.54 [95% CI: 1.04 to 6.23], p=0.04. However, median PD time in the presence of any of these three characteristics was 21 (23) mins and in the absence of these characteristics was 17 (10) mins. We identified 10 outliers who took more than 50 mins for puncture to device deployment. Factors responsible for this were presence of atypical origin of great vessels, common carotid and cervical ICA tortuosity, age > 65 years, distal occlusions (M2 MCA), unsuccessful recanalization and procedures performed during evening and night hours.

Conclusions
The presence of any of non-conventional origin of great vessels from the arch, common carotid
artery tortuosity and cervical ICA loops predict delay in puncture to device deployment time. Early identification and reporting of these features to the interventional team before the procedure may help mitigate delays. However, its important to realize that these features do not always result in delays subject to operator experience.

KEYWORDS: Interventional, Intraarterial, Stroke

Table1. Anatomical characteristics analyzed.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Categories and definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin of great vessels</td>
<td>0 – Conventional origin of great vessels (Brachiocephalic, left CCA and left Subclavian arising separately from the Arch)</td>
</tr>
<tr>
<td></td>
<td>1 – Common origin of left CCA and Brachiocephalic</td>
</tr>
<tr>
<td></td>
<td>2 – left CCA arising from innominate artery</td>
</tr>
<tr>
<td>Types of Arch</td>
<td>0 – Type 1 (Brachiocephalic/CCA arise at the same level as the top of arch)</td>
</tr>
<tr>
<td></td>
<td>1 – Type 2 (Brachiocephalic / CCA arise at lower level from top of arch. The distance between origin of these vessels and top of arch is &lt;= twice the diameter of CCA)</td>
</tr>
<tr>
<td></td>
<td>2 – Type 3 (Brachiocephalic / CCA arise at lower level from top of arch. The distance between origin of these vessels and top of arch is &gt; twice the diameter of CCA)</td>
</tr>
<tr>
<td>Arch atheroma</td>
<td>0 – No atheroma</td>
</tr>
<tr>
<td></td>
<td>1 – Atheroma present</td>
</tr>
<tr>
<td>Stenosis</td>
<td>0 – No stenosis</td>
</tr>
<tr>
<td></td>
<td>1 – Stenosis present</td>
</tr>
<tr>
<td>ILCT (Intra-luminal Carotid Thrombus)</td>
<td>0 – No thrombus</td>
</tr>
<tr>
<td></td>
<td>1 – Thrombus present</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| CCA tortuosity                                                           | 0 – No tortuosity  
                                       1 – Tortuosity present                                                     |
| Cervical ICA Tortuosity (loops)                                          | 0 – No loop  
                                       1 – One loop  
                                       2 – Two or more loops (Each loop is 180 degree turn)                        |
| Intracranial ICA tortuosity                                              | 0 – No tortuosity  
                                       1 – Tortuosity present                                                     |
| Descending Aorta                                                         | 0 – Straight  
                                       1 – Aorta swings to the right  
                                       2 – Aorta swings to the left                                                 |
| Horizontal distance between descending aorta and origin of target vessel | 0 – < 4 cm  
                                       1 – >= 4 cm                                                                   |
Does Maintaining the Patency of the Posterior Communicating Artery Aneurysm after Coiling Increase the Risk of Ischemic Events in the Posterior Circulation?

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Purpose
Posterior communicating artery (PComA) aneurysms are common intracranial aneurysms located at the ICA-PComA junction. Endovascular coiling is a widely used option for treatment of ruptured and un-ruptured intracranial aneurysms. When demonstrated patency of ipsilateral, PComA and P1 segment, some operators choose to intentionally occlude the PComA in order to prevent clots from being carried downstream into the ipsilateral posterior circulation. In our institution we generally perform selective coiling of the aneurysm maintaining the patency of the PComA. This retrospective study aims to determine and compare the incidence of ischemic events post coiling in ipsilateral posterior and anterior circulation.

Materials and Methods
We reviewed our database from May 2006 till June 2013 for all consecutive patients with following inclusion criteria: 1) endovascular coiling of PComA aneurysms; 2) patent ipsilateral PComA and P1 segment and 3) MRI with DWI performed within a week after coiling. Two readers, blinded to the endovascular treatment, reviewed the DWI for presence and scoring of the acute ischemic events within the anterior and posterior circulations. The number of foci of restriction of diffusion, defined as DWI hits, was counted as measures of embolic events. The DWI hits were scored from 0 to 5 (0: none, 1: less than five, less than 10 mm in size, 2: more than 5 or larger than 10 mm, 3: one territorial infarct, 4: multiple territorial infarcts, 5: watershed infarcts). We used Cohen Kappa for interobserver agreement and Fisher exact and Chi-square test for statistical analysis of the data.

Results
Thirty eight patients (10 males and 28 females) with 39 aneurysms who had MRI with DWI performed within 96 hours post coiling were included. DWI was found positive for hits in 36% posterior and 72% anterior circulation by the reader 1 and 23% posterior and 74% anterior circulation by the reader 2. There was very good agreement between readers with respect to anterior ischemic events (Kappa = 0.89, 95% CI 0.78-1.00) and substantial agreement between readers with respect to posterior ischemic events (Kappa = 0.78, 95% CI 0.57-0.98). Although not statistically significant, there was a trend towards more acute ischemic events seen within anterior rather than posterior circulation (P=0.06). There was no significant difference in the hits score between posterior and anterior circulations territories for either reader (P=0.23 and P=0.22).

Conclusions
This study did not show an increased number or worse grading of acute ischemic events within the ipsilateral posterior circulation, post coiling of PComA aneurysms, with preservation of the PComA. This finding needs to be validated on a larger group of patients and by longstanding follow up imaging results.

KEYWORDS: Aneurysm Embolization, Aneurysm Treatment, Diffusion-Weighted Imaging

EP-161

6:30AM - 9:00PM

Feasibility and Utility of Intravascular Ultrasound in Cerebral Venous Sinus Stenosis
Purpose
Idiopathic intracranial hypertension (IIH) is a disease of elevated intracranial pressure of unclear etiology. Many symptomatic patients are found to have focal cerebral venous sinus stenosis on noninvasive imaging with impaired cerebral venous drainage. Venous sinus stenting may help reduce this gradient. Intravascular ultrasound (IVUS) can assist with more precise diagnosis and treatment of this disease.

Materials and Methods
This was a prospective, observational cohort study at an urban academic center. Inclusion criteria were as follows: diagnosis of IIH, evidence of venous sinus stenosis on magnetic resonance imaging, and manometric pressure gradient of >10mmHg in the cerebral venous sinuses. Cerebral venography was performed for localization of a focal venous sinus stenosis. IVUS was then performed in the superior sagittal, transverse, and sigmoid sinuses based on the findings on venography with the Volcano Eagle Eye Platinum ST IVUS catheter. The IVUS catheter is mounted on a rapid exchange system with a distal radio-opaque ultrasound probe. The primary endpoint was to (1) confirm the exact location of radiographic stenosis, (2) measure the cross-sectional area of normal and stenotic segments, (3) measure the length of stenosis, and (3) search for the presence of multiple venous channels in the sinuses. These findings were used to choose the appropriate stent dimensions and determine the proximal and distal landing zones for stent delivery.

Results
Nine patients were prospectively studied and treated based on the results of the IVUS. All IVUS catheters were advanced successfully over the rapid exchange system and ultrasonic images/measurements were obtained on all patients without any periprocedural complications. One patient had multiple venous channels in their sinuses. All patients had successful implantation of venous sinus stents based on IVUS measurements.

Conclusions
IVUS is a feasible and efficacious tool in characterization of cerebral venous stenosis and useful in planning for the precise placement of a venous sinus stent.

KEYWORDS: Cerebral Venous System, Idiopathic Intracranial Hypotension, Venous Sinus Stenting
Feasibility of the transbrachial guide-sheath specifically designed for direct common carotid artery cannulation in carotid artery stenting

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Purpose
Transfemoral approach is a common technique for carotid artery stenting (CAS), and requires guide-wires and/or coaxial catheters for transferal cannulation to CCA. They may be the risk of distal embolism when a high-grade stenosis exists at the CCA. We have used the specifically designed guide-sheath for direct cannulation to CCA without any guide-wire neither coaxial catheter in CAS. The aim of our study is to investigate utility and safety of the specific guide-sheath.

Materials and Methods
Included in our retrospective analysis were patients who underwent CAS for CCA with the transbrachial guide-sheath (6Fr MSK-guide with 0.088 ID, Medikit Co.Ltd, Japan) specifically designed for direct cannulation to CCA, between February 2011 and November 2013 in our institution. Technical success, procedure time, periprocedual complications and 30-day major cardiovascular events (stroke, myocardial infarction, and death) were investigated.

Results
Eight patients were analyzed. Two patients of them underwent transbrachial CAS for right CCA stenosis, and other six for left CCA lesion. In all cases, we were successful in direct cannulation.
to the target CCA with the transbrachial guide-sheath, and performed CAS safely. The median time from the arterial picture to the end of procedure was 44.5 minutes (IQR: 13.5). Neither periprocedural complications nor cardiovascular events within 30 days following CAS occurred.

Conclusions
We successfully and safely performed CAS for CCA stenosis with the transbrachial guide-sheath specifically designed for direct cannulation to the CCA.

KEYWORDS: Brachial Artery, Carotid Artery Stenting, Common Carotid Artery

(Filename: TCT_EP-146_MSK-guide7-25-.jpg)

EP-169

LONG TERM FOLLOW UP WITH WEB SINGLE LAYER DEVICE FOR INTRACRANIAL ANEURYSMS

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1ENERI, BUENOS AIRES, Argentina, 2ENERI - SAGRADA FAMILIA, BUENOS AIRES, Argentina

Purpose
The endovascular treatment of intracranial aneurysms (IA) presented continuous changes in the last two decades, starting with coils, balloon or stent assisted coiling, and recently with the development of flow diverting devices. The treatment of complex aneurysms such as terminal and bifurcation with wide neck and unfavorable anatomy is challenging. WEB represents an intrasaccular flow diversion device to treat this kind of aneurysms. Our purpose is to report our experience and long term follow up using WEB single layer device (SL)

Materials and Methods
We present 3 IA treated with WEB SL, 1 ruptured, and 2 unruptured. 1 basilar tip, 1 MCA bifurcation and 1 Ophtalmic. Size aneurysms were between 5 and 10mm. Clinical and angiographic follow up were performed at 3, 6 and 12 months and every year after.

Results
Two patients have DSA control at 2 years and 1, at 3 years, all with complete occlusion and modified Rankin Scale of 0. No additional treatment was required. No complications were observed in the periprocedural time or during follow up.
Conclusions
The WEB SL proved to be an alternative for the treatment of bifurcation and terminal aneurysms. Clinical and angiographic controls showed stable results at long term follow up.

KEYWORDS: Aneurysm Treatment, Flow Diverter

EP-145

MECHANICAL THROMBECTOMY IN ACUTE STROKE

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Purpose
Acute ischemic stroke secondary to proximal middle cerebral artery and/or extracranial internal carotid artery (ICA) occlusion has a poor outcome in 35-38% of patients. We assess the safety and efficacy of the Solitaire™ FR device used for mechanical thrombectomy and stenting in ICA/pMCA stroke pts with contraindications for IV-rtPA.

Materials and Methods
47 ICA/pMCA stroke pts treated with the Solitaire™ FR stent without IV-rtPA were found between December 2009 and October 2013. Treatment was performed with a 8-hour window time from onset (or in the case of wake-up strokes, the MRI mismatch and the absence of FLAIR hyperintensities were required).

Results
Mean NIHSS score was 17.7. The principal contraindication for IV-rtPA was time (12 of 17, Wakeup strokes were 41.1%). Vessel occlusions were in the proximal middle cerebral artery (M1, 53%) or in the internal carotid artery (ICA, 48%). Stand alone thrombectomy was performed in 67 % and stent placement in 33 %. Five patients received IA-tPA (doses between 10 and 30mg). Arterial recanalization (TIMI 2/3, TICI 2b/3) was successful in 94.1% . Symptomatic complications were observed 11.8%. 30-Day good clinical outcome (mRS 0/2) was achieved in 41.4 % of the patients, 47% had a moderate outcome (mRS, 3/4), and 11.8 % had a poor outcome or died (mRS, 5/6).

Conclusions
Endovascular Treatment of Acute Stroke of the internal carotid artery or proximal middle cerebral artery with Solitaire™ FR device without intravenous thrombolysis demonstrated a rapid and safe recanalization in patients with contraindications for IV-rtPA.

KEYWORDS: Acute Ischemic Stroke, Thrombectomy

EP-156

Neurological hemispheric deficits following contrast media exposure after neurointerventional procedures: a stressful and rare complication.

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Purpose
Regressive cortical blindness, which can be associated with retrograde amnesia and/or confusion, is a rare and well-described complication of neurotoxicity following contrast media exposure due to a temporary breakdown of the blood-brain barrier (BBB). Nevertheless in the literature, hemispheric focal signs, such as hemiparesis/plegia, aphasia, and hemispatial neglect have been reported in very few cases. We report clinical and imaging data in 5 patients with clinical symptoms due to penetration of contrast medium through the blood-brain barrier (BBB).

Materials and Methods
Five patients developed neurological symptoms following a neuroangiographic procedure (aneurysm endovascular treatment in 3 cases and cerebral angiography in other 2). Clinical finding included: 1 case with right hemiplegia, aphasia and right homonymous hemianopsia; 1 case with right hemiparesis and aphasia; 2 cases with aphasia; 1 case with confusional syndrome. All patients underwent CT-scan and MR study (T2 FLAIR, Diffusion Weighted Images and 3D TOF MRA) after the onset of neurologic symptoms and at follow-up.

Results
In all cases, CT-scan showed local oedema and hyperattenuation of cortex and sulci due to penetration of contrast agent through the blood-brain barrier. MRI confirmed CT findings and showed no acute ischemic lesions. Follow-up imaging studies normalized within 24 to 72 hours associated with complete regression of clinical symptoms.

Conclusions
Development of transient hemispheric signs due to a temporary breakdown of the BBB and neurotoxicity of contrast media is a rare, not well-known and stressful complication of diagnostic and therapeutic angiographic procedures. CT-scan and MRI are mandatory in differentiating this rare entity, precipitated by intracortical contrast leakage, from an ischemic or hemorrhagic stroke needing a prompt and often invasive treatment.

KEYWORDS: Angiography, Contrast Extravasation, Interventional
the solitaire stent. The purpose of this study was to evaluate the safety and efficacy of this new device and persistent anatomic results in the treatment of intracranial wide neck bifurcation aneurysms.

Materials and Methods
Our series include 18 consecutive patients (men age: 53 years) with an unruptured or previously ruptured aneurysm treated using the pCONus device. Sixteen aneurysms were located on the anterior and 2 on the posterior circulation. Four cases were recanalized aneurysms.

Results
Successful deployment of the device was observed in all cases. No hemorrhagic or ischemic complications were observed. One patient had a groin hematoma. After the initial embolization procedure, a 90 to 100% occlusion rate was achieved in all cases but a neck remnant was evident in 3 patients. Follow-up data at 6 months showed good results in all case except in one recanalized aneurysm.

Conclusions
The pCONus device allows a safe coil occlusion of wide neck bifurcation aneurysms. Although more experience and longer follow-up are needed in order to evaluate the pCONus System, this device is an interesting alternative in the treatment of wide neck intracranial aneurysms.

KEYWORDS: Aneurysm Embolization, Interventional, Stents

EP-153
6:30AM - 9:00PM

Place of Value of DSA in the diagnostic workup of pulsatile tinnitus.

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Purpose
Pulsatile tinnitus (PT) is a rare complaint, which can be a symptom of life-threatening disease. It is often caused by vascular conditions, e.g. dural arteriovenous fistula (DAVF), arteriovenous malformation (AVM), tumor or stenosis and might have a treatable cause. The current diagnostic pathway includes neurological examination, cranial MRI and an additional digital subtraction angiography (DSA). The aim of this study was to evaluate the diagnostic impact of DSA in cases of unsuspicous MRI.

Materials and Methods
Retrospectively, 54 consecutive patients with pulsatile tinnitus were evaluated, who were examined in our department between 2002 and 2013. All patients had a diagnostic workup including cranial MRI and DSA. MRI examinations were blinded and retrospectively analyzed in consensus by two experienced neuroradiologists (>10y). The MR examinations were evaluated for each performed sequence separately: time-of-flight angiography (TOF-angio), contrast-enhanced-angiography (ce-angio), T2-Spin echo-sequence (T2), contrast enhanced-T1 spin echo-sequence (ce-T1) and a contrast-enhanced-T1-sequence-with-fat-saturation (ce-T1-fs).
Results
Thirty-seven of the fifty-four patients showed a PT explaining pathology in MRI, which was detected by the readers in 100%. 26 dural arteriovenous fistula (DAVF), four paraganglioma, two arteriovenous malformations (AVM), two carotico-cavernous fistulae, one AV fistula of the vertebral artery, one aneurysm and one stenosis of the internal carotid artery were described. All patients without pathology in MRI did also not show any pathology in DSA.

Conclusions
Our study suggests that MRI is sufficient for the diagnostic workup of pulsatile tinnitus of patients with an inconspicuous MRI if TOF-angio, ce-angio, T2, ce-T1 and ce-T1-fs sequences are performed. DSA is still mandatory for graduation of pathologies e.g. fistula.

KEYWORDS: Angiography, MR Imaging, Tinnitus

EP-136 6:30AM - 9:00PM

Relationship between aneurysm occlusion and flow diverting device oversizing in a rabbit model

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Purpose
Flow diverter pore density is considered a prime determinant of device efficacy and is thought to be strongly influenced by proper matching between the device size and parent artery diameter. The objective of this study was to characterize the correlation between device sizing, degree of metal coverage, and the resultant occlusion of aneurysms following flow diverter treatment in a rabbit model.

Materials and Methods
Saccular aneurysms were created in 18 rabbits. Aneurysms were treated with flow diverters (iso-sized to proximal parent artery at the neck, 0.5 mm over-sized, or 1.0 mm over-sized, respectively, n=6 for each group). Eight weeks after implantation, the aneurysm along with the device-implanted vessel was harvested. The neck of the aneurysm covered with the flow diverter struts was photographed. The parent artery diameter to flow diverter diameter was calculated. The metal coverage (amount of metal surface area covered by the device) and pore density (number of pores per unit surface area) at the neck of the aneurysm were calculated and correlated with degree of aneurysm occlusion.

Results
Angiographic results showed there were no statistically significant differences in aneurysm geometry and occlusion among groups. The mean parent artery diameter:flow diverter diameter ratio was higher in the 1.0 mm oversized group compared with other groups. Neither the percentage metal coverage nor the pore density showed statistically significant differences among groups. Logistic regression analysis predicted that the propensity of aneurysm occlusion decreased by 8.8 fold for every millimeter increase in the neck width, irrespective of the size of the device implanted.

Conclusions
Device sizing alone does not predict resultant pore density or metal coverage following flow
diverter implantation. Aneurysm occlusion was not impacted by either metal coverage or pore density, but was inversely correlated with the diameter of the neck.

KEYWORDS: Aneurysm Embolization, Flow Diverter

EP-139

6:30AM - 9:00PM

Relationship of Clot Length to Number of Stent Retrievals, Revascularization Rates, and Functional Outcomes in Endovascular Thrombectomy for Acute Ischemic Stroke

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Purpose
The aim of this report is to study the relationship between intracranial thrombus length and number of stent retrievals, revascularization rates, and functional outcomes in the endovascular treatment of acute ischemic stroke.

Materials and Methods
We prospectively collected data from anterior cerebral circulation endovascular stroke cases performed at our single center institution from April 2012 to September 2013. Thrombus length was measured using either susceptibility weighted MRI, MR angiography, CT angiography, and/or digital subtraction angiography. Demographic and clinical details, the involved vessels, and procedural details, including the number of devices used and number of retrievals utilized for each device, were recorded. Revascularization rates and 90 day functional outcomes were recorded.

Results
Thirty-seven endovascular thrombectomy procedures for acute stroke using stent retriever devices were performed during the 18 month study period. Data regarding length of thrombus in the anterior cerebral circulation was available for 28 patients. There was no significant association (p = 0.9412) between thrombus length and number of stent retrievals. There was a statistically significant direct relationship (p = 0.0458) between clot length and final thrombolysis in cerebral infarction (TICI) score, and a statistically significant inverse relationship (p = 0.0280) between number of retrievals and the final TICI score. No statistically significant relationship existed between clot length and 90 day modified Rankin Scale (p = 0.7208).

Conclusions
Our data suggest no relationship between thrombus length and number of stent retrievals utilized during acute intracranial thrombectomy nor functional neurological outcomes at 90 days. These results do not support a predictive value for thrombus length quantification in the evaluation of stroke.

KEYWORDS: Stents, Stroke, Thrombectomy
EP-144  

Risk Factors for Major Recurrence of Intracranial Aneurysms after Endovascular Treatment: A Single-Center Multivariate Survival Analysis

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Purpose
Major recurrence of intracranial aneurysms after endovascular treatment is the most important criterion in considering re-treatment due to the risk of impending hemorrhage. Detecting the risk factors for major recurrence could also help optimize the individual imaging follow up schedule. We investigated the risk factors associated with major recurrence of the coiled intracranial aneurysms according to Digital Subtraction (DSA) or Magnetic Resonance Angiography (MRA).

Materials and Methods
A retrospective analysis of the coiling data prospectively collected from 2003 to 2012 was performed. There were 467 aneurysms in 435 patients (55±12 years old; 74% female).
Aneurysms were acutely ruptured (61%) or unruptured (39%), located in the anterior (74%) and posterior (26%) circulation with ACA/ACOM as the most common site (30%). Mean (±SD) aneurysm dome size was 7.5±3.7 and the neck size was 3.4±1.5. Conventional coiling was performed in 57% of the aneurysms while 33% and 10% of the procedures were assisted by balloon inflation and stent placement, respectively. Major recurrence according to the Raymond-Roy Classification was chosen as the primary outcome in the univariate Cox Proportional Hazards Model followed by multivariate regression analysis of the variables with probability values < 0.1.

Results
Baseline occlusion was complete (class I) in 196(42%), near complete (class II) in 191(41%) and incomplete (class III) in 80(17%) of the aneurysms. Excluding the pre-discharge mortality (10.1%) and the lost to follow-up (7.6%) cases, a total of 1367 angiographic follow-up studies were performed after 1-108 months (Mean: 40.0±28.6; Median: 37), 1-10 times (Mean: 3.6±2.0; Median: 3) in 358(82.3%) patients harboring 384(82.2%) aneurysms. Three aneurysms (0.8%) re-bled after 3, 38 and 81 months without mortality. Major recurrence was detected in 98(21%) aneurysms after 16±18 months. After multivariate analysis of the significant and marginally significant hazard ratios (P<0.1), the significant predictors (P<0.05) of major recurrence included: age>65y (HR: 1.61; P=0.043), male gender (HR: 2.13; P=0.0005), hypercholesterolemia (HR: 1.65; P=0.032), aneurysm neck size≥4mm (HR: 1.79; P=0.015), aneurysm dome size ≥7mm (HR: 2.44; P=0.0004), non-stent-assisted coiling (HR: 2.87; P=0.019), and baseline occlusion class III (HR: 2.18; P=0.008).

Conclusions
When applying our definition of major recurrence post coiling, the angiographic follow-up of patients after endovascular treatment of intracranial aneurysms may be individualized on the patients harboring the above described risk factors.

KEYWORDS: Aneurysm, Coil Embolization, Recanalization

EP-163 6:30AM - 9:00PM

Saline Push Technique during Pediatric Cerebral Angiography: Contrast Dose Reduction

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Purpose
The technique of chasing a contrast dose with a bolus of saline is well established in CT and MR imaging. This paper describes an angiographic technique for minimization of contrast dose in children and compromised adults using a saline push technique by either hand injection or by power injector. The efficacy of this technique is supported by a retrospective review of 75 consecutive pediatric diagnostic and interventional endovascular cases during which contrast volumes were recorded and calculated according to body weight.

Materials and Methods
A retrospective review of angiographic data in 75 pediatric patients spanning 6 years was conducted during which time our technique for minimization of contrast dose evolved. During all cases the contrast volume was recorded cumulatively with each administration of contrast.
During the first 3 years of this review period, an "inject and aspirate" technique was used. Contrast was injected by hand in pediatric cases, and at the completion of each run the waste contrast in the dead-space of the catheter system was aspirated until blood was seen reaching close to the aspirating syringe. This aspirated volume was then subtracted from the injected volume to establish the true dose per injection to the patient. During the latter 3 years of this period, a "saline-push" technique was used. The dead-space (2.5mL) of the catheter system was pre-loaded with a precise volume of contrast which was then pushed with a syringe of saline. When necessary the volume of available dead-space was expanded by attaching a side-tubing of up to 8mL in capacity. Contrast doses were reviewed for diagnostic and interventional procedures and evaluated by dose per body weight with particular emphasis on smaller children (<11 years).

Results
All 75 cases of varying complexity and difficulty were completed with an average of 0.86mL of Omnipaque 240/kg body wt, range 0.2 - 2.3ml/kg. For small children <11y (N=27) , the mean dose and range of doses were slightly higher for interventional cases (1.4 mL/kg, range 1.3-2.0) than for diagnostic cases (0.75, 0.2-1.6). Differences in recorded volume of contrast per case and per kg body weight were not statistically significant comparing between the two time periods of this study. However, the saline push technique was considered preferable for several reasons. The technique is cleaner by eliminating the need to aspirate blood mixed with contrast back into the catheter system at the end of each run. Secondly, it permits a more precise dosing of contrast by eliminating operator guesswork in the calculation of aspirated volume of mixed blood and contrast.

Conclusions
The saline-push technique described in this paper is a precise, inexpensive, and technically clean method of minimizing and recording contrast volumes during pediatric cerebral angiography. Intervventional cases of considerable complexity can be completed satisfactorily in small children well within recommended limits of contrast dose per body weight.

KEYWORDS: Angiography, Contrast Optimization, Pediatric Cerebrovascular Disease

EP-157
6:30AM - 9:00PM

The Documentation of a Normal Venous Phase During Spinal Angiography Does Not Rule Out the Presence of a Spinal Cord Vascular Malformation with Perimedullary Drainage. Four Cases Illustrating a Potential Angiographic Pitfall.

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Purpose
It is commonly assumed that the observation of a normal venous phase during spinal angiography rules out the presence of a spinal vascular malformation with perimedullary drainage. This report describes four cases of spinal cord with perimedullary drainage in which a normal venous phase was documented.

Materials and Methods
The lesions reviewed here include one cervical spinal arteriovenous malformation (SAVM), two
spinal epidural arteriovenous fistulas (SEAVFs) (one sacral and one thoracic), and one lumbar spinal dural arteriovenous fistula (SDAVF). Except in the latter instance, the lesions were symptomatic. The MRI studies obtained in the two cases of SEAVFs showed abnormal spinal cord signal. Conservative management was recommended for the cervical SAVM, while the two SEAVFs were treated endovascularly with clinical excellent outcomes.

Results
A "normal" venous phase was documented in each case during the selective injection of the main radiculomedullary contributor (artery of Adamkiewicz). Figure 1 shows an example of SEAVF with a normal venous phase. Figure 1 legend: A shows a left S1 SEAVF (arrowhead), with extensive ascending perimedullary venous drainage. The white arrow indicates the T12 level. B documents a selective injection of the left T12 ISA, which provided the artery of Adamkiewicz (not shown); the perimedullary venous system (arrowheads) is identified during the venous phase.

Conclusions
While it may still be considered a useful angiographic sign, the observation of a normal venous phase during spinal angiography does not allow ruling out a spinal vascular malformation with perimedullary drainage. As a consequence, interrupting a spinal angiogram after the documentation of a normal venous phase carries the risk of overlooking clinically significant lesions.

KEYWORDS: Pitfalls, Spinal Angiography, Spinal Arteriovenous Malformation
The Success of Flow diversion of large and giant sidewall aneurysms may depend on the size of the defect in the parent artery

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Purpose
Flow Diverters (FD) are braided stents designed to occlude aneurysms while preserving flow to jailed arterial branches. We postulated that treatment success depended on the size of the aneurysm neck.

Materials and Methods
Large and giant canine sidewall aneurysms, featuring a branch located immediately opposite the aneurysm, and a small 6-8mm (Group A; n=6) or a large 10-16mm neck (Group B; n=6) were created to study the effects of flow diversion on aneurysm or branch occlusion. Angiographic results after deployment and at 3 months were scored using an ordinal scale. The amount of neointima formation on the segment of the device overlying the aneurysm ostium was determined by postmortem photography.

Results
Group B aneurysms had significantly larger necks (mean 13±2mm) than group A aneurysms (8±1mm; p=0.002). At 3 months, group B aneurysms had significantly worse angiographic outcomes (p=0.002). Aneurysm volumes were also significantly different at 3 months (p=0.002). Group A aneurysms decreased while group B aneurysms increased in volume at 3 months (p=0.004). Neointimal coverage of the FD was more complete in group A compared to group B aneurysms (p=0.002). The most significant correlation was between neointimal coverage and angiographic evolution of aneurysms (p=-0.757; p=0.004). There was a significant correlation between the angiographic evolution of lesions at 3 months and the size of the neck (p=0.620; p=0.03).

Conclusions
The larger the neck, the less likely the same FD is to occlude large or giant experimental aneurysms. LEGEND: Angiographic (A,B) and pathological results (C,D) 3 months after Flow Diversion treatment of narrow (A,C) or wide neck aneurysm (B,D). In C, the neointima fully cover the FD stent whereas in the wide neck aneurysm (D) neointimal coverage is discontinued and permit flow to enter the aneurysm via the transition zone.

KEYWORDS: Aneurysm Treatment, Animal Model, Flow Diverter
Topographic Vascular Mapping of the Right Hepatic Artery Segmental Branches Using C-arm CT with 3D-Reconstruction in Patients Undergoing Transarterial Chemoembolization (TACE) of Hepatic malignant Lesions

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Purpose
To create a map for right hepatic artery (RHA) segmental branches using 3D reconstruction of C-arm CT in TACE patients

Materials and Methods
The study was retrospectively performed on 20 patients with primary or secondary hepatic malignancy. C-arm CT was performed during the first TACE session and the images were reconstructed using 3D reconstructed overlaid images using Inspace application of the angiography suite. Segmental arteries of RHA were identified based on segmental liver enhancement when the CT images were overlaid on the 3D reconstructed model of RHA branches. Each segmental branch was evaluated regarding its calibre at origin (CO), detectable length (L), angle of origin (AO) from its main stem

Results
In all 20 patients the anterior segmental artery was the direct continuation of the RHA and it gave origin to the arteries of segments 5 and 8. The mean calibre of artery to segment 5 (A5) at origin was 1.8 + 0.7 mm, its length was 6.2 + 2.01 cm, angle at origin 90.7 + 44.3 while artery to segment 8 (A8) showed 4.7 + 104 mm, 4.8 + 1.7 cm & 0 angle respectively. The posterior segmental artery gave origin to arteries of segment 6 and 7. Artery to segment 6 (A6) showed 2.5+ 1.04 mm, 6.3+ 1.9 cm and 90.5 + 43. Artery to segment 7 (A7) showed 2.8 + 1mm, 5.1+1.6 cm, 0 angle respectively.

Conclusions
Knowing the topographic vascular mapping of the right hepatic artery segmental branches can produce superselective chemoembolization for the hepatic malignant lesions with minimally invasive maximally effective therapy

Transform Balloon for the Treatment of Intracranial Aneurysms, Preliminary Experience

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Purpose
The technique of balloon remodeling allows the endovascular treatment of wide-neck intracranial aneurysms. For many years the only available devices were Hyperform and Hyperglide (Covidien/ev3, Irvine, CA). Recently, other companies developed newer devices,
single or double lumen. We present our initial experience with the Transform (Stryker Neurovascular, Freemont, CA) balloon-remodeling device for the treatment of intracranial aneurysms.

**Materials and Methods**
We retrospectively analyzed from our prospectively gathered aneurysm database all the aneurysms that were treated with balloon remodeling using Transform balloons from January 2013 to November 2013. We assessed patient demographics, morphologic features of the aneurysms, procedure success, technical and clinical complications.

**Results**
Twenty-three patients harboring 24 intracranial saccular aneurysms were treated during 23 procedures. Clinical findings were: 11 incidental discovery, seven SAH, four compressive symptoms, one recanalization and one intraparenchymal hematoma. Twenty-three aneurysms were in the anterior and one in the posterior circulation. Mean sac and neck size were respectively 6.0 mm (sd:4.6) and 3.7 mm (sd:1.8). Thirteen aneurysms were treated with Transform C and 11 with Transform SC. We collected a peri-procedural thromboembolic event and a coil protrusion, without clinical complications. No early rebleeding occurred.

**Conclusions**
In our small series, the Transform balloon-remodeling device seems to be safe and effective for the treatment of intracranial aneurysms, in ruptured and unruptured cases.

**KEYWORDS:** Aneurysm Embolization, Balloon Assistance

**EP-147**

**TREATMENT OF INTRACRANIAL ANEURYSMS USING A FULL RETRIEVAL FLOW DIVERTER P64: BUENOS AIRES EXPERIENCE**

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**Purpose**
Flow diversion is a new approach to the endovascular treatment of intracranial aneurysms which uses a high density mesh stent to induce sac thrombosis. These devices have been designed for the treatment of complex and large size aneurysms. So far, safety and efficacy data published on this approach is scarce.

**Materials and Methods**
Over 18 months (May 2012 to November 2013), standardized clinical and angiographic data were collected on 42 patients with 56 aneurysms (36 women; median age, 60.9 years) treated with PHENOX flow diverter device (p64FMD). 54 (96.4%) aneurysms were in anterior circulation. 42 (75%) aneurysms were small, 10 (17.9%) large and 4 (7.1%) were giant aneurysms. Clinical and angiographic follow up at 3, 6 and 12 months were performed.

**Results**
Technical deployment success was 92.3%. In 38 patients (90.5%) one single device was used. Occlusion rate at 3, 6 and 12 months were 50%, 57% and 100% respectively. One patient (2.4%)
presented intracerebral hematoma 2 months after treatment and died, another patient presented ischemic stroke 5 months after treatment. Morbidity and mortality rate was 4.8%.

Conclusions
This early experience with p64FMD revealed a promising fully retrievable flow diverter device with an acceptable morbi-mortality rate in the short term.

KEYWORDS: Aneurysm Treatment, Flow Diverter

EP-138

Utility of Dual-Lumen Balloon Catheters for Embolization of Experimental Vascular Malformations with Liquid Agents

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Purpose
Liquid embolic agents (LEA) are increasingly used to treat vascular malformations. In an experimental setting, the performance of dual-lumen balloon catheter was compared to stand-alone injection of LEA in the rete mirabilis.

Materials and Methods
Fourteen controlled injections of LEA were performed using a dual lumen catheter with balloon inflated (n=8), or not (n=6). During embolization, attention was paid to the extent of antegrade filling of the porcine rete, retrograde flow of the embolic agent, and any technical difficulties such as difficulty of catheter withdrawal. Pigs were euthanized immediately following embolization, and the rete mirabilis harvested and fixed prior to pathological and radiological examinations. Angiographic and pathologic rete penetration and the density of liquid embolic within the rete vessels were scored using ordinal grading scales.

Results
Injections of LEA controlled by balloon permitted more complete penetration of porcine rete by LEA compared to stand-alone injections (P<0.05, Mann Whitney U test). Reflux of LEA occurred with greater frequency when a balloon was not used. There was no technical complication related to balloon catheter retrieval.

Conclusions
Dual-lumen catheter-mounted balloons may permit more complete embolization of experimental vascular malformations compared to standard microcatheter techniques. LEGEND: Radiological results of extension of the liquid embolic agent using stand-alone injection (A) and injection using dual-lumen balloon inflation (B).

KEYWORDS: Animal Model, Arteriovenous Malformation, Endovascular Embolization
Achondroplasia in children: Is there a correlation between size of the foramen magnum, jugular veins, emissary veins and degree of ventriculomegaly?

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Purpose
Achondroplasia is a skeletal dysplasia with diminished growth of the skull base secondary to inhibited enchondral bone formation that leads to narrowing of the foramen magnum and associated stenosis of the jugular foramen, with subsequent ventriculomegaly and prominence of the emissary veins. Progressive hydrocephalus and cervicomedullary compression secondary to a small foramen magnum guide decisions on cerebrospinal fluid (CSF) diversion and/or posterior fossa decompression. Emissary veins in the posterior fossa and prominent meningeal veins along the convexities are usually seen on conventional magnetic resonance imaging (MRI) sequences. In order to test our hypothesis of correlation between severity of ventriculomegaly, narrowed jugular foramen and foramen magnum and emissary vein enlargement, we 1) assessed the size of the foramen magnum and jugular veins, prominence of the emissary veins and degree of ventriculomegaly, in achondroplasia patients and age-matched controls and 2) performed correlation and regression analysis between these parameters.

Materials and Methods
Retrospective review of MRI findings was performed in children with achondroplasia prior to surgery and age-matched controls. Conventional MRI sequences were utilized to measure the surface area of the foramen magnum and the jugular foramina. Ventriculomegaly was measured by dividing the bifrontal width and biparietal diameter. The presence and/or prominence of bilateral occipital, mastoid and condylar emissary veins, bilateral superior ophthalmic veins, bilateral meningeal vessels and occipital sinus were assessed (total score of severity 0-11). In order to remove age as a confounder, median values of foramen magnum, jugular foramina and ventricular size or area were obtained from the control group for 3 age-groups, namely, 0-0.99 year, 1-2.99 years and > 3 years. Ratios for foramen magnum surface area, ventricular size and jugular foramina surface area were calculated for each patient with respect to the median value for age obtained from the controls. Statistical analysis comparing the patients with age-matched controls was done using Wilcoxon signed rank test. In addition, Spearman correlation and multiple regression analysis of the individual parameters was carried out.

Results
16 patients (5 females and 11 males) with achondroplasia and 16 age-matched controls were
included in this retrospective study. Compared to age-matched controls, in children with achondroplasia the surface of the foramen magnum (median 0.50cm², range 0.23cm²-1.37cm² vs. 3.14cm², 1.83cm²-6.68cm², p<0.001) and jugular foramina (median 0.02cm², range 0cm²-0.10cm² vs. 0.21cm², 0.03cm²-0.61cm², p<0.001) were smaller, whereas ventriculomegaly (0.28, 0.24-0.4 vs. 0.26, 0.21-0.28, p<0.001) and enlargement of emissary veins (6, 0-11 vs. 0, p<0.001) were higher. Amongst the patients, Spearman correlation and multiple regression analysis did not reveal correlation for severity between the individual parameters.

Conclusions
Our study confirms significant differences in ventricular size, emissary vein enlargement and surface area of foramen magnum and jugular foramina between children with achondroplasia and age-matched controls. The absence of correlation between the individual parameters in patients suggests a complex dynamic interplay between these parameters which is different for each patient.

KEYWORDS: Hydrocephalus, MR Imaging, Skeletal Dysplasias

EP-184

6:30AM - 9:00PM

Acute Disseminated Encephalomyelitis in Children: A regional experience of 35 Patients

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Purpose
Acute disseminated encephalomyelitis (ADEM) is an uncommon inflammatory demyelinating disease of the central nervous system (CNS). Magnetic resonance imaging (MRI) is regarded as the diagnostic modality of choice. There are limited series in the literature on acute disseminated encephalomyelitis (ADEM) in children. Moreover, very rare studies of childhood ADEM have been undertaken in Tunisia and African countries. Our objectives are to describe the clinical, laboratory, and neuroimaging features, treatment and outcome of ADEM in Tunisian children and to undertake a systematic review of published ADEM pediatric cohorts in order to find prognostic elements on the initial MRI and to particularly highlight the contribution of advanced techniques (Diffusion and MR spectroscopy).

Materials and Methods
We retrospectively reviewed the medical records and MR images of 35 children diagnosed as ADEM between January 2005 and June 2013. Diagnosis was based on the definition proposed by the International Pediatric Multiple Sclerosis Study Group. All patients were assessed by initial MRI and 28 MRI undergone iterative controls (from 1 to 3). Diffusion was used in 31 patients and MR spectroscopy in 10 patients.

Results
Twenty boys and 15 girls with mean age at disease onset of five years. Eighteen children experienced a prodromal illness. MR imaging showed focal abnormal signal changes mainly in the subcortical white matter of frontal and parietal lobes. Nine patients showed corpus callosum and eight cortical gray matter involvements. A high rate of deep gray matter involvement
including thalami and basal ganglia also was noted. Apparent diffusion coefficient (ADC) values were obtained only in 14 cases with restricted diffusion noted in seven cases. All of the latter have evolved to gliosis. MR spectroscopy (MRS) showed lactates peak in seven cases at the acute phase, associated in four to restricted diffusion. Twenty-three patients recovered completely with normal control MRI. The period of follow up was two months to years with a mean of one year six months. Cases with gliosis were well correlated with neurologic sequellae: lower limb paresis (2), hemiparesis (1), partial epilepsy (3), abnormal behavior (2) and/or speech (2). Death was noted in one case.

Conclusions
The present study demonstrated that ADEM in children is a relatively benign condition. MR imaging usually demonstrates a subcortical white matter and deep gray matter lesions whereas cortical gray matter involvement is rare. Advanced MRI techniques are useful to the prognosis approach.

KEYWORDS: Acute Disseminated Encephalomyelitis, ADEM, Advanced MR Imaging

EP-200

Acute Neurotoxicity Related to High Dose Systemic Methotrexate Chemotherapy

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Purpose
Neurotoxicity with MR changes following methotrexate administration has been documented in the literature, though the mechanism is not completely understood. Acute neurotoxicity following intrathecal chemotherapy has been the subject of several recent publications. The purpose of our study is to present acute changes of neurotoxicity following systemic methotrexate on diffusion-weighted MR imaging (DWI).

Materials and Methods
Retrospective evaluation was performed of charts of patients who developed acute neurologic toxicity after receiving and high dose systemic methotrexate. Imaging findings were reviewed and correlated with duration of treatment and temporal correlation with methotrexate administration was evaluated. A retrospective review was performed of 8 patients who were treated at our institution from April 2009 to March 2012. All patients had an MRI at presentation of acute symptoms, including DWI, and 3 of 8 (38%) underwent at least one follow-up MRI.

Results
Acute DWI changes were found in all 8 patients, primarily in the centrum semiovale, imaged at 1 to 9 weeks following systemic chemotherapy. Complete clinical recovery was demonstrated in 5 patients and the remaining 3 patients had significant improvement with no major deficits. The DWI changes improved on the 3 follow-up exams with eventual fluid-attenuated inversion recovery (FLAIR) changes on 1 exam.

Conclusions
High dose systemic chemotherapy produces similar acute neurotoxicity as does intrathecal administration. Most experience transient stroke-like symptoms with restricted diffusion in the
periventricular and/or subcortical white matter on DWI sequences. The majority made a full
clinical recovery with the MRI changes representing areas of demyelination or focal subcortical
ischemia. Sparing of the gray matter explains the relatively mild and transient nature of
neurological deficits.

KEYWORDS: Leukemia, MR Imaging/Diffusion, Neurotoxicity

EP-187

Adrenoleukodystrophy and the Blood Brain Barrier: Does Disruption of the BBB cause
Cerebral ALD?

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Purpose
Adrenoleukodystrophy (ALD) is a rare, X-linked disease, with a wide range of neurologic
manifestations and disease courses ranging from (1) no neurologic sequelae, (2) slowly
progressive neurologic involvement, (3) neurologic progression with eventual stabilization, and
(4) rapidly progressive and ultimately fatal course. The University of Minnesota is a large
referral center for ALD. Two very interesting patients presenting with evidence of acute cerebral
infarction subsequently demonstrated rapidly progressive ALD. Alternatively, two patients who
developed posterior reversible encephalopathy (PRES) had stable findings of ALD. This
suggests that ALD progression may be related to breakdown of the blood brain barrier. In this
study we reviewed all referred cases of ALD searching for pathologic processes unrelated to
ALD to evaluate how they affected the progression of ALD.

Materials and Methods
The database of adrenoleukodystrophy patients at the University of Minnesota was
retrospectively reviewed to identify patients with additional, presumably separate and distinct
diseases. The cases were reviewed by consensus by a board and CAQ certified neuroradiologist
and a third year radiology resident. Image findings were matched with clinical information as
available in the electronic medical record. Correlation with ALD progression was determined by
review of the subsequent imaging.

Results
A total of 129 patients with 832 MR scans were reviewed. Two patients presented with acute
arterial cerebral infarction and suffered rapidly progressive ALD spreading from the area of
infarction. Another patient with an infantile cerebral infarction, presumably prior to development
of a functioning immune system, had no apparent significant effect on ALD course despite
multifocal infarcts. One patient presented in an Addisonian crisis with findings of hypoxic
ischemic encephalopathy (HIE) with subsequent marked progression of ALD. Two patients
developed PRES without enhancement, with stable ALD on followup. One patient developed
venous sinus thrombosis without infarct or other effect on ALD course. Two patients developed
subdural hemorrhages, one with associated subarachnoid hemorrhage, and neither appeared to
have significantly altered course of ALD.

Conclusions
By evaluating how ALD is affected by other, unrelated diseases, we can better understand its
pathophysiology. We suggest that the accumulation of abnormal very long chain fatty acids (VLCFA) does not actually cause the typical MRI findings of cerebral ALD, rather it is primarily the immune system reaction that causes the neurologic manifestations. The triggering mechanism responsible for rapid disease progression may be a breakdown of the blood-brain barrier. This is congruent with our findings of rapid disease progression after CVA and HIE and the lack of progression with PRES, intracranial hemorrhage, and venous sinus thrombosis. Interestingly the infant with CVA did not demonstrate the expected ALD progression, possibly due to lack of a well-developed innate immune system.

KEYWORDS: Adrenoleukodystrophy, Blood-Brain Barrier

EP-204

Arterial Spin labeling MRI: a New Imaging Tool for Arteriovenous Malformations Management

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Purpose
Arterial Spin labeling is a recent perfusion sequence using labeled arterial protons as an endogenous perfusion agent to quantify cerebral blood flow. As cerebral AVM are high flow lesions, we postulated that arterial spin labelling could be useful in AVM diagnosis and follow up.

Materials and Methods
Studies were performed during the last 2 years on a 1.5 Tesla General Electric MRI. Following sequences were acquired: T1 weighted, T2 weighted, MR angiography, and gadolinium injection. We used pulsed continuous Arterial spin labelling in axial scan plane with port label delay of 1025 seconds, with 40 slices of 4mm. All patients had a conventional angiography. 13 patients with a cerebral AVM and PC-ASL imaging were included.

Results
7 patients were recently diagnosed with a brain AVM, 4 patients had been previously treated by surgery or endovascular treatment, 2 patients were followed after radiosurgery. ASL showed hyperperfusion inside the AVM nidus in 100% of the cases. Mean nidal CBF was 143 mL/ (100 min cm3), and nidus size ranged between 0.4 and 12.2cm2. Image fusion between 3DT1Gd and PC-ASL sequences showed precise reproducible co-localization of the nidus. After radiosurgery, CBF decreased in both patients from 200 to 94 and from 151 to 93 mL/ (100 min cm3) after 17 and 14 months respectively,

Conclusions
Arterial spin labelling is a promising tool to diagnose AVM after intra cerebral hemorrhage and to detect residual lesion after treatment. Measurement of CBF and nidus size will quantify objectively the efficacy of radiosurgery and may replace gadolinium injection

KEYWORDS: ASL, AVM, Pediatric Cerebrovascular Disease
ASL Perfusion MR Imaging In Children Presenting With Acute Neurological Deficits: a Useful Tool For Differential Diagnosis

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Purpose
To evaluate brain perfusion during focal neurological deficits using ASL (arterial spin labeling) perfusion MR imaging in children.

Materials and Methods
Seven children aged from 2 to 13 years admitted with acute focal neurological deficits were consecutively enrolled over a 12-months-period. 3 Tesla MRI was performed from 3 to 12 hours after the onset of symptoms using ASL perfusion MR imaging in addition to our standard stroke protocol. A follow-up MRI was performed from 24 hours to 10 days.

Results
Initial MRI DWI was normal in 6 children. One child had punctuated hyperintense lesion on DWI in the left parietal lobe. In all patients, ASL demonstrated a hypoperfusion in the contralateral hemisphere to the deficit in association with venous stagnation in T2* and poor visualization of some distal middle cerebral artery branches on MRI angiography. At 24 hours clinical follow-up, neurologic examination was normal in 6 children. On ASL sequences, a hyperperfusion was observed instead of the initial hypoperfusion. Conventional sequences were normal. Ten days MRI follow-up was still normal, in particular no abnormalities were observed on ASL perfusion MR imaging.

Conclusions
Our preliminary results suggest that ASL perfusion MR imaging is a useful tool in the differential diagnosis in children with focal neurological deficit, in particular in cases of migraine preceded by auras or focal neurological deficits. Variations in cerebral blood flow founded in ASL perfusion MRI imaging seems to support the vascular theory in the physiopathology of migraine headache.

KEYWORDS: Arterial Spin-Labeling, Childhood, Migraine

Brainstem morphology reflects extent of brain damage in Late infantile Krabbe disease.

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Purpose
The Loes score is based on a point system derived from location and extent of disease and the presence of focal and/or global atrophy. While global scores have been correlated to disease progression, specific training and strong expertise in the field of pediatric neuroimaging is required to avoid interpretation bias. We explored if there were morphological changes typical of early and late infantile forms and if a simpler scoring system could be used to assess disease severity. Based on the knowledge that Krabbe disease is a leukodystrophy with progressive atrophy in areas that are actively demyelinating, we speculated that morphological changes in the midbrain may reflect the severity of neurodegeneration.

Materials and Methods
Two neuroradiologists calculated the Loes score in 28 early infantile and 6 late infantile patients. The affected areas identified by the Loes scores were compared between the early and late infantile patients. A severity score of 0 to 2 based on the severity of midbrain abnormalities as indentified on midsagittal neuroimages was calculated for each exam and correlated to the Loes scoring system.

Results
The total Loes score correlated with the midbrain morphology score (p<.001). Patients scoring a 1 in midbrain morphology averaged 8.7 points higher in Loes score and those with a score of 2 in midbrain morphology scored 17.6 points higher in Loes score. Moderate to severe abnormalities in midbrain morphology were evident in both early and late-infantile patients. A small subset of asymptomatic early infantile patients had scans with normal midbrain morphology findings.

Conclusions
We demonstrate that morphological changes involving the midbrain identify moderate to severe changes in the brain that correlate with the Loes score. This new finding may help detect abnormalities in areas not previously evaluated by the Loes scores and may prove to be a useful and simpler scoring system to follow disease progression in patients at risk or diagnosed with Krabbe disease.

KEYWORDS: Leukodystrophy

EP-214 6:30AM - 3:00PM
Comparison of Brain Myelination at 1.5 and 3Tesla in Children Under 2 Years of Age

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Purpose
To determine whether there is a significant difference between 1.5 and 3Tesla magnets in assessment of myelination of the pediatric brain between 0 and 2 years of age

Materials and Methods
We select 100-200 normal MR Studies of patients from 0 to 2 years of age, divide them into 5 age groups (0-3m), (3-6m), (6-12m), (12-18m), (18-24m). Each group includes 10 to 20 exams done on 1.5Tesla, and 10 to 20 exams done on 3 tesla magnets. Selected regions of interest will be analyzed, including for instance, ventral pons, middle cerebellar peduncles, cerebellar white
matter, internal capsule, optic radiations, corpus callosum and peripheral subcortical white matter. Subjective comparison of their signal intensity will be made with that of cortical ribbon. Patient selection will be based on MRI reports interpreted as normal by pediatric radiologists, including control cases of an ongoing prospective research study. Exclusion criteria include history of hypoxic ischemic injury, epilepsy, follow-up of previously described anomaly, and microcephaly.

Results
We anticipate that this study provides critical information regarding morphological and spatial differences between data acquired using 1.5 Tesla and 3 Tesla protocols at the two scanner field strengths, giving us a better understanding on the pattern of myelination in a growing brain. The data acquired will help create a teaching database of normal pediatric brain development that will always be available to residents and fellows.

Conclusions
The physiological process of brain myelination during the first two years of age has been well described and assessed with the 1.5 tesla magnets. With the increase in number of high-field clinical magnets, it is essential to have access to a database of normal myelination assessed on 3Tesla magnet.

KEYWORDS: MR Imaging Brain, Myelination, Pediatric Brain

EP-174

Comparison of Image Deformation Registration Techniques in a Case of Re-Irradiation of Recurrent Pediatric Ependymoma

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Purpose
Re-irradiation of recurrent cancers presents the potential problem of exceeding radiation tolerance of at-risk tissue volumes. This concern is particularly complicated in re-irradiation of pediatric patients, as the gross anatomy is likely to have grown and changed since the initial treatment. As such, the conventionally used rigid fusion of first and second treatment plans for dose summing is inaccurate, as it does not accommodate this degree of change in structure. Instead, deformable registration allows for more accurate matching and dose summing of first and second planning CT scans. We seek to explore the utility of two different deformable registration algorithms, MIM and VelocityAI, in a case of recurrent pediatric ependymoma.

Materials and Methods
The patient is a Caucasian male with recurrent posterior fossa ependymoma, treated first at the 15.5 months and again at six years. The first treatment entailed focal IMRT (59.4 Gy). He was re-irradiated to the left cerebellopontine angle five years later with IMRT (54 Gy with a simultaneous boost to 59.4 Gy). The brain volume at each treatment was 1082.8 cc and 1399.7 cc, respectively, an increase of 29.3%. At the time of treatment we did not have access to deformable image algorithms, so we used rigid registration of first and second planning CT scans for dose summing. In this study, we retrospectively registered the first and second planning CTs.
using MIM 5.6.1 (MIM Software Inc., Cleveland, OH), a constrained, intensity-based deformable registration algorithm, and VelocityAI 3.0 (Velocity Medical Solution, Atlanta, GA), using multi-pass B-spline registration. We then applied each algorithm to the 3D dose grid of the first treatment plan and added the deformed dose grid to the second treatment plan dose grid, producing dose sum maps for evaluation of total dose values. In order to evaluate the risk of radiation toxicity, we calculated the volume receiving 50 Gy (V50) for the spinal cord and the V60 for optic chiasm. To compare differences between the results of the two algorithms, we compared the calculated sums to a reference sum, obtained by manual point dose summation of the original first and second treatment plans.

Results
For both the spinal cord and the optic chiasm, VelocityAI predicted a higher V50 and V60 than did the rigid registration calculation used originally. This result suggests that VelocityAI may reveal potential radiation dose hotspots in regions that were not recognized previously. The elucidation of new hotspots suggest that deformable image registration is more useful than rigid registration in avoiding radiation toxicity. However, it is important to consider that the high degrees of image deformation that may be needed to appropriately match first and second planning CTs must be validated. MIM calculations deviated from reference values for the spinal cord and optic chiasm, but not for other at risk volumes. Although deformable image registration is a promising technique to better sum doses across treatments in children occurring years apart, the differences found in morphing volumetric doses may indicate that further optimization and validation is need for these algorithms.

Conclusions
For both the spinal cord and the optic chiasm, VelocityAI predicts a higher V50 and V60 than does the rigid registration calculation used originally. This result suggests that VelocityAI may reveal potential hotspots of excessive radiation exposure in regions that were not recognized previously. The elucidation of new hotspots suggest that deformable image registration is more useful than rigid registration in avoiding radiation toxicity. However, it is important to consider that the high degrees of image deformation that may be needed to appropriately match first and second planning CTs (separated by enough time to permit significant growth to occur) must be validated. MIM calculations deviated from reference values for the spinal cord and optic chiasm, but not for other at risk volumes. Although deformable image registration is a promising technique to better sum doses across treatments in children occurring years apart, the differences found in morphing volumetric doses may indicate that further optimization and validation is need for these algorithms.

KEYWORDS: Pediatric Brain Tumors, Radiation Dosage, Radiation Exposure

EP-205
6:30AM - 9:00PM
Comparison of Rapid Cranial Magnetic Resonance Imaging to Computed Tomography for Diagnosing Ventricular Shunt Malfunction

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Purpose
Cranial computed tomography (CT), the practice standard for evaluating children with possible ventricular shunt malfunction, exposes them to cumulative ionizing radiation doses associated with significant lifetime malignancy risk. Rapid cranial magnetic resonance imaging (MRI), a new radiation-sparing alternative, has not been compared to CT for diagnosing shunt malfunction. Our goal was to compare the accuracy of rapid cranial MRI to CT for diagnosing ventricular shunt malfunction.

Materials and Methods
We performed a single-center retrospective cohort study of children ≤ 21 years of age with ventricular shunts who underwent either rapid cranial MRI or CT in the emergency department (ED) for possible shunt malfunction. Neuroimaging studies were classified as "normal" (unchanged/decreased ventricle size) or "abnormal" (increased ventricle size). We defined ventricular shunt malfunction as required operative revision to relieve mechanical shunt flow obstruction within 72 hours of initial ED evaluation. We calculated test characteristics for each imaging modality. Our primary analysis tested non-inferiority of the accuracy of rapid cranial MRI to CT for diagnosing shunt malfunction (non-inferiority margin 10%).

Results
We included 657 ED visits for 265 unique patients [median age at visit 10.2 years (interquartile range 6.0-15.6 years)]. Patients underwent CT in 324 (49%) or rapid cranial MRI in 333 (51%) ED visits for evaluation of possible shunt malfunction. Patients had operative revision for shunt malfunction in 95 ED visits (15%). The accuracy of rapid cranial MRI was not inferior to CT scan for the diagnosis of shunt malfunction [80.5% MRI vs. 83.3% CT; risk difference -2.8%; 95% Confidence interval (CI) -8.7%, 3.1%]. The median ED length of stay was longer for visits with a rapid cranial MRI [6.1 hours MRI vs. 5.4 hours CT; difference 0.8 hours; 95% CI 0.4,1.2], in part due to longer times to obtain neuroimaging (1.1 hours MRI vs. 0.7 hours CT; difference 0.4 hours, 95% CI 0.2, 0.6).

Conclusions
Rapid cranial MRI was not inferior to CT for diagnosing ventricular shunt malfunction.

KEYWORDS: MR Imaging Brain, Shunt

EP-191
Complications of Cerebral Catheter Angiography in Children: A Review of 316 Cases

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Purpose
Cerebral catheter angiography is an important tool for the investigation of intracranial vascular lesions and is a requirement before stereotactic radiosurgery (STRS) for arteriovenous malformations (AVMs). Knowledge of complication rates is required for adequate consent but there is limited complication rate data for paediatric angiography available in the literature. There are no published studies with elective STRS patients forming the majority of the study population. This study aims to assess the complication rates associated with paediatric cerebral
catheter angiography at our institution, where most procedures are performed electively prior to STRS.

Materials and Methods
All diagnostic angiograms performed on patients under the age of 17 years between January 2000 and August 2013 were identified using the radiology information system. Data collection was predominantly prospective, using the local angiography database or the data sheets of individual operators; and partially retrospective, using case note review. A total of 323 cases were identified and sufficient data for analysis was available for 316 of these. The following data was collected: age; indication for procedure; diagnosis; operator; complications.

Results
Prospectively collected data was available for 277 cases. Retrospective case note review yielded data for a further 46 cases. Seven cases were excluded as there was no prospective data entry and insufficient information available in the case notes. The age range for the 316 included cases was 2 to 16 years (mean age: 12.0 years). 285 (90.0%) of angiograms were performed in patients having STRS for AVMs. The next largest patient groups were those with parenchymal haemorrhage; 15 patients (4.7%), and vascular tumours; 6 patients (1.9%). There were two complications in total, both in STRS patients. One child (0.3%) had a common femoral artery dissection during the procedure, but remained well at discharge the following day. One child (0.3%) bled from the puncture site post-procedure after haemostasis was thought to have been achieved. This was successfully treated with manual pressure without formation of a significant haematoma or false aneurysm.

Conclusions
In children the complication rates for cerebral catheter angiography are low. This is particularly the case when the procedure is performed electively for STRS. Our results compare favourably with the previously published paediatric data from smaller series.

KEYWORDS: Angiography, Complications, Pediatric Cerebrovascular Disease

EP-177

Desmoplastic Infantile Ganglioglioma (DIG): Imaging features of an uncommon tumour of infancy

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Purpose
Description of the imaging features of desmoplastic infantile ganglioglioma (DIG), a rare tumor of infancy.

Materials and Methods
We describe two patients; the first was a five-day-old term female infant with a complicated delivery who had a routine antenatal cranial ultrasound scan demonstrating a cystic lesion in the left parietal lobe. The second patient was a six-month-old female infant presenting with seizures; cranial ultrasound showed a large cystic lesion in the left frontal lobe. Computed tomographic (CT) scans showed part solid and part cystic lesions in both patients, with no calcification. Both patients underwent magnetic resonance imaging (MRI) of the brain, with routine T1/T2-
weighted and gradient echo sequences, along with postgadolinium and diffusion-weighted imaging (DWI). Single voxel magnetic resonance spectroscopy (MRS) was performed in one of the patients.

Results
In both cases, a large intra-axial predominantly cystic lesion was seen with a peripheral homogenously enhancing nodular plaque-like solid component, with moderate vasogenic edema. The solid component extended to the dural surface. Diffusion-weighted imaging showed increased diffusion within the cystic portions of the tumor, with some areas of restricted diffusion within the solid components, in both patients. The MRS performed in one patient demonstrated a large lactate peak with low N-acetylaspartate (NAA) and choline. Both patients underwent initial histological confirmation with image-guided biopsy of the lesions, with subsequent definitive total resection of the tumors. Follow-up imaging current at the time of this report showed no recurrence or postsurgical disease progression in either patient.

Conclusions
Desmoplastic infantile ganglioglioma is an uncommon tumor of infancy presenting in the first 18 months of life. Along with a further histologic subtype, Desmoplastic infantile Aastrocytomas, these tumors form part of the larger group of desmoplastic infantile tumors (DIT), believed to have a favorable prognosis. Imaging features usually are consistent with a large cystic supratentorial lesion with an enhancing peripheral solid component extending to the dura. Despite seemingly aggressive appearances, surgical resection is curative in the majority. Our two cases demonstrate the typical imaging features of this tumor and to date both patients have not shown recurrent disease postsurgical resection. Appearances on diffusion-weighted imaging have not, to our knowledge, been described previously. Although the cause of the small areas of diffusion restriction described remains obscure, they may correlate with any aggressive histological appearances.

KEYWORDS: Desmoplastic Infantile Ganglioglioma

(Filename: TCT_EP-177_postgad1.jpg)
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Purpose
Spondylolysis, i.e. defect in pars interarticularis of the vertebral neural arch, considered due to chronic stress injury, is a relative rare condition (6%) but identifiable cause of low back pain in children and adolescents. We present our series of 6 adolescent patients affected by spondylolysis and treated conservatively.

Materials and Methods
We diagnosed spondylolysis by means of MR imaging in six young patients (age ranging from 14.5 to 16.8 ys; male:female = 3:3) affected by low back pain. Elapsed time between symptoms onset and evaluation was 1 to 5 months. Back pain was associated with bilateral sciatalgia in one. Two patients were active in sports.

Results
Diagnosis was obtained by non-contrast MRI, showing the typical morphological aspect of defect of the pars interarticularis of the posterior vertebral arch on T1- and T2-weighted sagittal sequences. Spondylolysis was bilateral in all but one case; the interested vertebrae were L5 in four patients and L3 and L4 in one, respectively. The condition was always associated with edema of bone and usually of adjacent soft tissues, demonstrated as hyperintense signal on T2 fat sat sequence. In two cases CT scan was also performed. All patients were treated in a conservative way, by rest and use of a hard brace. Follow up was carried out by means of MR performed every 3-6 months for a period of 12-16 months, till the resolution of edema and demonstration of bone fusion were obtained. Bone repair was confirmed in 2 patients by CT scan, performed with radiation doses as low as possible. In all cases the healing was associated with complete resolution of symptoms.

Conclusions
Our experience shows that diagnosis of spondylolysis in young population with low back pain is feasible not invasively by MRI; the early diagnosis of this condition is important to prevent the occurrence of forward slippage whose treatment could require more aggressive, surgical procedure in the adulthood.

KEYWORDS: Spondylolysis

EP-192
6:30AM - 9:00PM

Diffusion tensor imaging of the brainstem in children with achondroplasia

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Purpose
Achondroplasia is a skeletal dysplasia and the most common form of disproportionate short stature in children with diminished growth of the skull base that leads to narrowing of the cranio-cervical junction (CCJ) and foramen magnum, which may lead to cervicomedullary compression. Diffusion tensor imaging (DTI) is a magnetic resonance imaging (MRI) technique that allows in vivo evaluation of the microstructure and integrity of white matter tracts. DTI is highly sensitive to detect white matter abnormalities and is a suitable technique to study white matter changes that may result secondary to chronic cervicomedullary compression in achondroplasia. This study aimed to 1) assess the microstructural integrity of the white matter using DTI in the brainstem in comparison to age-matched controls and 2) correlate severity of CCJ narrowing and neurological findings with DTI scalars in children with achondroplasia.

Materials and Methods
The inclusion criteria for this retrospective study were: 1) confirmed diagnosis of achondroplasia (imaging and/or genetic findings), 2) availability of presurgical DTI data without artifacts enabling a high quality DTI post-processing and 3) age at MRI 18 years and younger. DTI data were acquired on a 1.5 T MR-scanner using a balanced pairs of diffusion gradients along 20 non-collinear directions. Measurements from regions of interest sampled in each pontine corticospinal tract (CST), medial lemniscus (ML) and middle cerebellar peduncle (MCP) as well as in the lower brainstem were obtained for fractional anisotropy (FA), mean (MD), axial (AD) and radial (RD) diffusivity. Additionally, a severity score for achondroplasia was assessed by measuring the CCJ narrowing.

Results
8 patients with achondroplasia and 8 age-matched controls were included in this study. Compared to age-matched controls, decrease in FA and increase in MD and RD were found in the lower brainstem of patients. CST's and MCP's showed increase in MD, AD and RD. FA in the lower brainstem negatively correlated with the degree of CCJ narrowing.

Conclusions
Reduction in FA and increase in diffusivities in the lower brainstem may reflect secondary encephalomalacic degeneration and cavitation of the affected white matter tracts as shown by histology. In children with achondroplasia, DTI may serve as a potential biomarker for brainstem white matter injury and aid in the management of these patients.

KEYWORDS: Brainstem, Childhood, Diffusion Tensor Image

EP-203
6:30AM - 9:00PM

Emerging left-right asymmetry of white matter brain pathways in humans: Fetal, neonatal, and toddler stages

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Purpose
Studies show that cognitive abilities such as language and hand preferences, characteristics unique to the human species, are strongly lateralized in the human brain. However, it is unknown whether asymmetric structural development in the brain influences or is the result of these functional hemispheric asymmetries. Characterizing white matter pathways in developing human brains may provide insight into how asymmetries arise and elucidate a temporal relationship between structure and function. The purpose of this study is to compare the spatio-temporal hemispheric asymmetry of developing white matter pathways using high-angular resolution diffusion imaging tractography in intact human fetal, neonate, and toddler brains.

Materials and Methods
Human ex vivo fetal brain specimens of post-gestational week (W) 17 (n=1) and W20 (n=3) were imaged using a 4.7T Bruker MR system. Premature newborns (W30, W34; n=3), term-birth newborns (W40; n=3), and toddlers (2years; n=1) were imaged in vivo using a 3T Siemens MR system. A 3D diffusion-weighted spin-echo echo-planar imaging (EPI) sequence (61 measurements), TR/TE 1000/40 ms, with b = 8,000 (for ex vivo) and b= 1,000 to 3,000 (for in vivo), small/large delta = 12.0/24.2 ms was performed. Spatial resolution ranged from 400x500x550 μm to 2x2x2 mm depending on the brain size. Tractography pathways were reconstructed using a streamline algorithm with an angle threshold of 40 degrees, and white matter pathways were segmented using TrackVis. Fractional anisotropy (FA), apparent diffusion coefficients (ADC), trajectories and volumes between hemispheres were compared at different developmental time points. A laterality index (LI) for FA, ADC, and volumetric values was calculated (LI= (L-R)/0.5(L+R)). Positive and negative LI values correspond to a left and right-sided preference, respectively. Because ADC values may be affected by the fixation process and b-value, ADC values for brains that were imaged in vivo were standardized against age-equivalent post-mortem brains. This approach facilitated ADC comparisons across in vivo and ex vivo imaged brains. The brains used for standardizing had only one hemisphere and were excluded from asymmetry analyses.

Results
Age-related development of laterality was not observed in a migration stream from the ganglionic eminence nor in a limbic connectional pathway (cingulum bundle or fornix). Among the studied cortico-cortical association pathways (inferior longitudinal fasciculus, inferior fronto-occipital fasciculus, and arcuate fasciculus), only the inferior longitudinal fasciculus showed development of age-related laterality emerging as early as the second trimester. When comparing ages older and younger than 40GW, a leftward asymmetry in the volume of the cingulum bundle in ages older than 40GW emerged. A rightward asymmetry in ADC and a leftward asymmetry in FA emerged in the inferior longitudinal fasciculus in ages older than 40GW.

Conclusions
Regional emergence of fetal brain axonal connectivity appears to proceed from a postero-dorsal to antero-ventral direction with local variations related to the later appearance of gyri and sulci. Hemispheric asymmetry in white matter pathways appears to arise substantially later than asymmetry in related cortical areas. These findings suggest development of hemispheric laterality may be more vulnerable to early life experiences or interventions.

KEYWORDS: Diffusion Tensor Image, Fetal Brain Development, Lateralization
Hippocampal Fractional Anisotropy Changes in a Cortical Dysplasia Animal Model

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Purpose
Up to 79% of children with temporal lobe epilepsy (TLE) and mesial temporal sclerosis have cortical dysplasia (CD) (1). To better understand the role between cortical dysplasia and epileptogenesis we studied an animal model combining focal cortical dysplasia induced by cryolesion at postnatal day 1 (P1) and hyperthermia-induced seizures at P10 (2). Previous studies have demonstrated that rat pups with focal cortical dysplasia develop status epilepticus lasting more than 30 minutes when exposed to hyperthermia while controls experienced only brief seizures. This dual pathology animal model causes hippocampal atrophy (3) and increased hyperexcitability in CA1 hippocampal pyramidal cells early on (4). Diffusion tensor imaging (DTI) studies have reported substantial white matter abnormalities in the epileptogenic network of patients with TLE (5) but the link between CD and TLE remains unclear. To our knowledge, DTI has never been applied to study fractional anisotropy (FA) changes in an animal model of cortical dysplasia. Here we use this technique to assess microstructural changes in the hippocampus that could explain increased epileptic activity and seizure propagation in our animal model.

Materials and Methods
Seven male Sprague-Dawley rat pups were divided into two groups: naïve controls (NC, n=2) and freeze-lesion (L, n=5). A freeze lesion was induced on the right frontoparietal cortex at postnatal day 1 (P1) to mimic CD (2). At P8, MR images were acquired on a seven T MR scanner (Varian, Palo Alto, CA) with a 210 mm bore and detection was performed using a rat head coil (Rapid Biomed, Columbus OH). Axial T2-weighted images were obtained to confirm the presence and analyze the location of the cortical dysplasia: TR = 2000 ms, TE = 12 ms, eight echoes, FOV = 25 mm\(^2\), acquisition matrix 256 x 256, slice thickness = 0.7 mm. A six-direction spin echo sequence was used to acquire 2D multislice diffusion-weighted images with the following parameters: TR = 2,000 ms, TE = 35 ms, strength of gradient = 20 G/cm, Δ = 13 ms, δ = 6 ms, FOV = 32 x 32 mm\(^2\), slice thickness = 0.25mm, acquisition matrix 128 x 128, number of acquisitions = 1. Manual delimitation of the hippocampus and frontoparietal cortex was performed with the help of an atlas using Dipy (www.dipy.org) software to calculate FA, mean diffusivity (MD), as well as axial and perpendicular diffusivities (\(\lambda//\), \(\lambda\perp\)). Diffusion tensor imaging metrics statistics in each cerebral region was performed on SPSS (SPSS, Chicago, IL) with a Student’s t-test (p=0.05).

Results
Results demonstrate significantly lower FA in the right dorsal hippocampus (NC=0.32±0.05; L=0.21±0.1; p<0.05) but not on the left side (NC=0.29±0.6; L=0.33±0.02). \(\lambda\perp\) (x10-3mm\(^2\)/sec)
increased but nonsignificantly in the right hippocampus (NC=0.00088±0.00012; L=0.00106±0.00005; p=0.18). Colored FA maps demonstrate important alteration in the fiber orientation of the CD rat pups (Figure 1). On the right cortical lesion side (arrowhead), very few superior-inferior tracts are seen both in the right dorsal hippocampus (short arrow) and thalamus (long arrow) compared to the contralateral side.

Conclusions
Lower FA values are seen in the ipsilateral hippocampus after cortical insult. It has been suggested that FA values in the premature rat brain correlate with microstructural anisotropy (6). Thus, our results could indicate that a superficial cortical lesion can potentially alter the microstructure deep in the developing brain. Previous studies demonstrate that the induction of cortical dysplasia at P1 causes a reorganization of thalamocortical connections (7) but the effects on the limbic system is unknown. We know that rat pups with CD have a lower epileptic threshold and EEG epileptogenic discharges in the hippocampus and amygdala after induction of experimental febrile seizures (2, 8). Further longitudinal studies are required to evaluate if these changes are transient or cause permanent white microstructural reorganization linked to TLE.

KEYWORDS: Cortical Dysplasia, Diffusion Tensor Image, Pediatric Epilepsy
Imaging Evaluation of Developmental Anomalies of the External and Middle Ear: What the Surgeon Wants to Know.

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Purpose
The aim of this exhibit is to provide a review of the developmental anomalies of the external and middle ear. We will discuss the embryologic basis, anatomy, and imaging features of these anomalies with illustrative examples and clinical cases.
Materials and Methods
Developmental abnormalities of the external and middle ear comprise an important group of disorders which are associated with mild to profound hearing loss. We will provide a brief review of external and middle ear embryology and relevant anatomy. We will describe the common developmental abnormalities including external auditory atresia, ossicular maldevelopment spectrums, developmental cholesteatoma, cranial nerve VII dehiscence, stapedial artery variant, dehiscent jugular bulb, etc. We also will discuss various syndromes which are associated with malformation of the external and middle ear structures. The descriptions will focus on common clinical presentation, and classic imaging features with illustrative examples.

Results
Incidence of the congenital external and middle ear anomalies is 1 in 10000 – 20000 live births. Unilateral involvement is more common than bilateral (4:1). Bilateral abnormality is associated more frequently with syndromes. Unilateral versus bilateral nature of the abnormality, auricle and external auditory canal abnormality, course of the facial nerve, status of the oval window, morphology of the stapes and status of inner ear structures are the among the most important features that guide the surgical management in these cases. The complex and compact anatomy of the middle ear can make imaging evaluation difficult and intimidating. While it is important to recognize and characterize pathology it also is critical to provide clinically useful information for the referring physician who is tasked with treating these complex abnormalities.

Conclusions
The objective of this exhibit is to familiarize radiologists with the common developmental abnormalities of the external and middle ear as well as discuss the features and information which the referring otolaryngologist is looking for.

KEYWORDS: Middle Ear, Pediatric Head And Neck, Temporal Bone

EP-196
6:30AM - 9:00PM

Incidence, Clinical and Radiographic Characteristics of Intracranial Hypertension in Children with Osteopetrosis Undergoing Hematopoietic Stem Cell Transplantation

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Purpose
Osteopetrosis (OP) is a rare, life-threatening disease caused by abnormal osteoclast function resulting in dense sclerotic bone, cranial nerve impingement, recurrent fractures, osteomyelitis, and hematopoietic failure. Disease presentation and severity vary with genotype. While hematopoietic stem cell transplantation (HSCT) remains the usual treatment, there continue to be numerous complications in the OP population. Intracranial hypertension (IH) has been described in OP, but few case reports exist in the literature. We report the incidence, clinical and radiographic characteristics of IH in OP patients treated with HSCT at our center.
Materials and Methods
Thirty-one OP patients undergoing HSCT at the University of Minnesota from 1978-2013 had medical records and/or neuroimaging available for review.

Results
Ten patients (32%) developed IH at a median age of 11 months. Onset was post-transplant in 3 patients (days +21, +204, and +286) and pre-transplant in 7 (median, day –28). Signs and symptoms included headache, irritability, somnolence, bulging fontanel, proptosis, increased scalp venous markings and sudden vision changes. Three patients had evaluable opening pressures upon lumbar puncture (LP): 1 at 17 cm H2O (3 month-old), and 2 at >55 cmH2O (1 year-old and 15 year-old). For patients with IH, the median age of OP diagnosis was 3 months (range, 0 - 176 months). All 4 patients with genotypic data demonstrated compound heterozygous TCIRG1 mutations. Six patients had evidence of IH at presentation of OP. Neurologic deficits prior to HSCT included hearing loss (3), facial nerve palsy (1), nystagmus (6) and optic nerve atrophy (9). Relative macrocephaly was present in 6 of 7 patients with available anthropometrics. Imaging just prior to intervention for IH was available for up to 5 patients at a median age of 12 months. Four (80%) demonstrated subdural hemorrhage. Three (60%) demonstrated posterior globe concavity. Mean optic nerve sheath diameter was 8.3mm. Mean jugular foramina (pars vasculosa) diameter was 5.4mm. Three patients demonstrated maximal venous engorgement in the posterior superior sagittal sinus (13.4, 12.1, and 11.7mm, transverse dimension). Two patients had maximal dilation in a transverse sinus (10.1 and 12.3mm, A/P dimension). The average maximal third ventricular diameter was 4.9mm.

Interventions for IH occurred in nine patients, including shunting (8), serial LP (2), optic nerve decompression (2), and acetazolamide (1). Transplant occurred at a median age of 12 months. Eight patients experienced respiratory failure and three demonstrated pulmonary hypertension. Five patients died from transplant-related complications and two from disease progression. Three patients survive (3 years, 3 years, and 10 years post-transplant).

Conclusions
Intracranial hypertension appears common in children with osteopetrosis who present for and undergo hematopoietic stem cell transplantation. Ongoing cohort analysis aims to further identify clinico-radiographic features of, and outcomes following intervention for, IH in OP. Ultimately, we hope such analysis will inform rational intervention, perhaps even pre-emptively, for this patient population.

KEYWORDS: Intracranial Hypertension, Osteopetrosis

EP-199

Incidental Hypothalamic Cleavage Anomalies in Children

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Purpose
Structural anomalies of the hypothalamus can either be seen in isolation, as in hypothalamic hamartomas, or can be associated with several midline congenital disorders such as holoprosencephaly spectrum and septo-optic dysplasia. In the literature, hypothalamic anomalies
are almost always associated with symptoms referable to hypothalamic-pituitary dysfunction, seizures, or a midline congenital disorder, with very few asymptomatic patients reported (1-2). Aside from large hypothalamic hamartomas, isolated anomalies of the hypothalamus are difficult to detect by routine MRI, due to its small size and the difficulty in separating the hypothalamus from adjacent structures (3). Using high-resolution isotropic T1 weighted MR imaging, we have observed a number of isolated and apparently incidental hypothalamic structural anomalies. The purpose of our study is to further characterize these anomalies and determine any clinical significance.

Materials and Methods
The Children's Hospital Colorado case file was searched for patients identified with isolated hypothalamic anomalies. Patients with a history of hypothalamic-pituitary dysfunction (including precocious puberty), seizures, hydrocephalus, or neurofibromatosis type I were excluded. These criteria resulted in a study cohort of 8 patients, of equal gender distribution, ranging in age from 18 days to 17 years, mean age 5 years. MR imaging indications for the group included vertigo, concussion, dural venous sinus thrombosis, tongue hypertrophy, and premature birth. Images were reviewed by 2 neuroradiologists for other congenital abnormalities, including lack of midline cleavage, pituitary anomalies and cortical malformations.

Results
In all 8 cases, the hypothalamic anomaly consisted of a band of tissue spanning the anterior recess of the third ventricle (Figure 1a) that appeared nodular on sagittal images (Figure 1b). In all patients, the band of tissue was T2 isointense to gray matter, did not contact the mammillary bodies, and did not extend below the tuber cinereum. On review of the images, no additional structural abnormality was identified, with particular attention to midline structures and for cortical malformations.

Conclusions
This hypothalamic anomaly was observed incidentally through the routine acquisition of high-resolution T1 imaging. No referable symptoms or other congenital anomalies were identified in the study group. As the described anomaly is subtle and only apparent on isotropic T1 imaging, it is likely under recognized. However, as high resolution MRI techniques become more routinely employed, these hypothalamic anomalies or variants are likely to be increasingly identified. Although the underlying etiology is unclear, it may be the result of incomplete hypothalamic cleavage. In the appropriate patient population where related symptoms are absent, the described hypothalamic anomalies are most likely incidental, and should not be misdiagnosed as hypothalamic hamartomas.

KEYWORDS: Congenital Brain Malformations, Hypothalamus, Midline Developmental Anomalies
Interhypothalamic Adhesion: A Case Series

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Purpose
The interhypothalamic adhesion (IHA) is a newly described disease entity. IHA is characterized by an abnormal parenchymal band of tissue connecting the medial margins of the hypothalami across the third ventricle. The purpose of this case series is to describe the imaging findings from 4 additional patients with IHA discovered on brain MR.

Materials and Methods
MR images from 4 separate patients with IHA encountered over a 5 month period at a single academic children's hospital were reviewed. Each study was evaluated by a CAQ holding neuroradiologist. Each patient's electronic medical record was researched for presenting symptoms, past medical history, pertinent physical exam findings, and additional relevant diagnostic tests.

Results
Case Presentations:
Case 1: A 2 month-old former 26 week preterm infant male with a history of a normal head ultrasound presented for a term equivalent brain MR. MR demonstrated an IHA and mild hippocampal under rotation.
Case 2: A 4 year-old male underwent a brain MR for headaches and vomiting. Past medical history was remarkable for Leber congenital amaurosis. Brain MR depicted an IHA, optic pathway atrophy, and old frontal lobe white matter injury.
Case 3: An 11 month-old male with a history of global hypotonia presented for brain MR evaluation. Imaging revealed an IHA as the isolated intracranial abnormality.
Case 4: A 9 year old male with presumed Dandy-Walker malformation continuum underwent brain MR. In addition to cerebellar hypoplasia, a posterior fossa cyst, and periventricular nodular heterotopia, an IHA was discovered.

Conclusions
Interhypothalamic adhesion is a newly described disease entity, first recognized in a patient with cleft palate with additional intracranial findings that raised the possibility of a form fruste holoprosencephaly. We describe associated imaging findings in 4 additional patients with IHA.

KEYWORDS: Congenital Anomalies
Intracerebral Hemorrhage Following Shunting of Neonatal Hydrocephalus: Is it the Vulnerable Venous Vasculature?

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Purpose
Intracerebral hemorrhage following shunting of hydrocephalus is a rare but serious occurrence. While shunt-related complications, including subdural hemorrhage, have been described in both the radiology and neurosurgical literature, there is only a single report detailing parenchymal hemorrhage. The etiology of this potentially fatal complication remains unclear. Based on the subcortical location of the hemorrhages, it is thought that the bleeds are venous in etiology. In the adult population, similar pathology has been described in the setting of rapid decompression of chronic subdural hematomas (CSH). In that clinical context, a variety of differing theories have been postulated as to the etiology of the parenchymal hemorrhages: a) perfusion breakthrough bleeding, b) disrupted cerebral vascular autoregulation, c) vascular damage secondary to mechanical shift of cranial contents, and d) the interplay between intracranial and venous pressures. At the heart of all of these theories lies one common denominator, the vulnerable venous vasculature. We postulate a similar mechanism for parenchymal hemorrhage following shunting of neonatal hydrocephalus.

Materials and Methods
The case file at a tertiary care children's hospital was searched over the last 7 years for neonates with hydrocephalus who developed intracerebral hemorrhage within one week following shunt placement. All available imaging was reviewed. Patients with underlying coagulopathy, infection, or anomalous vasculature were excluded. A literature review of underlying principles and postulated mechanisms for parenchymal hemorrhages following treatment of CSH was performed.

Results
Three infants ranging in age from 4 days to 4 months with subcortical hemorrhages immediately post-shunting of hydrocephalus were identified. Two were female and one was male. In all cases, the subcortical hemorrhages occurred bilaterally involving all cerebral and cerebellar lobes, were unrelated to the drainage catheter sites, and were associated with subdural hematomas. All were associated with a rapid change in ventricular size. We postulate that with increased parenchymal blood flow and altered pressure dynamics following CSF diversion intracerebral veins are vulnerable to rupture. Venous vulnerability is a reflection of disrupted autoregulation, and leads to a type of perfusion breakthrough bleeding.

Conclusions
Intracerebral hemorrhage following shunting of congenital hydrocephalus is likely due to venous vulnerability resulting from the unique environment established by long-standing hydrocephalus leading to altered venous pressure dynamics.

KEYWORDS: Hemorrhage, Hydrocephalus, Shunt
Intraoperative MRI with Diffusion Tensor Imaging (DTI) at 3Tesla for Evaluation of the Extent of Disconnection of White Matter Tracts in Modified Functional Hemispherectomy.

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Purpose
1) To emphasize the role of intra-operative MR imaging (MRI) in the post-surgical outcome of modified functional hemispherectomy performed for seizure control in pediatric epileptic patients. 2) Evaluate the role of DTI in intra-operative MRI, in determining complete disconnection of the white matter tracts for optimal postsurgical results.

Materials and Methods
Ten pediatric patients with recurrent seizures underwent modified functional hemispherectomy for various etiologies of seizure [Congenital Middle Cerebral Artery Infarct with gliosis (n=5), Hemimegalencephaly (n=1), Rasmussen encephalopathy (n=1) Extensive Polymicrogyria (n=1), Cortical Dysplasia (n=1) and Hemorrhagic Encephalitis (n=1)]. All patients had undergone previous MRI examination (including DTI in most cases) and presurgical evaluation including detailed history, neurologic examination and electroencephalogram. All intra-operative MRI scans included 3D T1- and T2-weighted images as well as 32 directional DTI. All cases were all scanned on the same intra-operative 3T MR scanner (Philips Medical Systems, Netherlands). Diffusion tensor images were acquired with SENSE head coil. Each DTI dataset was acquired with a multislice, single shot echo-planar imaging (SENSE factor = 2.5) spin echo sequence. Transverse slices were acquired (parallel to the line connecting the anterior and posterior commissures) covering the whole brain with no slice gap and 2.5 mm isotropic resolution. Diffusion weighting was applied along 32 directions with b value of 1000 s/mm². To improve the signal to noise ratio, additional DTI datasets were acquired and averaged after coregistration. The complete sequence took seven minutes. The images obtained were postprocessed on the Philips Workstation to obtain color maps and also for fiber tracking. The studies were evaluated simultaneously by two fellowship-trained pediatric neuroradiologist blindfolded to the findings of each other.

Results
Two out of the 10 patients had suspected incomplete disconnection on the conventional images which was confirmed further by DTI images. They proceeded for second surgery which then showed complete disconnection on subsequent DTI.

Conclusions
Initial data suggests that addition of DTI sequence to intraoperative MRI, may significantly improve outcome in patients undergoing modified functional hemispherectomy which depends upon complete disconnection of the white matter tracts.

KEYWORDS: Diffusion Tensor Image, Pediatric Brain, Seizure
Longitudinal Changes in Diffusion Properties in the White Matter Pathways in Patients with Tuberous Sclerosis Complex

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Purpose
The purpose of this study was to identify predictors of longitudinal changes in diffusion properties of white matter tracts of projection, association and commissural fibers in patients diagnosed with Tuberous Sclerosis Complex.

Materials and Methods
Structural and diffusion magnetic resonance imaging was carried out in 17 subjects diagnosed with Tuberous Sclerosis Complex (TSC) (mean age, 7.2 ± 4.4 years, range: 2 – 17.5 years) and with at least 2 scans (mean number of days between the 2 scans 419.4 days ± 105.4 days, range: 309 – 741 days). There were 10 males and 7 females; 5 of whom had autism spectrum disorder (ASD); and 10 of whom had seizure disorder. A coordinate-based tractography atlas was used to guide ROI placement to segment the bilateral internal capsule/corona radiata, bilateral cingulum bundle, and corpus callosum. These ROIs were then co-registered using FLIRT to each subject's second scan. The outcomes were mean change in apparent diffusion coefficient (ADC) and the mean change in fractional anisotropy (FA).

Results
Multiple linear regression analyses showed gender to be a significant predictor of mean change ADC in TSC subjects in the left internal capsule, right and left cingulum bundles, and corpus callosum (Fig 1), adjusting for initial ADC scan measures. Gender also emerged as a significant predictor of mean change in FA in the corpus callosum, adjusting for initial FA scan measure. Adjusting for initial ADC scan measures, seizure disorder emerged as a significant predictor of mean change in ADC in the left internal capsule. ASD did not emerge as a significant predictor in either the mean change in ADC or FA in the studied white matter tract pathways.

Conclusions
Gender and seizure disorder were independent predictors of mean change in ADC or FA in some white matter tract pathways in TSC subjects. White matter microstructural integrity was more affected in males than in females in the left internal capsule, right and left cingulum bundles, and corpus callosum and more affected in TSC subjects with seizure disorder in the left internal capsule than in subjects without seizure disorder.

KEYWORDS: Diffusion Tensor Image, Tuberous Sclerosis
Magnetic Resonance Imaging of the Pediatric Calvarial and Spinal Bone Marrow

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Purpose
The purpose of this educational exhibit is to show how the MR imaging (MRI) signal pattern observed in diseased bone marrow differs from the patterns seen in the normal developing pediatric skull and spine.

Materials and Methods
A focused systematic review of age-related normal MR imaging signal characteristics of the developing axial skeleton is provided. Subsequently examples of the MRI patterns seen in a range of disease processes that involve the calvarium and spine will be shown and categorized as: (1) neoplastic, (2) inflammatory/infectious, (3) genetic/autoimmune (such as the T1 sagittal image of a 14-year-old girl with Blackfan-Diamond anemia shown below), (4) hematologic/vascular, or (5) traumatic/iatrogenic.

Results
MR imaging has long been proven to be the mainstay of bone marrow evaluation because of its excellent tissue contrast differentiation. The normal developing bone marrow undergoes the most rapid change in size, composition and cellularity during the first 25 years of life. In order to facilitate detection of diseased bone marrow, we need to know the MRI appearance of normal bone marrow.

Conclusions
This educational review can facilitate accurate diagnosis of head and spine bone marrow
pathology by providing a fundamental knowledge of the normal MR imaging pattern seen during various stages of development of the pediatric skull and spine. Examples of abnormal bone marrow pathology will be shown.

KEYWORDS: Bone Marrow, Calvarial, MR Imaging Spine

Mapping the Prenatal Connectivity of the Human Cerebellum and Brainstem Using Diffusion Tensor Tractography

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Purpose
Diffusion tensor based tractography is a non-invasive approach that enables the prenatal visualization of unmyelinated axonal pathways such as the corpus callosum and the corticospinal tract in 3D (1-2). The cerebellum shows a widespread connectivity with various forebrain regions and the spinal cord represented by the superior- (SCP), middle- (MCP) and inferior cerebellar peduncles (ICP). Due to the small dimensions of these pathways in the developing fetal brain, they have not been attempted to be visualized in vivo and in utero. This in utero diffusion tensor imaging (DTI) study aims to depict the connectivity of the normal and abnormal fetal cerebellum in vivo.

Materials and Methods
34 cases (24 normal, 10 brain pathologies, gestational age: 19 gestational weeks (GW) to 36GW) were retrospectively extracted from an existing in utero DTI datasets, after acquisitions with visible fetal movement (>80% of examinations) were excluded. DTI sequences were acquired on a 1.5 T Philips Achieva unit (axial rapid echo planar diffusion tensor sequence; maximum acquisition time 1 min 50 s; 16 gradient encoding directions, b values of 0 and 700 s/mm², reconstructed asymmetric voxel size: 0.94 _ 0.94 _ 3 mm, field of view 230 mm, 408 slices). Tractography was performed using a deterministic approach (threshold: FA=.1, angle change 32°) after defining multiple regions of interest in the area of SCP, MCP, and ICP. Visualization of these structures in adults served as anatomical reference for the tracking procedure (3-4).

Results
The MCP and transverse pontine/corticocerebellar fibers were consistently observed in 18/34 (53%) patients, in association with the SCP in 9/18 (50%) (Figure), ICS in 3/18 (17%) and both in 4/18 (22%). In 5 patients (15%), the transverse pontine trajectories could not be visualized, whereas the MCP (4/5 80%), ICP (2/5 40%) and SCP (5/5 100%) proper were successfully depicted. In 11/34 (32%) patients, cerebellar peduncle pathway identification was not possible, because of a low signal/noise ratio (5/11) (46%) or minor fetal or maternal motion (6/11) (54%).

Conclusions
Despite the small size, low DTI resolution and the random orientation of the fetal head, cerebellar outflow and inflow tracts traveling through the MCP, SCP and ICP were depicted by DTI and tractography in a preselected group of fetuses. Due to the small dimensions of the examined structures, almost complete absence of maternal or fetal motion as well as an optimal signal/noise ratio (coil position) are required to achieve anatomically plausible tractography results.

KEYWORDS: Cerebellum, DTI Tractography, Fetal MR Imaging
Mesial Temporal Lobe Morphology in Intractable Pediatric Epilepsy: So Called Hippocampal Malrotation, Associated Findings, and Utility for Presurgical Lateralization

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Purpose
Diagnostic criteria for hippocampal malrotation (HIMAL) include: asymmetric rounded hippocampal shape, vertical collateral sulcus, blurring, and low fornix. Relationship to epileptogenesis remains speculative and utility as a lateralizing finding for seizure surgery is unknown. Given normal developmental changes, analysis of HIMAL in a pediatric population is needed to further define this entity and determine potential utility for surgical selection.

Materials and Methods
48 surgically treated children with intractable epilepsy formed the study group excluding tumors, destructive lesions, and gyral malformations involving the temporal lobe. An age, sex, and handedness matched control group (N=48) excluded subjects with a history of neurologic or psychiatric illness (including seizures). Volumetric 1-1.25 mm T1 and T2 FLAIR images were reviewed using MPR perpendicular to the hippocampi blinded to surgical side. Each temporal lobe was evaluated for imaging features associated with HIMAL: rounded hippocampus, blurring, vertical collateral sulcus, wider choroidal fissure, enlarged temporal horn, lower fornix location, hippocampal signal, and findings consistent with hippocampal sclerosis. A mesial temporal score (MTS) was calculated by summing the number of features. Collateral sulcus angle (CSA) was measured on coronal images perpendicular to the hippocampus.

Results
All epilepsy patients had cortical dysplasia (CD) on pathology, mean age:9.6 years (3m-18 y),
M:F 27:21; normal group was statistically identical. Imaging findings included: hippocampal sclerosis (5), findings of CD (20), encephalomalacia (3), non-lesional (23). Only 3 epilepsy (6.2%) and none of the normal subjects exhibited full features of HIMAL, as above (p=0.12). 8/48 (16.7%) epilepsy versus 2/48 (4.6%) normal subjects had both a rounded hippocampus and vertical collateral sulcus (suggesting HIMAL) (p=0.045). All features except lower fornix and rounded hippocampus were more prevalent in the epilepsy group. In normal subjects, all findings except larger temporal horn were more prevalent on the left (low fornix position, p=0.035). In seizure patients all MR imaging findings except larger temporal horn and hippocampal sclerosis were more prevalent on the left (vertical collateral sulcus and lower fornix, p=0.035). No difference in MTS comparing sides was noted in either group. Epilepsy subjects had larger MTS compared with normal (z = -2.95, p = 0.002). 14.6% of epilepsy subjects had a MTS > 3 compared with 1% of normal (p=0.0003). The left CSA was more acute (mean 67.3, 63.9) than the right (mean 74.7, 71.3) in both normal and epilepsy subjects respectively (p<0.0001). Both CSAs were more acute in epilepsy subjects, compared with side matched normal (p=0.04). There was no significant association with surgical side in those with HIMAL or lateralizing CSAs. Lateraling raw MTS had a significant association with surgical side, p=0.03, OR:7.33.

Conclusions
Strictly defined HIMAL occurs rarely in children with intractable epilepsy (6.2%). Using less stringent criteria HIMAL occurs more commonly in surgically treated pediatric epilepsy patients (16.7%) versus normal subjects (4.6%). CSA is more acute, and MTS are larger in epilepsy patients compared with normal subjects. Only raw MTS was significantly lateralizing to the surgical side. Morphologic differences between left and right temporal lobes in normal subjects and epilepsy patients need to be taken into account when evaluating these regions.

KEYWORDS: Hippocampus
Morphologic Differences in Hippocampi of Children with Down Syndrome who Develop Infantile Spasms

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Purpose
The prevalence of epilepsy in children with Down syndrome (DS) is higher than the general population, but lower than in other causes of mental retardation. In patients with epileptic DS, a majority of whom will suffer from infantile spasms (IS), 40\% will have seizure onset within a year of birth. Among mental retardation syndromes, only DS exhibits hippocampal dysfunction. Additionally, studies of DS children, demonstrate that these low hippocampal volumes are not attributed to neurodegenerative changes, but likely are due to developmental differences. We hypothesized that DS with IS patients would have abnormal hippocampal volumes and morphology compared to IS patients without DS.

Materials and Methods
This HIPAA compliant retrospective study was performed after IRB approval. Patients with DS and IS who had MRI of the brain were identified from a chart review, and compared to a
demographic-matched control groups of patients with IS without DS. Hippocampal axis of rotation and volume was evaluated on review of MRI by a neuroradiologist blinded to the diagnosis. Volume loss and axis of rotation were scored in using a 4 point Likert scale (0 normal, 1 mild, 2 moderate, 3 severe). Intrasubject asymmetry in shape, volume and signal intensity was also evaluated.

Results
Six patients had diagnosis of DS with IS (age 1.07 years +/- 0.65, 3M/3F) and six patients had a diagnosis of IS without DS (age 1.05 years +/- 1.00, 3M/3F). Hippocampal volumes were lower in the DS with IS group (p = 0.0046). And hippocampal malrotation was more likely to be present in DS with IS group (p=0.0361) compared to DS without IS.

Conclusions
Children with Down Syndrome and Infantile Spasms have morphologically different hippocampi compared to children with Infantile Spasms without Down Syndrome. These findings may be a demonstration of reported immunohistological evidence of pathologic changes in the GABAergic interneurons in all hippocampal subregions in Down Syndrome patients who suffer from Infantile Spasms.

KEYWORDS: Down Syndrome, Hippocampus, Infantile Spasm

EP-210
6:30AM - 3:00PM

MRI characterization of Brain tumors in children younger than 2 years old: Correlation with pathology results

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Purpose
To evaluate the signal intensity (SI) characteristics of brain tumors in children younger than 2 years old, in whom myelination is still in process of development.

Materials and Methods
Brain tumors diagnosed in patients younger than 2 years were retrospectively assessed from January 1998 to November 2013. Two major pediatric institutions were involved in the research. Tumors were classified according the most recent WHO intracranial tumors classification (2007). Two pediatric neuroradiologists and one pediatric radiology fellow retrospectively and independently assessed tumor's T1 and T2 signal intensity qualitatively (hyperintense, hypointense relative to cortex) and quantitatively (measuring the signal intensity ratio [tumor SI / cerebral cortex SI]). The tumor architecture, presence of hemosiderin, ferritin, necrosis, and fibrosis in pathology was correlated with the imaging findings. The study was approved by the local Ethics Boards.

Results
Twenty eight children were enrolled (15 boys: age range 1-24 months; mean 15 months). The brain tumor pathologies included: Thirteen astrocytic tumors; 11 Grade 1 (4 midbrain, 3 suprasellar, 2 infratentorial and 2 supratentorial), 1 malignant suprasellar pilocytic astrocytoma and one glioblastoma multiforme. Five embryonal tumors; medulloblastomas (4; three classic
and one desmoplastic in a child with Gorlin syndrome) and one malignant rhabdoid tumor. Four neuronal and mixed neuronal-glial tumors; 2 gangliogliomas, 1 DNET, and 1 dysplastic cerebellar tissue. Three ependymal tumors, grade 1, grade 2 and anaplastic types respectively. One oligodendroglioma, one choroidal plexus papilloma and one posterior fossa dermoid cyst. Astrocytic, ependymal, embryonal and dermoid cyst had similar signal intensity ratio on T1-weighted and T2-weighted images. Neuronal-glial tumors demonstrated opposite SI. On T1-weighted images, astrocytic, ependymal tumors and dermoid cysts were hypointense (mean SI ratio of 0.81, 0.95 and 0.69 respectively). From all these tumors, only one brainstem glioma was hyperintense. All the glial tumors were hyperintense on T1-weighted sequences (mean SI ratio of 1.18). On T2-weighted images, astrocytic, ependymal tumors and dermoid cysts were hyperintense (mean SI ratio of 1.59, 1.44 and 1.53). Only one suprasellar pylocitic astrocytoma was hypointense on T2-weighted sequences. All glial tumors were hypointense on T2 (mean SI ratio of 0.72).

Conclusions
Brain tumors in the young child are rare but when present often the diagnosis is challenging. Applying the SI of the tumor relative to cortex can add information for characterization of the tumor. In our sample, neuronal-glial tumors had a decrease T1 and an increase T2 ratio; different from the rest of the tumors.

KEYWORDS: Neoplasm

EP-185

MRI Findings in Patients Presenting with (Post)Infectious Acute Cerebellar Ataxia.

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Purpose
The development of acute cerebellar ataxia (ACA) following an infection is extremely rare. Previously published articles regarding imaging features solely refer to single case reports or very small patient populations (n < 4). This study was conducted to determine MRI findings of the largest known population of adult and pediatric patients with the clinical presentation of acute ataxia due to infectious or postinfectious cerebellitis.

Materials and Methods
Patients were identified by searching MRI radiology reports from 2003 – 2013 for the terms „cerebellitis” and „cerebellar ataxia”, and were then matched with the clinical history. Clinical cases submitted from subspecialty collaborating neurologists were also included. Patients with infratentorial as well as supratentorial involvement and cerebellar spread were included. Initial MRI studies of eligible patients were retrospectively reviewed by two neuroradiologists.

Results
During the period studied, 14 patients (7 pediatric and 7 adult patients) presented with infectious or postinfectious acute cerebellar ataxia. Two patients had completely unremarkable imaging. The remaining patients primarily showed cerebellar as well as vermian volume loss, bright signal abnormalities in the cerebellar peduncles, cerebellar hemispheres and / or dentate nucleus and
signs of increased intracranial pressure. Contrast enhancement was observed in cerebellar parenchyma (n = 3) as well as subarachnoid space (n = 3).

Conclusions
The imaging features of acute cerebellar ataxia syndrome vary from non-descript unremarkable findings to fulminant parenchymal inflammation with secondary hydrocephalus. This entity is likely multifactorial and the imaging features have yet to be well-characterized.

KEYWORDS: Cerebellum, Infections
Purpose
To describe changes in DTI, MR perfusion and tumor volumetrics in children and young adults with DIPG undergoing novel primary therapy with Bevacizumab (Bev) and radiotherapy (RT) and identify whether these metrics predict survival.

Materials and Methods
An institutional pilot study of bevacizumab based therapy in newly diagnosed DIPG was performed. MRI analysis (including DTI and DSC perfusion) was performed at 3 time points: baseline, prior to maintenance therapy (PTM, after RT and initial Bev), and at progression. DSC perfusion was processed and maximum normalized cerebral blood volume (mCBV) values within the tumor obtained. Tumor volumetrics were performed at each time point [total tumor volume (TV), enhancement volume (EV)] using a semi-automated technique implemented in BrainLab iPlan 3.0. %TV exhibiting enhancement (%EV) was calculated. DTI data was processed in the same system calculating diffusivity (D), and fractional anisotropy (FA) within the TV. Correlation of imaging metrics with progression free survival (PFS) and total survival (TS) was performed.

Results
8 patients were selected from this pilot clinical study (ages: 3-29 y). Mean PFS was 231 days, mean TS was 313 days. TV decreased markedly in most subjects at PTM (mean 50.7%). A reduction in D at PTM was noted in 7/8 subjects (overall mean change: -21%). Lower baseline D showed a trend towards correlating with TS, but was not significant (p=0.08). At progression D increased in 6 patients. A mixed change in FA was noted at PTM with 5 subjects showing an increase (mean: + 43%) and 3 showing a decrease (mean: -27%). maxCBV decreased (mean change: -30%) at PTM and increased (>20%) in only 3/7 at progression. Tumor enhancement was noted in 5 subjects. (Mean EV and %EV: 5.02 cc and 12.9% respectively). EV decreased in 4/5 at PTM (mean: – 76%) and continued to decrease at progression. Baseline TV, D, FA, EV, %EV and mCBV as well as percent changes of each metric at PTM did not significantly correlate with PFS or TS. No significant tumoral hemorrhage was noted during the treatment course.

Conclusions
During primary treatment of DIPG with Bevacizumab and RT in children there was a decrease in TV in all subjects, and decrease in D, mCBV, and EV in most subjects at the PTM time point. At progression, D increased in most. mCBV, EV, and EV% increased in a minority of cases, potentially related to the anti-angiogenic effects of Bevacizumab. Baseline TV, D, FA, EV, %EV and mCBV as well as percent changes of each metric at PTM did not significantly correlate with PFS or TS.

KEYWORDS: Brain Neoplasms
Multimodal Magnetic Resonance Imaging of Neonatal Encephalopathies.

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Purpose
Neonatal brain disorders consist of a wide chapter including brain malformations, hypoxic–ischemic encephalopathy, intracranial infections, perinatal trauma and metabolic encephalopathy. We will focus here on hypoxic–ischemic encephalopathy, intracranial infections (especially materno-fetal infection with or without prolonged and/or premature rupture of membranes) and metabolic encephalopathy, those three conditions being the most frequent so far in our experience. Neonatal stroke is also analyzed. The applications of advanced MRI techniques, such as diffusion-weighted imaging (DWI) and magnetic resonance spectroscopy (MRS) are emphasized.

Materials and Methods
From January 2009 to March 2012, 40 newborns were investigated for neurological impairment without hypoxic-ischemic evident condition, by the neuroradiological staff of medical imaging department in Sahloul University Hospital, Sousse/Tunisia. All the patients underwent a conventional MRI with diffusion and monovoxel Spectroscopy.

Results
MR Imaging including DWI and MRS demonstrated hypoxic-ischemic encephalopathy in 3 cases, infectious disease in 2 cases, inborn errors of metabolism in 13 cases, neonatal focal stroke in 4 cases and isolated cerebral malformation in 2 cases. In 9 cases, various abnormalities were found. MRI was considered as normal in 7 cases.

Conclusions
Neuroimaging in the neonatal period is of great importance to depict parenchyma brain damage. Multimodal MRI is actually considered as a very effective tool in dealing with neonatal encephalopathy especially when a hypoxic-ischemic evident condition is not found. MRI can be performed in the early days of life when the neonate is stable enough and is highly efficient though diffusion images and spectroscopy in brain evaluation.

KEYWORDS: MR Diffusion, MR Spectroscopy, Neonatal Encephalopathy

Neonatal Brain MRI findings; What brings the neonate to MRI suite.

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Purpose
Review of brain MR imaging (MRI) findings in neonates; spectrum of normal, normal variants and pathology.

Materials and Methods
Retrospective study of brain MRIs done in our institute during years 2012 and 2013.

Results
Range of etiology of brain and systematic pathology superimposed on incompletely mature neonatal brain.

Conclusions
Neonatal period is high in morbidity and mortality due to many combined factors, such not fully mature brain, antenatal and perinatal illnesses. Neonatal brain shows variable range of normal and normal variants; myelination and morphology, with superimposed pathology; ischemia, bleeding, sepsis and inborn metabolic disorders.

KEYWORDS: Meningitis, Myelination, Neonatal MR Imaging

EP-188
6:30AM - 9:00PM

Patterns of Adrenoleukodystrophy: Influence of Age on Site of Involvement and Incidence of Asymmetry

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Purpose
Adrenoleukodystrophy (ALD) is a rare, X-linked disease, most frequently affecting adrenal cortex, testes and central nervous white matter. When cerebral white matter is involved, disease typically begins in the posterior corpus callosum (CC) and progresses contiguously. Furthermore, the demyelination pattern at presentation is thought to be highly symmetric about the midline sagittal plane, with the progression of disease equally symmetric. In this study, we (1) evaluated for difference in age of presentation of typical versus atypical pattern cerebral ALD, and (2) determined the incidence of asymmetric white matter involvement at any time during the course of disease.

Materials and Methods
All ALD patients (129 patients) referred to the University of Minnesota were evaluated to determine average age of presentation and pattern of cerebral involvement at diagnosis. Patients were excluded if (1) they demonstrated no radiographic evidence of cerebral disease, or (2) known previous diagnosis of ALD without sufficient prior images at onset of cerebral disease.

Age at presentation was defined by first abnormal brain MRI within the University of Minnesota electronic records. Typical presentation was defined as posterior pattern of demyelination, beginning in the splenium of the CC with or without contiguous progression into surrounding white matter and/or into the brainstem. Atypical presentation was defined as disease originating from the genu corpus callosum, internal capsule, or any other atypical location. Presence of
asymmetry was noted either at the time of presentation or, for patients with more than 1 evaluable scan, at any time point during the course of disease.

Results
A total of 129 male subjects with 832 MR scans were evaluated. Based on the exclusion criteria described, 118 patients were included in the study. 64 patients (54.2%) presented typically, while 54 (45.8%) presented atypically. The median age of typical presentation pattern was 7 years, 7 months (range, 3y, 11m – 22y, 2m), while that of atypical presentation pattern was 9 years, 5 months (range, 4y, 0m – 37y, 6m) (p = 0.0004). Among patients with atypical presentation pattern, 20 demonstrated disease emanating from the genu of the CC (median age of presentation 10y, 1m) while 36 showed independent corticospinal tract involvement (median age of presentation 9y, 8m). At presentation, 17 patients (16%) demonstrated asymmetric disease as their only abnormality. A total of 53 patients (44.9%) demonstrated asymmetry at any time point.

Conclusions
Cerebral adrenoleukodystrophy has several different presentations, with the typical one originating posteriorly from the splenium of the corpus callosum and extending into the surrounding white matter and into the brainstem. The typical presentation is more common in a younger subset of patients, with atypical presentation occurring in an older population. This suggests different locations of selective vulnerability through childhood development. Asymmetric disease involvement was surprisingly common, seen in 44.9% of patients. To our knowledge, aside from one case report, this has never been reported. However, despite asymmetry at presentation or during follow-up, many of the patients with asymmetric disease demonstrated more symmetric disease with further follow up.

KEYWORDS: Adrenoleukodystrophy

EP-207
6:30AM - 9:00PM

Pediatric spinal cord diffusion tensor imaging: a feasible study?

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Purpose
Diffusion tensor imaging (DTI) of the spinal cord (SC) is technically limited by several reasons including small volume of the SC and low signal to noise ratio. In pediatric SC DTI application, the possibility of increased motion artifact makes obtaining accurate and reproducible DTI parametrics even more difficult. But, it could be still feasible and might give additional valuable information. Our purpose is to show our preliminary SC DTI results in different patient groups.

Materials and Methods
Pediatric SC DTI studies of patients with clinically confirmed pathology of the SC or central nervous system were prospectively evaluated for the study. Patients were divided into 5 groups according to their clinical history and conventional magnetic resonance imaging (MRI) findings. Region of interest (ROI) were placed manually by a radiologist in the sagittal plane at 7 intervertebral disc levels at the cervical SC (CSC) and 3 intervertebral disc levels at the thoracolumbar SC (TLSC). Fractional anisotropy (FA) and mean diffusivity (MD) values were
obtained for each level. The CSC group FA and MD values were compared with our previous normal CSC DTI database. TLSC values were evaluated independently.

Results
A total of 26 DTI studies of the 20 CSC MRI and 6 TLSC DTI were included in the study (One patient had both CSC and TLSC DTI). The mean age of the children was 6.64 (between 0.17 and 16) years. There were 11 girls and 14 boys in the study. The patients were divided as 1) Group 1: Hypoxia to the brain (3 patients), 2) Group 2: Craniocervical junction malformations (9 patients), 3) Group 3: Vertebral pathologies (4 patients) 4) Group 4: Head trauma (4 patients) 5) Group 5: Thoracolumbar DTI group (6 patients). Different groups were showing different FA and MD changes. One of the interesting findings was lower FA and higher MD at all CSC levels in a patient in group 1, who had chronic ischemic changes in his brain MRI due to hypoxic brain injury following cardiopulmonary arrest nine months ago. Our results also showed that, cranial malformations which cause compression at the level of craniocervical junction might cause lower FA and higher MD values in the upper CSC level. We had 6 TLSC DTI patients and we found variable FA-MD changes in patients with different pathologies.

Conclusions
Our preliminary data showed pediatric SC DTI is feasible at both CSC and TLSC levels and may give additional microstructural information by utilizing quantitative data which may be useful for clinical evaluation or follow-up of patients. DTI may also bring new insights in diseases such as Chiari 1 malformation or hypoxic brain injury in which conventional MRI may show normal cord. Further studies are needed in different disease groups with larger patient populations.

KEYWORDS: Diffusion Tensor Image, Pediatric Spine, Spinal Cord

<table>
<thead>
<tr>
<th>Patient Group</th>
<th>Number of Patients</th>
<th>History</th>
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<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>Previous hypoxia to the brain (3 patients)</td>
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<tr>
<td>2</td>
<td>9</td>
<td>Chiari 1 (3 patients), post-op Chiari 1 (3 patients), Chiari 2 (2 patients), Achondroplasia (1 patient)</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>Tethered cord (1 patient), Spina bifida (1 patient), Scoliosis and spine deformity (2 patients), Floating-Harbor Syndrome with hydromyelia and sacral dimpling (1 patient)</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Head trauma (4 patients)</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>Guillain-Barret Syndrome (3 patients), Transverse myelitis (1 patient), Intramedullary tumor (1 patient), Floating-Harbor Syndrome and sacral dimpling (1 patient-same)</td>
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Pituitary Gland Enlargement in Sanfilippo Syndrome

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Purpose
CNS imaging findings in Sanfilippo syndrome (MPS III) are not well characterized. The purpose of this study is to confirm our initial hypothesis of pituitary gland enlargement in patients with Sanfilippo syndrome during routine MRI observed at our institution.

Materials and Methods
Patients with a clinical diagnosis of Sanfilippo syndrome and at least one brain MRI from 2007 onward were initially considered for inclusion from our PACS system. This yielded 15 patients that ranged in age from 2-19. For comparison to controls, a maximum age of 7 was chosen to avoid the potential for confounding pubertal changes. 3 patients were above age requirements and were excluded from statistical comparison. Controls with normal brain MRI were extracted from our PACS system and matched for age and sex, as both have been shown to correlate with differences in pituitary size. 11 children with a clinical diagnosis of Hurler syndrome (MPS I) met initial inclusion criteria of prior brain MRI from 2007 onward. 2 were excluded from statistical comparison for exceeding 7 years of age. Pituitary volumes were estimated using the prolate ellipsoid volume calculation method \( \pi/6 \times L \times W \times H \). The hyperintense foci on T1 imaging representing the posterior pituitary was measured separately and together with the rest of the gland to achieve whole, anterior, and posterior pituitary volume estimates. Pituitary shape was assessed by assignment of an Elster's grade. (Grade 1 = markedly concave, grade 2 = mildly concave, grade 3 = flat, grade 4 = mildly convex, and grade 5 = markedly convex.) Many patients in the Sanfilippo group had multiple studies with a maximum range of 26 months. Pituitary growth over these intervals was analyzed for longitudinal trends.

Results
12 patients with Sanfilippo syndrome, 11 patients with Hurler syndrome and 11 normal controls were included. Anterior, posterior, and whole pituitary volume, as well as Elster grade were all significantly greater in patients with Sanfilippo syndrome than in healthy controls and in patients with Hurler syndrome (all p values less than 0.05). Mean pituitary volumes were 530 mm\(^3\) in Sanfillipo patients, 310 mm\(^3\) in Hurler syndrome, and 217 mm\(^3\) in controls.

Conclusions
The results show a significant increase in anterior, posterior, and whole pituitary volume, as well as Elster grade in the patients with Sanfilippo syndrome when compared to both normal controls and patients with Hurler syndrome.

KEYWORDS: Metabolic, Pituitary Gland
Purpose
Imaging diagnosis of retinal hemorrhage in pediatric abusive head trauma (AHT) can be of important clinical value in very ill children in whom immediate ophthalmologic evaluation with dilated fundus exam is not feasible. Based on the preliminary evidence that trauma-induced breakdown of the blood-brain barrier with subsequent diffusion of inflammatory cells and cytokines can alter the biochemical profile of the vitreous humor (Morescalchi, Duse et al. 2013), we speculated that the vitreous humor will demonstrate altered diffusivity in the presence of trauma-induced retinal hemorrhage with associated inflammatory response. The study therefore evaluated the potential utility of measuring apparent diffusion coefficient (ADC) of the vitreous humor to detect diffusivity changes in the vitreous compartment.

Materials and Methods
The study was approved by our Institutional Review Board as part of a larger study related to the identification and evaluation of children at risk for AHT. A total of 16 brain MR imaging (MRIs) from March 1, 2011 to June 1, 2012 obtained at Children's Hospital of Pittsburgh of UPMC from
children with retinal hemorrhage and a clinical diagnosis of AHT were retrospectively evaluated. As controls, 22 negative brain MRIs obtained from patients of similar age with varying clinical indications for the exam including seizure, nonspecific neurologic complaints, developmental delay, ingestion, and nontrauma neurologic insults were studied. None of the controls obtained dilated fundus exam as there was no clinical indication. Apparent diffusion coefficient values of the right and left eye were obtained of both cases and controls to evaluate for potential correlation to the presence or absence of retinal hemorrhage on dilated fundus exam. Region of interest (ROI) with an area of 2-3 cm² was drawn in the right and left eye directly on the Stentor workstation. For internal control, ROI with an area of approximately 1 cm² was drawn of the frontal horn of right lateral ventricle.

Results
The median age was 4.6 months (quartiles: 2.6, 7.4) in the control group and 5.5 months (quartiles: 4.3, 18) in the trauma group with no statistically significant different between them (p = 0.10). The percent of subjects that were female was 46% in the control group and 38% in the retinal hemorrhage group with no statistically significant difference between groups (p = 0.60). Additionally, there was no statistically significant correlation between ADC values and age (R² = 0.2, p = 0.44) or sex (p = 0.29). The median ADC value was 3.0 (quartiles: 2.9, 3.2) in the control group and 3.0 (quartiles: 2.9, 3.1) in the retinal hemorrhage group (p = 0.55). Similarly, there was no statistically significant difference in normalized ADC values between the control and retinal hemorrhage groups (-0.13 and -0.08 respectively, p = 0.55). The areas under the receiver operating curve for the determination of the presence of retinal hemorrhage based on ADC values and normalized ADC values were 0.56 and 0.44, respectively.

Conclusions
Apparent diffusion coefficient has not shown to be a sensitive imaging biomarker for detecting changes in molecular diffusivity within the vitreous compartment in children with retinal hemorrhage associated with AHT. More recently, Bodanapally et al. (Bodanapally, Kathirkamanathan et al. 2013) found that trauma-related diffusivity changes in the posterior segment of the optic nerve differentiated patients with traumatic optic neuropathy from those without (p<0.05). It may be that the degree of ocular trauma is better evaluated with optic nerve diffusivity than vitreal compartment diffusivity. Alternatively, high resolution susceptibility MRI can be instituted to better delineate the presence of retinal hemorrhage as confirmed previously by our group (Zuccoli, Panigrahy et al. 2013). Continued efforts will be needed to develop a sensitive imaging biomarker for ocular manifestations of AHT in children.

KEYWORDS: Abusive Head Trauma, Diffusion-Weighted Imaging, Orbits
Pre-Operative Quantitative Diffusion Tensor Tractography to Determine Language Laterality in Pediatric Epilepsy.

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Purpose
Language functions often are affected in epilepsy patients. Surgical candidates require detailed neuropsychological assessment to determine language functional status and hemispheric laterality. Functional MR imaging (fMRI) is the currently accepted gold standard in adults to determine hemispheric dominance; however, in children the application and interpretation is not straightforward, often leading to failed or indeterminate exams. Diffusion tensor tractography (DTT), on the contrary, is easier to perform and does not require active patient participation. The purpose of this study was to assess if DTT-derived metrics can reliably determine hemispheric language laterality preoperatively in pediatric epilepsy patients.
Materials and Methods
Seven consecutive pediatric epilepsy patients, who were determined to be surgical candidates, underwent blood oxygen level dependent (BOLD) fMRI in a 3 T magnet as part of their routine presurgical work up. Diffusion tensor imaging was performed in the same sitting. Diffusion tensor imaging data and fMRI data were postprocessed separately by two readers blinded to the findings of the other. Tractography was performed using standard software (DTI Studio) and DTI metrics including number of tracts, number of voxels, tract length and tract density were calculated. This was followed by calculation of laterality indices (LI) from each of these metrics. A composite DTI-LI was generated to represent hemispheric language laterality from DTI. These LIs subsequently were compared to BOLD fMRI-determined language laterality.

Results
There was correlation in six of the seven cases (85.71%) between DTI-LI and fMRI lateralization. The sensitivity and specificity were 83.3% and 100% respectively, while the positive and negative predictive values were 100% and 50% respectively. However, no correlations were found between classically used clinical features (duration and frequency of seizures) with strength of lateralization or the total number of fiber tracts.

Conclusions
These preliminary data show that DTT-derived metrics hold promise in determining hemispheric language laterality in pediatric epilepsy patients. This could potentially play a role in pediatric epilepsy cases where fMRI is not feasible, not interpretable or indeterminate.

KEYWORDS: Diffusion Tensor Image, Fractional Anisotropy, Pediatric Epilepsy

EP-194
6:30AM - 9:00PM

Relationship of Syrinx Size and Tonsillar Descent to Spinal Deformity in Chiari I Malformation with Associated Syringomyelia

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Purpose
Chiari Type I Malformation (CIM) is a developmental abnormality often associated with a spinal syrinx. Syringomyelia in CIM patients is known to be associated with scoliosis. However, the influence of specific radiographic features on the prevalence of scoliosis remains unclear. The primary purpose of this study is to assess the relationship between maximum syrinx diameter and the presence of scoliosis in patients with CIM-associated syringomyelia. A secondary purpose was to explore the role of CVJ characteristics as additional risk factors for scoliosis.

Materials and Methods
A retrospective review was performed of children with CIM and syringomyelia who were evaluated at a tertiary local academic institution from 2000 to 2012. Syrinx morphology and craniovertebral junction (CVJ) parameters were evaluated by magnetic resonance imaging (MRI), while the presence of scoliosis was determined using standard radiographic criteria. Multiple logistic regression was used to analyze radiological features that were associated with scoliosis.
Results
Ninety-two subjects with CIM and syringomyelia were identified. Mean age was 10.5±5 years. A total of 35/92 (38%) patients were found to have spine deformity, of whom 23/35 (66%) were referred primarily for deformity and 12/35 (34%) were diagnosed with deformity during workup for other symptoms. Multiple regression analysis identified larger maximum syrinx diameter (>6mm) (OR 12.1, CI95% 3.63 - 40.57, p < 0.001), and moderate (5-12 mm) rather than severe (>12mm) tonsillar herniation (OR 7.64, CI95%2.3 - 25.31, p = 0.001) as significant predictors of spine deformity when controlling for age, gender, and syrinx location.

Conclusions
The current study further elucidates the association between CIM and deformity by defining specific radiographic characteristics associated with the presence of scoliosis. Specifically, patients with larger maximum syrinx diameter (>6mm) are at increased risk of scoliosis at presentation.

KEYWORDS: Chiari Malformation type 1, Syringohydromyelia

EP-206 6:30AM - 9:00PM
Screening Cranial MRI and MR Angiography in Sickle Cell Anemia: A Frequency and Cost Evaluation Study

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Purpose
A devastating complication of sickle cell anemia (SCA) is overt clinical stroke. Overt clinical stroke incidence may be reduced with institution of chronic transfusion therapy after consecutive abnormal transcranial doppler (TCD) examinations. Patients with abnormal TCDs and/or prior overt stroke, many of whom are placed on chronic transfusion therapy, regularly undergo MRI/MRA to screen for vasculopathy and silent cerebral infarctions. Currently, however, there exists no evidence based recommendations for the appropriateness of screening MRI/MRA. Such screening, regardless, is commonly performed on an empiric basis at annual or biennial frequencies, contributing to significant medical risk (due to the need for sedation in young children) and cost. The purpose of this study is to assess the cost and efficacy of screening frequency for MRI/MRA detected abnormalities with regard to temporal progression of infarct and arterial stenosis in a large group of SCA patients.

Materials and Methods
IRB approval was obtained. At a large tertiary referral children's hospital, a retrospective review of MRI/ MRA reports of SCA linked to a database containing patients currently undergoing chronic transfusion therapy for either abnormal TCD (primary prophylaxis) or previous overt clinical stroke (secondary prophylaxis) was evaluated noting the presence of chronic white matter disease, basal ganglia and large territory infarcts, vessel stenosis and progression of such findings between exams. Exclusion criteria included blood dyscrasia other than SCA and patients older than 21 years. Data were analyzed for both descriptive and inference-based statistics along with a hypothetical cost basis analysis.
Results
595 MRI/MRA reports in 140 patients were reviewed with the population having undergone a mean of 4.25 (SD=2.639) MRI/MRA exams occurring on average 18.054 months apart (SD=11.429). Assuming a unit cost of $2000/exam, the total cost in this group was $1,191,000. The higher the patient's age and higher number of transfusions the patient had received, the more likely they had received a higher number of MRI exams (p< 0.001). While 40 out of 140 (29%) patients had progression of stenosis and 19 out of 140 (14%) had progression of infarcts, neither the presence of progression of stenosis or progression of infarcts had a significant relationship with the number of months between examinations (p=0.271 and p=0.654, respectively) based on a two-sample t-test.

Conclusions
In a group of SCA patients undergoing chronic transfusion therapy, MRI/MRA documented progression of stenosis and infarcts correlated poorly with examination frequency with current empiric practices while resulting in significant cost impact, raising the critical issues of possible overutilization or misutilization. Prospective trials assessing individualized clinical and radiological criteria, to include distinction between patients undergoing chronic transfusion for primary versus secondary prophylaxis, are needed to procure evidenced based MRI/MRA screening guidelines in patients with SCA.

KEYWORDS: Cost-Effective, Screening, Sickle Cell Disease

EP-176
6:30AM - 9:00PM

Tecto-cerebellar dysraphism with occipital encephalocele is part of the Joubert syndrome spectrum

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1Johns Hopkins University School of Medicine, Baltimore, MD, 2Medical University, Innsbruck, Austria, 3University of Calgary and Alberta Children’s Hospital, Calgary, AB, Canada, 4Kennedy Krieger Institute, Baltimore, MD, 5University Hospital, Salzburg, Austria, 6University of Calgary, Calgary, AB, Canada, 7Mendel Laboratory, IRCCS Casa Sollievo della Sofferenza Institute, Roma, Lazio, Italy, 8The Johns Hopkins University School of Medicine, Baltimore, MD, 9University Children’s Hospital, Zürich, Switzerland

Purpose
Tectocerebellar dysraphia with occipital encephalocele (TCDOE) describes vermian hypogenesis with tectal malformation and occipital encephalocele. Based on conventional MR imaging (MRI) and diffusion tensor Imaging (DTI) findings, we recently suggested that TCDOE may be part of the Joubert syndrome (JS) spectrum. We report on clinical, neuroimaging (conventional and DTI) and genetic findings in four children with TCDOE.

Materials and Methods
Conventional MR images were evaluated for infra- and supratentorial abnormalities. Color-coded fractional anisotropy (FA) maps were evaluated for presence of the midbrain decussation of the superior cerebellar peduncles (SCP). Data about neurological findings and outcome were
collected from clinical history and follow-up examinations. Genetic analysis was performed in three patients.

Results
Four children were included (2 females). All patients presented at birth because of an occipital encephalocele. At last follow up, only two patients were alive. Two children died at the age of 18 months and 10 years. Data on neurocognitive development were available for three children at 4 months, 6 years and 17 years, respectively. Truncal hypotonia was present in all patients. Two patients had intellectual disability (severe in one patient and mild in the other one), the youngest patient impaired global development. Ataxia, spasticity of all extremities, anarthria, ptosis, neonatal breathing abnormalities, facial dysmorphic features and choroidal colobomas were present in one patient. In all patients, MRI demonstrated hypoplasia of the cerebellar vermis, tectal beaking, and elongation, thickening, and horizontal orientation of the SCP with a deepened interpeduncular fossa forming a molar tooth sign (MTS). Additionally, in all patients there was congenital ventriculomegaly that required a ventriculo-peritoneal shunt in three children. Finally, in one patient, subependymal heterotopia and focal cortical dysplasia were noted. Diffusion tensor imaging data were available for three children and showed absence of the SCP decussation in all. Genetic analysis revealed a homozygous deletion leading to a frameshift and premature stop codon in exon 6 of the TMEM237 gene (one of the 23 JS genes known so far) in one patient. Whole exome sequencing did not reveal causative mutations in the two other patients.

Conclusions
The presence of MTS in all, absence of the SCP decussation on DTI in three, and a homozygous mutation within the TMEM237 gene in one patient confirm our first hypothesis that TCDOE may not be a nosological entity, but rather represents a structural manifestation within the JS spectrum.

KEYWORDS: Diffusion Tensor Image, Joubert Syndrome

EP-190
6:30AM - 9:00PM


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Purpose
To review the clinical presentation and neuroimaging findings of patients with genetically confirmed Leigh syndrome.

Materials and Methods
We reviewed the clinical and imaging findings of the 15 genetically confirmed Leigh syndrome patients followed at the University of Texas Houston Leigh clinic.

Results
Of our 15 genetically confirmed Leigh syndrome patients, 9 were male and 6 were female. The age of first symptom onset was birth in 6 (40%), less than two years in 4 (26%), and more than three years in 5 (33%). The most frequent presenting symptoms were hypotonia (n=11, 73%),
developmental regression (n=11, 73%), hypertonia (n=4, 26%), and ataxia (n=4, 26%). Genetic studies showed mitochondrial DNA mutations in 11 and nuclear mutations in 4. MR findings included lesions in the brainstem in 7 patients (46%), basal ganglia in 12 (80%), thalami in 3 (20%), cerebellar white matter in 2 (13%), and global atrophy in 2 (13%). The lesions in the brainstem were most frequent in the midbrain and medulla oblongata. Increased number of original lesions was seen in 4 of the 7 patients with follow up studies, evolution of the initial lesion was seen in 4, and regression of the original lesions was seen in a single patient. No cerebral white matter or cortical lesions were found in any of the 15 patients.

Conclusions
Leigh syndrome is a devastating neurodegenerative disorder characterized on neuroimaging by focal, bilateral symmetric lesions in the basal ganglia and brainstem. Historically it is described as presenting in infancy with death by 2 years. The availability of genetic testing has enabled us to recognize clinical and genetic heterogeneity in this devastating disease. Diverging from the classic descriptions, we found a significant proportion of patients presenting after the third year of life (33%). In concordance with the literature, we found that Leigh syndrome does not have predilection for cerebral white matter or cortical involvement¹⁻³. Children follow a similar pattern of bilateral, symmetric basal ganglia or brainstem changes. The presence of white matter or cortical lesions in a child with regressive neurologic disease should prompt investigation for other etiologies, besides Leigh syndrome. Lesions in Leigh syndrome evolve over time. The lack of visible lesions should not necessarily exclude the diagnosis of Leigh syndrome. If the diagnosis is highly suspected, repeat imaging may be indicated. In summary, it is crucial for neuroradiologists to include Leigh syndrome in the differential of any child presenting with bilateral, symmetric basal ganglia or brainstem lesions.

KEYWORDS: Mitochondrial Disease, MR Imaging Brain, Neurodegenerative
Comparing Preliminary and Final Neuroradiology Reports: What are the Factors that Determine the Differences?

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Purpose
Trainees' initial interpretations of neuroradiological studies are typically reviewed and finalized by neuroradiologists on staff. In this study we set out to identify the factors that determine the
degree to which the preliminary neuroradiology reports are modified compared to the finalized reports.

Materials and Methods
Study protocol was approved by our internal review board (IRB). All neuroradiology reports composed by a trainee and finalized by faculty between November 2012 and October 2013 were analyzed. The character length of the preliminary and final reports was determined, and the percent character change (PCC) between the preliminary and final reports, defined as 100 x total number of single character changes / total number of characters in the initial report, was calculated. Additional data including exam time (day vs. night), critical finding (CF) flag, trainee training level (R1, R2, R3, R4, and fellow), faculty experience level (junior, intermediate, senior), imaging modality (CT vs. MRI), and native vs. non-native English speaker status of the interpreter were collected. Univariable and multivariable linear regression models were employed to evaluate the marginal and joint association between PCC and the factors considered. Model parameters were estimated using generalized estimating equations accounting for the possible correlation between data on reports written by the same trainee and/or faculty.

Results
34,661 reports, including 21,204 (61.2%) CT and 13,457 (38.8%) MRI, were reviewed. 20,123 (58.1%) were performed during the daytime and 14,538 (41.9%) were at night. 4,091 (11.8%) were flagged with a CF. 21,998 (63.5%) were read by fellows, 2,322 (6.7%) by R1s, 4,429 (12.8%) by R2s, 3,663 (10.6%) by R3s, and 2,249 (6.5%) by R4s. 3,920 (11.3%) were read by junior, 12,885 (37.2%) by intermediate, and 17,856 (51.5%) by senior faculty. Of the 58 trainees, 12 were non-native English speakers, and of the 18 faculty, 10 were non-native English speakers. The average PCC was 14.8% (min=0%, 1st quartile=0.3% median=6.6%, 3rd quartile=21.1%, max=701.8.2%) for all reports. The distribution of all reports by PCC is depicted in Table 1. Multivariable analysis revealed that PCC was on average increased for CF flagged reports (+4.8%; p<0.0001), MRI exams (+3.7%; p<0.0001) and in reports involving non-native trainees (+4.0%, p=0.0248). Compared to R1 trainees, reports written by R2 (-5.5%; p=0.0017), R3 (-6.0%; p=0.0015), R4 (-8.2%; 0.0003) and fellows (-8.9%; p<0.0001) had decreased PCC on average. While junior and intermediate faculty were associated with similar average PCC (p=0.8589), on average, reports edited by senior faculty had a lower PCC (-6.88%, p<0.0001). The association between average PCC and either of exam time and native vs. non-native speaker status of the involved faculty was not statistically significant (p=0.6098 and 0.3516, respectively).

Conclusions
Our review of 12 months of neuroradiological reports showed that having a CF in the report, trainee training level, faculty experience level, imaging modality, and native vs. non-native English speaker status of the trainee are associated with the degree to which the preliminary reports are modified compared to final reports, and that exam time and speaker status of the faculty are not. We believe that understanding the factors that influence the extent of report revisions could facilitate and improve the quality of report generation.

KEYWORDS: Educational, Quality Assurance, Quality Improvement
<table>
<thead>
<tr>
<th>Percent Character Change (PCC)</th>
<th>Number of Reports</th>
<th>Percent of Total Reports</th>
<th>95% Confidence Interval (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (no change)</td>
<td>95</td>
<td>0.3%</td>
<td>0.2-0.5%</td>
</tr>
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<td>28.5-34.5%</td>
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<td>14.1%</td>
<td>13.0-15.2%</td>
</tr>
<tr>
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<td>4,232</td>
<td>12.2%</td>
<td>11.4-13.0%</td>
</tr>
<tr>
<td>10% &lt; x &lt;= 25%</td>
<td>7,351</td>
<td>21.2%</td>
<td>20.0-22.5%</td>
</tr>
<tr>
<td>25% &lt; x &lt;= 50%</td>
<td>4,918</td>
<td>14.2%</td>
<td>12.8-15.7%</td>
</tr>
<tr>
<td>50% &lt; x &lt;= 100%</td>
<td>2,007</td>
<td>5.8%</td>
<td>5.0-6.8%</td>
</tr>
<tr>
<td>&gt;100%</td>
<td>278</td>
<td>0.8%</td>
<td>0.6-1.0%</td>
</tr>
</tbody>
</table>

Table 1: Distribution of all reports by percent character change (PCC).

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Effectiveness of Direct Physician-to-Physician Marketing When Compared with Physician-to-Patient Consultations on Imaging Volumes in Outpatient Imaging

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Purpose
The purpose of this study is to compare the effectiveness of direct radiologist-to-physician marketing with physician-to-patient consultations in maximizing imaging volumes in outpatient imaging.

Materials and Methods
Monthly cross sectional imaging referral volumes from target referring clinicians and cross-sectional imaging volumes for individual patients were tracked to determine the effect of direct physician-to-physician marketing when compared with the effect of physician-to-patient consultations on imaging volumes. From January to December 2009, baseline monthly physician referral data were obtained from 19 referring clinicians while a non-physician radiology sales representative visited the referring clinicians’ office every two weeks to establish a baseline referral volume. From January to June 2010, the same radiology sales representative visited the referring clinician offices every two weeks but was accompanied by a neuroradiologist once a month to assess the effect of direct radiologist involvement in marketing to referring clinicians. Direct radiologist to patient consultations on cross-sectional imaging studies were also performed for a 6 month period from January 2009 to June 2009. Imaging volumes from these patients were tracked from the point of consultation through June 2010 and compared with a representative control sample of patients who did not elect to have a personal consultation with a radiologist.

Results
Cross-sectional imaging referral volumes after direct physician-to-physician marketing were
approximately 2.5 times greater during the 6-month period when compared with the imaging volumes achieved by utilizing the sales representative alone (p< 0.0001) The increase in cross-sectional imaging volumes with physician to physician marketing was also significantly greater than the increase in cross-sectional imaging volumes derived from patients who participated in one-on-one physician consultations, even though these patients demonstrated a modest increase in utilization of imaging services when compared with baseline controls.

Conclusions
Direct physician-to-physician marketing is a highly effective tool in rapidly increasing cross-sectional imaging volumes and is significantly more effective than direct radiologist to patient consultations in increasing referral volumes in outpatient imaging.

KEYWORDS: Economics

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Expectations of Medical Student Neuroradiology Education: A Survey of Practicing Neuroradiologists and Neurologists

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Purpose
Currently, neuroradiology education for medical students does not have established guidelines. The purpose of this study is to determine which neuroradiological diseases neuroradiologists and neurologists feel are important for a medical student (MS) to competently recognize by the end of medical school. This information may be used to formulate national guidelines.

Materials and Methods
Members of the American Society of Neuroradiology (ASNR) and the American Academy of Neurology (AAN) were surveyed. Respondents were presented 32 diseases with neuroimaging findings, and asked which ones a MS should be expected to diagnose by the end of medical school. Using a 50% response threshold per disease entity, results were tabulated into three groups: diagnoses that 1) greater than 50% of neuroradiologists and neurologists felt MS should know radiographically by rotation completion; 2) less than 50% of respondents in both groups felt were important for MS to identify; and 3) both groups disagree are important for MS to identify.

Results
Most ASNR and AAN respondents thought MS should be able to diagnose intraparenchymal hemorrhage (ASNR 80.4%, AAN 84.3%; p=0.346) and subarachnoid hemorrhage (ASNR 74%, AAN 78%; p=0.394). Both groups (>50%) thought subdural hematoma, acute ischemic stroke, epidural hematoma, and spinal cord compression are important to diagnose. Conditions such as spine fractures, non-acute stroke, AVM, and ENT pathology showed varied results between both groups (Table 1).

Conclusions
Varying degrees of similarity and disparity exist between the expectations of neuroradiologists
and neurologists regarding MS neuroradiology education, presenting a positive opportunity for greater consensus, dialogue, and joint curriculum formation.

KEYWORDS: Medical Education, Neuroradiology Training

Table 1: Diagnoses Where the Respondent Groups Remarkably Differed

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>AAN neurologist respondents</th>
<th>ASNR neuroradiologist respondents</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstructive hydrocephalus</td>
<td>88 69.3%</td>
<td>131 46.0%</td>
<td>23.3%</td>
</tr>
<tr>
<td>Prior ischemic stroke</td>
<td>88 69.3%</td>
<td>141 49.5%</td>
<td>19.8%</td>
</tr>
<tr>
<td>Cerebral edema</td>
<td>84 66.1%</td>
<td>87 30.5%</td>
<td>35.6%</td>
</tr>
<tr>
<td>Uncal herniation</td>
<td>65 51.2%</td>
<td>106 37.2%</td>
<td>14.0%</td>
</tr>
<tr>
<td>Meningioma</td>
<td>66 52.0%</td>
<td>109 38.2%</td>
<td>13.7%</td>
</tr>
<tr>
<td>Central herniation</td>
<td>67 52.8%</td>
<td>135 47.4%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Cervical spine fracture</td>
<td>48 37.8%</td>
<td>162 56.8%</td>
<td>19.0%</td>
</tr>
<tr>
<td>Unstable spinal fracture</td>
<td>48 37.8%</td>
<td>154 54.0%</td>
<td>16.2%</td>
</tr>
</tbody>
</table>

Improving Quality of Patient Care by Minimizing Potential Risk: Decreasing Non-Contrast Head Computed Tomography Radiation Dose

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Purpose
At our facility, we perform approximately 800 non-contrast head computed tomography (CT) exams each month. Prior to this intervention, computed tomography (CT) technologists used a wide variety of personally installed non-contrast head CT (NCHCT) protocols to complete these examinations. As a result, many patients received radiation doses higher than the dose required to generate quality diagnostic images, and significant dose variability existed. The goals of this investigation were: (1) to evaluate the effect of standardizing NCHCT protocols on average radiation dose and on dose variability; and (2) to ensure no NCHCT was performed with a CT dose index volume (CTDIcon) greater than 70mGy.

Materials and Methods
All previously installed protocols for adult axial NCHCT's were erased from each of the six CT scanners and were replaced with standardized protocols. These updated protocols were based upon the recommendations of the American Association of Physicists in Medicine and vendor technical support. This investigation examined individual scan doses (CTDIcon) of a 100 patient sample from three time points: a baseline pre-intervention month, the month immediately following the intervention month, and three months post-intervention. A random order generator within Microsoft Excel was used to organize the patients scanned during each of the index

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months and the first 100 patients from each month who met inclusion criteria were included in analysis. The difference in mean CTDIvol between the pre-intervention month and the post-intervention months were analyzed by a two sample t-test. The difference in CTDIvol variance within the pre-intervention month and within the post-intervention months was analyzed using an F-test.

Results

All axial NCHCTs performed on adults as a discrete encounter were eligible for inclusion. If any portion of the exam had to be repeated due to technical error or patient motion, or the study was non-diagnostic, the patient was excluded. The average CTDIvol for a NCHCT performed during the pre-intervention month was 63.1mGy (SD: 10.5). The averages for the two post-intervention months were 48.6mGY (SD: 6.1) and 51.3mGy (SD: 7.6), a reduction of 23% and 19% in average radiation dose. The difference in CTDIvol between the pre-intervention month and each of the post-intervention months was statistically significant (both P<0.0001). The difference in variance within the pre-intervention month and each of the post-intervention months was also significantly different (P<0.0001 and P<0.0016). Finally, not a single exam performed in the post-intervention months had a CTDIvol greater than 70mGy, whereas before the intervention 33 of 100 of exams delivered a CTDIvol above 70mGy.

Conclusions

Study results demonstrate that standardization of head CT protocols significantly reduces the average patient radiation dose, reduces dose variability, and eliminates outlier techniques with excessive CTDIvol. These reductions were achieved while maintaining quality diagnostic imaging. The standardization of protocols was a meaningful step on a population level in achieving lower radiation exposure and on an individual level by preventing any one exam from delivering excessive radiation. This method of protocol update can be applied to other types of CT examinations performed at our institution.

KEYWORDS: Protocols, Radiation Dose Reduction, Radiation Exposure

EP-216 6:30AM - 9:00PM

Model for Calculating Effective Doses for CT-guided Spine Biopsies

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¹Mount Sinai Hospital, New York, NY

Purpose

Effective dose is a radiation exposure measurement that takes into account biologic sensitivity of different organs to radiation. It is a single parameter that reflects relative risk of detrimental biologic effects from nonuniform partial-body exposure to ionizing radiation in terms of a whole-body exposure. Characterizing radiation exposure as effective dose and comparing the value to other radiation risks is the best way to convey to the patient and referring clinician the relative potential for harm from a diagnostic imaging exam or image-guided procedure. We designed a model for determining effective dose conversion coefficients and, thereby, calculating effective doses for CT-guided spine biopsies. Then, we used our model to compare effective doses in patients who underwent CT-guided spine biopsies utilizing low-dose and regular-dose protocols.
Materials and Methods
We determined effective dose conversion coefficients for cervical, thoracic, lumbar and sacral spine by adjusting the scan range to different spine levels on the phantom provided in the ImpACT software package. The range for the cervical spine extended from z of 68.5 to z of 81, for the thoracic spine from z of 36.5 to z of 68.5, for the lumbar spine from z of 15.5 to z of 36.5 and for the sacrum from z of 1 to z of 15.5 (see images). ICRP 103 organ weighting scheme (2007) was used. Coefficients for cervical, thoracic, lumbar and sacral spine were calculated by dividing the effective dose (mSv) by the dose length product (DLP, mGy-cm). The four coefficients then were plotted in Excel with a polynomial trendline and an equation was generated, from which effective dose conversion coefficients (mSv/mGy-cm) centered on each vertebral level were calculated. Coefficients appropriate to the vertebral level biopsied were then multiplied by total DLP for each patient in order to calculate effective doses for 64 patients who underwent CT-guided spine biopsies as part of an IRB-approved retrospective study. Effective doses of patients who underwent CT-guided spine biopsies using low-dose and regular-dose protocols were compared using unpaired t-test.

Results
Effective dose conversion coefficients were determined to be 0.01095 mSv/mGy-cm for the cervical spine (centered on C4), 0.02037 mSv/mGy-cm for the thoracic spine (centered on T6), 0.0177 mSv/mGy-cm for the lumbar spine (centered on L3) and 0.0129 mSv/mGy-cm for the sacrum (centered on T2). An equation was generated after plotting the data on Excel and applying a polynomial trendline (y = 0.0017x^3 - 0.016x^2 + 0.0458x - 0.0205; see images). A distinct x-value was assigned to each vertebral level and plugged into the equation in order to calculate an effective dose conversion coefficient for each level (y-value; see Table). There was a statistically significant difference in effective doses between the low-dose and regular-dose protocol CT-guided spine biopsy groups (12.70 ± 1.193 mSv, N=31 and 28.90 ± 2.300 mSv, N=33 respectively; p< 0.0001).

Conclusions
Effective dose is the best measure of cancer risk to a whole organism due to ionizing radiation delivered nonuniformly to parts of the body. Therefore, it is very important to calculate effective doses for diagnostic imaging exams and image-guided procedures. We illustrated one method for determining effective dose conversion coefficients for each vertebral level in order to calculate effective doses in CT-guided spine biopsies.

<table>
<thead>
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<th>x-value</th>
<th>Vertebral level</th>
<th>Effective Dose Conversion Coefficient</th>
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<tr>
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<tr>
<td>0.8</td>
<td>C2</td>
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<td>0.9</td>
<td>C3</td>
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<tr>
<td>1</td>
<td>C4</td>
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<td>1.15</td>
<td>C5</td>
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<tr>
<td>1.25</td>
<td>C6</td>
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<td>1.35</td>
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</tr>
<tr>
<td>1.45</td>
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KEYWORDS: Dosimetry, Radiation Dose Reduction, Radiation Exposure
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<th>Value</th>
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</table>
MRI of the Internal Auditory Canals (IAC): What is the diagnostic yield in general practice?

A Knobel¹, G Panagopoulos¹, D Shatzkes¹

¹Lenox Hill Hospital, New York, NY
Purpose
Contrast-enhanced MRI of the IAC is commonly ordered in patients with a variety of symptoms referable to the seventh or eighth cranial nerves, including hearing loss, dizziness and facial palsy. The goal of this study was to assess the diagnostic yield of MRI of the IAC in a community hospital setting and to determine which variables, if any, impact this yield.

Materials and Methods
This retrospective study underwent IRB review and was deemed exempt from informed consent. A search of examination codes corresponding to MRI of the IAC for the 5 year period from 4/08 to 4/13 yielded 239 studies, of which 25 were excluded for known diagnosis of vestibular schwannoma, prior surgery in the area of examination, or age of patient less than 18 years old. Clinical information and reports available within the radiology information system were analyzed for indication, specialty of ordering physician and imaging diagnosis. Studies were categorized as negative, positive relevant to the presenting indication and positive irrelevant to the presenting indication (i.e. incidental). Statistical analysis was performed using the Fisher's exact test with a p-value less than 0.05 designated to indicate statistical significance.

Results
Out of 214 MRI IAC studies, six yielded a new diagnosis of vestibular schwannoma (3%). Moreover, there were 14 additional positive relevant diagnoses other than schwannoma (6%) and 8 positive diagnoses deemed irrelevant to the reported clinical indication (3.6%). When indications and referring physician specialty were analyzed, no statistically significant difference in diagnostic yield was identified.

Conclusions
In our practice setting, MRI of the IAC, when ordered in the absence of known disease, proved to be a low yield examination, with no change in diagnostic yield based on exam indication or specialty of ordering physician. Improved patient selection for this study may result in greater yield and cost-effectiveness.

KEYWORDS: Cost-Effective, Internal Auditory Canal, MR Imaging

<table>
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<tr>
<th>Results of MRI of the IAC</th>
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<tr>
<td>Finding</td>
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<tr>
<td>Normal</td>
<td>195 (87%)</td>
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<tr>
<td>Positive irrelevant (incidental findings)</td>
<td>6 (3%)</td>
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<tr>
<td>Positive relevant (excluding vestibular schwannoma)</td>
<td>17 (7%)</td>
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<tr>
<td>Vestibular Schwannoma</td>
<td>6 (3%)</td>
</tr>
<tr>
<td>Total</td>
<td>224</td>
</tr>
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</table>
Fig. 1-- (Vestibular Schwannoma): 45 year old male presented with right hearing loss and tinnitus. T1 weighed image (A) demonstrates an intermediate signal lesion in the left cerebellopontine angle (CPA) cistern and IAC that demonstrates low signal and homogeneous enhancement (C) consistent with a vestibular schwannoma.
Online Patient Resources – The Readability of Neuroradiology-Based Education Materials

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Purpose
The Internet is a frequently accessed resource for both patients and their families when encountering healthcare-related issues. As such, many professional medical societies have created online resources specifically for patients. Our goal is to evaluate these resources on the American Society of Neuroradiology (ASNR) website for their level of readability.

Materials and Methods
Online patient education resources were downloaded from the ASNR website, http://www.asnr.org/patientinfo/, as well as the patient education material available on the Society of NeuroInterventional Surgery (SNIS) website and analyzed for their level of readability using 10 quantitative readability scales, including the Flesch Reading Ease, Flesch-Kincaid Grade Level, Simple Measure of Gobbledygook, Coleman-Liau Index, Gunning Fog Index, New Dale-Chall, FORCAST Formula, Fry Graph, Raygor Reading Estimate, and the New Fog Count.

Results
The 20 different patient education resources were written between the 10.3 and 16.9 grade level. Only one patient resource was written below the 11th grade level and collectively, they were written at the 13.9 grade level. There was no statistical difference between the level of readability of the patient education materials found on the ASNR and SNIS websites.

Conclusions
All the patient education resources found on the ASNR and SNIS website are cast at a level well above the 3rd to 7th grade level that is recommended by the National Institutes of Health (NIH) and the American Medical Association (AMA). Revision of this textual information will increase the number of online viewers who can fully benefit from these resources and thus improve patient understanding of neuroradiology-related diseases, diagnoses, and treatments.

KEYWORDS: Educational, Health Outcomes

Radiation Exposure During Vertebroplasty

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Purpose
Radiation exposure and patient safety are being evaluated, tracked and recorded, according to new state and federal mandates. Texas, through our Department of State Health Services
(DSHS), recently enacted regulations to "establish guidelines for radiation reporting, training personnel, and establishing acceptable dose thresholds for various diagnostic and therapeutic procedures". We practice at a 250 bed, community-based Catholic hospital in Central Texas, and have a high volume Spine Intervention and Pain Management Service at our facility. We decided to proactively start evaluating these parameters for our procedures, and percutaneous vertebroplasty was the first of these to be selected for evaluation.

Materials and Methods
Starting on January 1, 2013, we began recording all patient demographics and procedure measures associated with every single-level percutaneous vertebroplasty performed. All patients were treated in the same Interventional suite (SIEMENS Neurostar), using similar equipment (COOK, Osteo-Site 13G Bone Biopsy needle kits) and the same bone cement (Stryker VertaPlex HV), for each therapy. No multilevel fracture patients were included, and no patients treated with mechanical assistance (curetting) or balloon augmentation (kyphoplasty) were included.

Results
Data were collected on 101 patients by the end of July, 2013. As expected, the majority of the patients were women (71%), and most fractures were in the mid-thoracic region (15% at T8/T9) and at the thoraco-lumbar junction (61% at T12-L3). Patients ranged in size from a 91 pound 90-year-old, to an almost 400 pound 41-year-old. Average cement volume in the thoracic spine was 3.8 cc/level, and in the lumbar spine it was 6.3 cc/level. Physician surgical time averaged 17.3 minutes for a thoracic level, and 16.7 minutes when treating a lumbar fracture. With thoracic fractures, fluoroscopic time averaged 6.3 minutes, total patient dose was 366.6 mGy, and average skin-entry dose was 3845.4 mcGy/sq-meter. Lumbar spine parameters were 5.1 minutes for average fluoroscopic time, total patient dose at 619.8 mGy, and an average skin-entry dose of 5677.1 mcGy/sq-meter.

Conclusions
We found that the procedures in the lumbar spine can be performed slightly faster, and with less fluoroscopic time for our patients; but compared to the thoracic spine, the total body dose per level was almost 60% higher, and the skin-entry dose was almost 70% higher per level. We hope that this source of data can help act as a reference point for similar type spinal interventions in the future. Our next step is to start reviewing outcome measures with this cohort of patients (evaluating pain relief and improvement in life-style, at one week, one month and one year after surgery), and to start tracking similar information for our other high-volume procedures.

KEYWORDS: Radiation Exposure, Vertebral Augmentation
Purpose
The aim of the project was to increase communication compliance between the Neuroradiology section and clinical services regarding non-contrast head CT findings in patients presenting with acute stroke who are being considered for tPA (tissue plasminogen activator). Practice guidelines established by the American Stroke Association (ASA) state, "For patients who are candidates for treatment with tPA, the goal is to complete the CT examination within 25 minutes of arrival at the ED, with the study interpreted within an additional 20 minutes (door-to-interpretation time of 45 minutes)." (1, 2) Initial baseline communication compliance collected by the Radiology Department quality committee from one year prior to the initiation of this project was available as a baseline measurement. Our goal was to increase compliance to greater than 90%.

Materials and Methods
We performed a group practice quality improvement project that included Neuroradiology faculty, clinical instructors, ACGME-accredited fellows and residents as well as administrative staff. The assessed metric was communication time in minutes, measured from the time of examination completion to the time of communication as dictated in the radiology report. Baseline communication compliance was collected from October 2011 through October 2012. The initial baseline denominator was based on a random sampling of all patients who were discharged from the hospital with a diagnosis of stroke. We then performed a root cause analysis and identified several systems based practice gaps. We implemented several changes to the workflow regarding stroke patients including 1) Designating a separate exam type titled "Stroke Code Head CT" to be ordered only in those patients presenting with acute stroke, 2) Placing a "stroke code pager" in the reading room to alert the radiology team when a "stroke code" was activated, 3) Limiting the auditing metric to include only those acute stroke patients in whom tPA was being considered. After implementing these changes we measured the communication compliance in all patients who underwent a "Stroke Code Head CT" from November 2012 - August 2013.

Results
Baseline communication compliance regarding head CT examinations in stroke patients measured 53%. We measured post implementation communication compliance in 272 patients in whom "Stroke Code CT" examinations were ordered for 8 months. The average compliance after the changes were implemented measured 92%.

Conclusions
Patients presenting to the hospital with symptoms of acute stroke have a narrow time window for making treatment decisions. This practice quality improvement project streamlined the ordering and interpretation of head CT examinations in patients presenting to our hospital system with
acute stroke, leading to greater compliance with ASA door-to-interpretation time guidelines and contributing to more expeditious delivery of care in patients who need it most.

KEYWORDS: Compliance, Quality Improvement, Stroke

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Electronic Poster - Spine
EP-225

Adult-derived mesenchymal stem cells and stromal vascular fraction from adipose tissue as a therapeutic treatment for osteoarthritis

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1Desert Medical Imaging, Palm Springs, CA, 2Desert Medical Imaging, Indian Wells, CA

Purpose
Autologous adult-derived mesenchymal stem cells (MSCs) of the stromal vascular fraction (SVF) found in adipose tissue serve to function as a clinical therapy for inflammation and granulation scar type tissue regions in and about facet joints. The more recent advent of obtaining MSC’s from adipose tissue, as opposed to more commonly using bone marrow, has several advantages including a greater concentration of stem cells per tissue, less degeneration in number of stem cells due to age, and greater modulation of immune response from endothelial progenitor and T regulatory cells found in adipose SVF. Furthermore, adipose SVF give rise to cells that express MSC surface markers and therefore share the same regenerative properties and diverse differentiation capabilities. This potential MSC/SVF treatment and efficacy is observed in an IRB-approved clinical study for patients that have been indicated to have reactive osteoarthritis.

Materials and Methods
Standard MRI spine imaging was performed without and with contrast providing for specific interrogation of potential reactive facet arthropathy. Inflammatory facet joint levels were identified and reported as potential sites for therapeutic intervention. Tissue was surgically extracted from abdominal fat via liposuction and the stromal vascular fraction was isolated from the adipose and collagen via centrifugation and collagenase. The unaltered SVF cells were infused in an autologous serum and were redeployed to sites of inflammation on the same day. Intra-articular facet joint injections were performed via CT image-guidance at the cervical level or lumbar level to ensure precise placement and for stem cells to act locally. Patients were scored according to the Oswestry Disability Index indicating level of pain and functional disability in the neck and back. Patients took the Oswestry questionnaire at variable intervals according to clinical practice to assess long-term therapeutic effect. Patients are scored according to the Oswestry Disability Index indicating level of pain and functional disability in neck, shoulders, back, or hips. Patients took Oswestry Questionnaire at regular evaluations every three months to assess long-term therapeutic effect.
Results
Forty-seven patients at baseline presented with an average Oswestry score of 10 due to lumbar spine osteoarthritis and were injected at inflamed levels as determined by postcontrast MRI analysis on T1 Fat Suppression sequencing. Numbers of patients 10, 11, 7, 2, 5, 1, and 1 were re-evaluated at 1, 3, 6, 9, 12, 15, and 18 months respectively. Average Oswestry follow-up scores were 9, 13, 13, 24, 5, 12, and 20 for the aforementioned returning patient numbers at the respective time intervals. Nineteen patients at baseline presented with an average Oswestry score of 18 due to cervical spine osteoarthritis and were injected at inflamed levels as determined by postcontrast MRI analysis on T1 Fat Suppression sequencing. Numbers of patients 4, 1, and 1 were re-evaluated at 1, 3, and 12 months respectively. Average Oswestry follow-up scores were 16, 15, and 0 for the aforementioned returning patient numbers at the respective time intervals. No adverse events were encountered.

Conclusions
Autologous adipose-derived mesenchymal stem cells and stromal vascular fraction may prove to be beneficial in attenuating degenerative osteoarthritis inflammation in facet joints. Preparation and same-day administration of SVF follows a protocol that is effective in minimizing ex-vivo manipulation and contamination. Results from this clinical study show that this new technique in regenerative medicine has the potential to reduce pain in patients with degenerative arthritis. Further rigorous clinical trials will be necessary to measure the efficacy of this treatment.

KEYWORDS: Image Guidance, Inflammatory, Stem Cell

EP-228

Carcinoma Cells Type Identification Based on the Texture Analysis

A Chaddad\textsuperscript{1}, R Colen\textsuperscript{2}, P Zinn\textsuperscript{2}
\textsuperscript{1}University of Texas MD Anderson Cancer Center, Houston, TX, \textsuperscript{2}MD Anderson Cancer Center, Houston, TX

Purpose
The robust recognition and classification of cancer cells can enhance work efficiency while identifying new inter-relationships among biological features. Texture analysis was chosen and the Haralick's features based on Gray Level Co-occurrence Matrix (GLCM) were applied for grade cancer cell discrimination. A critical characteristics study was employed using the five Haralick features, namely, Contrast, Entropy, Energy, Correlation and Homogeneity. These features capture useful information about the patterns that emerge in the texture of considered images. The proposed work is based on the values of the Haralick's coefficients used as a primary component to distinguish between different grades of cells namely, Stroma, Benign Hyperplasia (BH - benign condition), Intraepithelial Neoplasia (IN) that is a precursor state for cancer and Carcinoma (Ca) that corresponds to abnormal tissue proliferation (Cancer).

Materials and Methods
Optical microscopy provides multispectral biopsy images with the wavelength between 500 and 650 nm. The multi-spectral images are then analyzed at low, medium and high wavelength. Four categories of grade cells were applied, GLCM were calculated for each texture image using four distances $d = \{1, 2, 3, 4\}$ and phase = \{0; 45°; 90°; 135°\}. Texture features were computed using
the GLCM matrix. In each category of grade cells, we selected the dominant feature which is used for making the grade cells discrimination.

Results

512 bio-images from the optical microscopy were analyzed. Each grade of cells contains 128 images. Simulation result showed that the Energy feature is a dominant for BH cells identification with 0% error and by the Contrast feature we can identify the Carcinoma cells type with 0% error. These results mainly appear on the middle frequencies range.

Conclusions

Texture features extracted from four grades of cell using GLCM matrix, were successfully demonstrated that the Contrast feature allows discriminating the image characterized by a malignant cancer grade of Ca which was a difficult task previously. This is important as these features can be subsequently used to correlate between the underlying genomic composition of the tumor.

KEYWORDS: Cancer, Carcinoma

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<tr>
<td>Stroma (&quot; 5 features&quot;)</td>
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<tr>
<td>Benign Hyperplasia (&quot;Energy&quot;)</td>
<td>100</td>
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<tr>
<td>Intraepithelial Neoplasia (&quot; 5 features&quot;)</td>
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<tr>
<td>Carcinoma (&quot;Contrast&quot;)</td>
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EP-226

Comparison of Rapid MRI Lumbar Spine Protocol to Full MRI Lumbar Spine Protocol for Evaluation of Lumbar Spondylosis
Purpose
More than 80% of the population will experience an episode of LBP at some time during their lives. The condition is also costly, with total costs estimated to be between $100 and $200 billion annually, two-thirds of which are due to decreased wages and productivity. The average cost of a lumbar spine MRI is over $2,000. Reducing scan time without compromising diagnostic accuracy can reduce costs while benefiting patients. We will compare the effectiveness of a full lumbar spine MRI for spondylosis with a rapid protocol using 3-D T2 SPACE (Sampling Perfection with application-optimized Contrast with different flip-angle evolutions).

Materials and Methods
75 consecutive patients imaged for low back pain and radiculopathy using the full protocol were included in this IRB-approved study. The full protocol consists of standard fast spin echo (FSE) sagittal T1 and T2 weighted sequences and axial T2 weighted sequence as well as the rapid 3-D T2 SPACE sequence acquired in the sagittal plane. Scan time for the standard sequences is approximately 30 minutes versus approximately 5 minutes for the 3-D T2 SPACE. Several months after a final report was generated using the full protocol, the 3-D T2 SPACE sequences were retrospectively reviewed in isolation by 2 attending neuroradiologist who were blinded to the final reports. Each reader had the ability to manipulate the images into orthogonal planes on a 3-D workstation. At each disc space between L1 and S1 the following data was recorded: the presence or absence of disc herniations, synovial cysts and neural foraminal compromise in the central and lateral regions. Sensitivity and specificity of the rapid protocol was then compared to the final reads on the full study. Exclusion criteria included history of infection, trauma, cauda equina, tethered cord, metastatic disease.

Results
We will present data on the sensitivity and specificity of the rapid sequence for evaluation of low back pain and radiculopathy using the full protocol as the standard of care. We will also provide a cost effectiveness analysis using this shorter protocol during a typical workday.

Conclusions
We hypothesize that there is no significant difference in interpretation of lumbar spine degenerative changes between the rapid study and full study. This could allow institutions to save scanner time and reduce cost without compromising patient care.

KEYWORDS: Degenerative
Purpose
Computed tomography angiography (CTA) of the neck commonly is used as a first-line modality for screening for cervical arterial injury in victims presenting with a seatbelt sign following a motor vehicle accident. We present here a retrospective analysis of all CTA neck studies performed on victims of motor vehicle accidents at our Level I Trauma Center between 2001-2010 to determine whether the seatbelt sign has a direct correlation with cervical arterial injury.

Materials and Methods
Clinical histories and imaging results were analyzed retrospectively for all CTA studies performed on trauma victims from 2001-2010 using our center's PACS and electronic medical record. A total of 831 studies were evaluated. Of these, 397 studies were performed on victims involved in motor vehicle accidents and had unequivocal conclusions on imaging. These 397 studies were analyzed to determine if there was a significant correlation between the seatbelt sign and cervical arterial injury.

Results
Of 397 victims of motor vehicle accidents, a cervical arterial injury was found in four of 309 patients (1.3%) with a seatbelt sign compared to four of 88 patients (4.5%) without a seatbelt sign (p = 0.08). Of the four arterial injuries in patients with a seatbelt sign, one patient had no associated osseous injury or predisposition to arterial injury. Of the other three patients, one had adjacent cervical spine fractures, one had fibromuscular dysplasia and a carotid dissection, and one had a variant origin of the left vertebral artery from the aortic arch and rib fractures adjacent to the arterial injury.

Conclusions
Presence of a seatbelt sign has no significant correlation with cervical arterial injury.

KEYWORDS: Cervical Artery Dissection, CT Angiogram, Motor Vehicle Crash

EP-220
6:30AM - 9:00PM
Enhancing the Sensitivity of Nuclear Cisternography in Diagnosing Cerebrospinal Fluid Leaks

D Black¹, F Diehn¹, C Hunt¹, V Lehman¹, K Schwartz¹, P Luetmer², C Wood¹, R Carter¹, K Thielen¹, J Swanson¹, M O'Connor¹, R Witte¹
¹Mayo Clinic, Rochester, MN, ²placeholder, blank, blank

Purpose
In the evaluation of patients with possible cerebrospinal fluid leaks, we have noticed inconsistency and variability in the interpretation of Indium-111 DTPA cisternograms which conflict with the clinical diagnosis. Hence we sought to create a more objective method to evaluate the radiotracer kinetics in this patient population. The purpose of this study was to assess whether the sensitivity of Indium-111 nuclear cisternography in diagnosing cerebrospinal fluid leaks could be improved by dividing each planar image into multiple regions of interest and displaying the total radioisotope counts in each segment graphically over time in conjunction with traditional planar images.

Materials and Methods
We developed a relatively simple program which divides the planar images from our unchanged
In-111 cisternograms into seven regions of interest and plots the total radioisotope counts from each region on a graph wherein the counts are the ordinate and time is the abscissa. Nineteen sequential patients who had recently undergone cisternography for possible cerebrospinal fluid leak were enrolled after obtaining internal review board approval. Six blinded board certified radiologists reviewed the cisternograms, the graphs, and the combination of the cisternogram and associated graph and categorized each image as "leak" or "no leak." The readers were instructed to use their knowledge of spinal fluid circulation and resorption to interpret the graphs. Two unblinded authors reviewed the medical records and the final clinical diagnosis was compared with our readers' interpretations.

Results
The diagnostic sensitivity and specificity for CSF leaks was 63% and 83%, respectively, using planar images alone, 78% and 80% using the graphical depiction alone, and 55% and 61% using both the planar images and graphical representation simultaneously (p-values were 0.09 for sensitivity and 0.03 for specificity).

Conclusions
The sensitivity for the three methods ranged from as low as 55% to as high as 78%. While this degree of variability would be indicative of a clinically relevant variation in performance, the differences did not reach statistical significance with the available sample size. These initial findings suggest that adding a semi-quantitative graphical representation of the data already acquired during conventional nuclear cisternography may be beneficial but further study is required. Unexpectedly, the combination of planar and graphical data appeared to have the lowest sensitivity and this may reflect a negative bias of the planar data on the final interpretation.

KEYWORDS: Cerebrospinal Fluid, Leak

Increased Tc-99m Bone Tracer Activity in the Costovertebral and Costotransverse Joints on SPECT/CT: Does it Predict Pain and Response to Percutaneous Treatment?
Purpose
Pain related to the costovertebral and costotransverse joints is likely an underrecognized and potentially significant cause of thoracic back pain. With use of combined SPECT and CT, demonstration of Tc-99m bone tracer activity at these articulations is not rare. Overall, the relationship of radiotracer activity to pain and the ability to predict response to percutaneous intervention seems to vary at different joints throughout the axial skeleton. Therefore, evaluation of the potential significance of Tc-99m bone tracer activity at the costovertebral and costotransverse joints is desirable. We evaluated whether Tc-99m bone tracer activity at the costovertebral and costotransverse joints corresponded to clinical pain and if percutaneous injection of these joints correlated with improvement in thoracic back pain.

Materials and Methods
After obtaining IRB approval, a retrospective review was performed of all Tc-99m SPECT/CT reports completed at our institution from March 2008 to February 2013 to evaluate for examinations with Tc-99m bone tracer activity in the costovertebral or costotransverse joints as reported by the interpreting nuclear medicine radiologist. A chart review was performed to determine the presence of corresponding clinical pain as determined by the physician ordering the exam (typically a pain specialist), whether percutaneous injection was performed, and the patient's response to the injection.

Results
A total of 442 SPECT/CT examinations were identified. Increased Tc-99m bone tracer activity at costovertebral or costotransverse joints was reported on 31 examinations. Of these, 20 patients had corresponding clinical pain and eight (3 male and 5 female, average age 43, ranging from 17-76) proceeded to percutaneous injection of the costovertebral or costotransverse joint(s) that demonstrated increased activity. A total of 11 joints were injected by either an interventional radiologist or other interventional pain physician. All injections included a combination of local anesthetic and steroid and were performed under CT or fluoroscopic guidance. Clinical follow up between one and 12 weeks postinjection revealed that 0 (0%) patients had complete pain relief, one (13%) had near-complete pain relief, two (25%) had partial pain relief, and five (63%) had no pain relief.

Conclusions
There is little to no prior report in the English literature of the utility of Tc-99m bone tracer activity for direction of percutaneous treatment of costotransverse or costovertebral joints. Based on the present study, costovertebral and costotransverse joints with increased Tc-99m bone tracer activity on SPECT/CT examinations exhibit variability in terms of associated clinical pain and also response to percutaneous steroid injection, often with no reported pain relief. However, future prospective investigation with a larger number of patients is desirable to firmly establish the significance of costovertebral and costotransverse joint Tc-99m bone tracer activity.

KEYWORDS: Bone Scan, Spine Injections, Steroid Injection

EP-222
MR Imaging of the Brachial Plexus with and without Blood-suppression Pulse at 3T.

M Odashima¹, T Inaoka¹, N Kitamura¹, S Kasuya¹, R Kasai¹, H Kudo¹, T Nakatsuka¹, M Tozawa¹, H Nakazawa¹, M Sogawa¹, H Terada¹
¹Toho University Sakura Medical Center, Sakura, Chiba, Japan

Purpose
To compare MR images of the brachial plexus with and without blood suppression pulse at 3 T.

Materials and Methods
Four asymptomatic males (mean age: 26 years) were enrolled. All MR imaging (MRIs) were performed by using Siemens Magnetom Skyra 3 T and neck plus body coils. At the brachial plexus, STIR images using 3D FSE SPACE sequence with and without blood suppression pulses were obtained in coronal plane. Slice thickness was 0.8mm. The signal intensities of the cervical nerves, ganglia, veins, and muscles on the STIR coronal maximum intensity projection images with and without blood suppression pulses were measured, and the contrast ratios (cervical nerve-vein, ganglia-vein, and muscle-vein) on the images with and without blood suppression pulses were compared.

Results
With blood suppression pulse, average percentages of the decreased signal intensities were 8.1%, 16.6%, 26.7%, and 18.9% in the cervical nerves, ganglia, veins, and muscle, respectively. The contrast ratios of cervical nerve vein and ganglia vein were significantly higher in coronal STIR images with blood suppression pulse than those in coronal STIR images without blood suppression pulse (p< .05)

Conclusions
3D FSE SPACE STIR images with blood suppression pulse may show a better visualization of the brachial plexus in comparison with those without blood suppression pulse.

KEYWORDS: Brachial Plexus

EP-227
6:30AM - 3:00PM

Percutaneous Rupture of Lumbar Facet Synovial Cysts: What Factors Predict Success?

D Pastel¹, S Cambron²
¹Dartmouth-Hitchcock Medical Center, Lebanon, NH, ²Dartmouth Hitchcock Medical Center, Lebanon, NH

Purpose
Lumbar facet synovial cysts (LFSCs) most commonly arise in the setting of degenerative spondylosis and are a cause of back pain and radiculopathy (1-4). Treatment options include percutaneous rupture and surgical removal. We previously reported that T2 hyperintense and intermediate signal intensity LFSCs are easier to rupture and less likely to need surgery (5). Cyst size and location did not affect percutaneous rupture or surgical rates. The purpose of this follow-up analysis is to identify additionalsurgeries performed within our study group and identify other features that may predict outcome in patients undergoing percutaneous LFSC rupture.
Materials and Methods
We retrospectively reviewed the clinical outcome and imaging of 110 patients with 113 LFSCs who underwent attempted CT-guided synovial cyst rupture as primary treatment for symptomatic LFSCs. The rates of successful cyst rupture and need for subsequent surgery were recorded. Follow-up ranged from 7-93 months after the last attempted percutaneous rupture. This study will update the follow-up period by 18 months and report any additional surgeries performed within our study group. The following data will also be collected as they relate to percutaneous rupture success and need for subsequent surgery: BMI, narcotic use, previous back surgery, cyst wall calcification, facet effusion size, and spondylolisthesis.

Results
As previously reported, LFSC rupture was technically successful in 87% of all cases, with the highest success rates found in cyst of high and intermediate signal intensity. We reported lowest post-procedure surgical rates (29%) in patients with high signal intensity cysts. As discussed above, we will record additional surgeries performed since we first reported our data and analyze additional factors they may predict success.

Conclusions
Most patients with symptomatic LFSCs can avoid surgery with percutaneous rupture (5). Patients with T2-hyperintense synovial cysts are most likely to benefit from nonsurgical intervention (5). This study will identify additional features as described above that may predict outcome in patients undergoing percutaneous LFSC rupture. Information such as this can be valuable when selecting and counseling patients on their treatment options for symptomatic LFSCs.

KEYWORDS: Facet

EP-219

Percutaneous Treatment of Lumbar Disc Herniation with Gelified Ethanol: a Preliminary Study

M Runge

University Hospital, Besançon, France

Purpose
Evaluate the safety and efficacy of disk nucleolysis using gelified ethanol in the percutaneous treatment of herniated lumbar disk (HLD).

Materials and Methods
From March 2010 to July 2013, 42 consecutive patients (22 male, 20 female) aged 22-80 years (mean age 45.1) with a symptomatic HLD were included in this study and treated with gelified ethanol nucleolysis. Symptomatic levels (L3-L4: 3, L4-L5: 19, L5-S1: 20) were identified by clinical examination, computed tomography or MR imaging (MRI). In most cases, the clinical abnormalities corresponded to the lumber disk level. All procedures were performed in ambulatory condition under local anesthesia and under fluoroscopic guidance. Injection dose of radiopaque gelified ethanol was 1 ml. Three months after nucleolysis, a clinical exam and a MRI exam were performed to appreciate the follow up of HLD and to evaluate the signal changes of the surrounding endplates.
Results
Very good results with total disappearance of radicular pain were obtained in 54.8% of cases (24/42). Good results with a significant reduction of symptoms and medications were obtained in 33.3% (14/42) and bad results with the persistence of radicular pain and recourse to surgery in 11.9% (5/42). Two patients underwent diskolysis in more than one level (2 levels). No difference was observed in the results in comparison to those treated at a single level. There was no complication in any of our patients. Short term follow up (3-4 months) with MRI exam showed in all patients with very good and good clinical results a complete HLD disappearance in 16.7% of cases, a minimal reduction of hernia volume (less than a quarter of hernia size) in 21.4% and no changes in 61.9%. No changes were observed in the intervertebral space height and in the bone marrow signal intensity of the surrounding endplates.

Conclusions
This preliminary study shows the efficacy and the inocuity of nucleolysis with gelified ethanol in the treatment of any kind of HLD

KEYWORDS: Chemotherapy, Disk Herniation, Treatment Assessment

EP-224

Spontaneous Intracranial Hypotension Secondary to New Use of a Rowing Machine? A Case Report

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Purpose
To report a case of spontaneous intracranial hypotension in a female with no significant history except for first time use of the rowing machine at the gym. Case Report: A 29-year-old previously healthy woman presented with spontaneous onset of generalized headache, associated with nausea and vomiting, that prompted transportation to Bryn Mawr Hospital Emergency Department. The headache was consistently exacerbated by sitting or standing and improved while lying down. She had no recent history of infection or trauma, however did report first time use of the rowing machine at the gym. The patient had no neurological symptoms and a normal neurologic exam. Lab tests revealed an elevated WBC count of 12.2. CT brain performed was normal. When her symptoms did not improve she had a failed lumbar puncture attempted by Neurology.

Materials and Methods
An MR imaging (MRI) brain w/w/o contrast revealed diffuse pachymeningeal enhancement, with additional finding of edema involving the deep musculature of the upper dorsal cervical spine. Initial noncontrast MRI of the cervical and thoracolumbar spine revealed mildly prominent T1 hypointensity and T2 hyperintensity in the ventral extradural space extending from C2-T1, which maintains hyperintensity on the STIR sequence. Additional findings included a prominent dural venous plexus. These findings were most in keeping with spontaneous intracranial hypotension/CSF leak. Next a nuclear medicine cisternogram was performed in attempts to localize the site of CSF leakage. Initial 30 minute and one hour imaging revealed no abnormality. Delayed 3, 4.5 and 21 hour images revealed radiotracer activity outside the
expected confines of the thecal sac bilaterally, just below the level of the cervicothoracic junction. CT myelogram showed leakage of contrast along bilateral neuroforamina at C7-T1 and T1-T2, as well as along C1-C2 posteriorly. The patient's symptoms improved on purely conservative treatment including bedrest and oral hydration and was discharged home after several days.

Results
Spontaneous intracranial hypotension is a clinical syndrome of reduced CSF volume secondary to spontaneous leakage of CSF through small defects in the meninges. This condition affects women more frequently than men, and is associated with connective tissue disorders such as Marfan syndrome, Ehlers-Danlos syndrome, and ADPKD. Spontaneous intracranial hypotension is a well known clinical entity; however it is commonly under-diagnosed. Generally CSF leaks do not cause local symptoms and thus remain undetected unless specifically looked for in a patient suspected of having SIH. The main symptom is an orthostatic headache that worsens when upright and improves when recumbent. More often that not, there is history of a failed lumbar puncture attempt, a "dry tap," which would be expected in the setting of decreased CSF pressure. The exact cause of spontaneous spinal CSF leaks is unknown, but generally an underlying structural weakness in the spinal meninges is suspected. This, coupled with a seemingly insignificant traumatic/inciting event, can cause defects within the dura that allow CSF to leak into the epidural space. Many cases of SIH resolve spontaneously on their own, and treatment options for those seeking medical treatment are usually conservative.

Conclusions
Brain MRI characteristic features of SIH include: 1) pachymeningeal enhancement, 2) subdural fluid collections, 3) dural venous engorgement, 4) pituitary hyperemia, 5) sagging of the brain. Many of the MRI findings of SIH can be explained by the compensatory changes related to the loss of CSF volume. The Monroe-Kellie rule states that in an intact calvarium, the sum of the volumes of intracranial blood, CSF, and cerebral tissue must remain constant. Cerebrospinal fluid volume loss from the spine can be compensated for by an increase in the vascular component, which accounts for engorgement of venous structures, pachymeningeal enhancement, and pituitary hyperemia. Spinal myelogram with intrathecal contrast is currently the study of choice for identifying the location and extent of the CSF leak. The volume of CSF leak is variable. The vast majority of CSF leaks are found at the cervicothoracic junction or along the thoracic spine. It is not uncommon to demonstrate multiple sites of leakage. It is important to note that retrospinal collections of contrast at the level of C1-C2 should not be mistaken for the actual site of a CSF leak. Delayed imaging also may be necessary to visualize intermittent or slow leaks, and immediate imaging following injection of contrast may be necessary to identify the site of a fast high-volume leak. Radionuclide cisternogram also may be used to diagnose CSF leak; however it is limited in evaluating exact site of leakage, which may be obscure in up to one third of patients. Findings include early accumulation of radiotracer in the kidneys and bladder, slow ascent along the spinal canal, and a scarcity of activity overlying the cerebral hemispheres.

KEYWORDS: Idiopathic Intracranial Hypotension, Intracranial Hypotension, Spinal CSF Leak

Monday
6:30AM - 3:00PM
Palais des congrès de Montreal, 220d
A Case of Acute Cervical Myelopathy in a Myasthenic Patient

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Purpose
Intramedullary abscess is a very rare entity with around 120 cases reported in the literature since its first description by Hart in 1830. This is a case report of 77-year-old female patient with myasthenia gravis on corticosteroid immunosuppressive treatment presenting with acute cervical pain that was diagnosed as an Nocardia cervical intramedullary abscess. The purpose of this poster is to review the rare pathology that is intramedullary abscess and the diagnostic challenge such a case represents and also to discuss the use of diffusion-weighted image technique which was critical in the diagnosis and management of the case, a technique that has been reported in three cases of spinal abscesses in the literature.

Materials and Methods
The material used for this case report was a complete chart review of the clinical, laboratory and radiological investigations of the patient. The method is a case review of this patient that was admitted to our institution. The patient was a 77-year-old female that presented to the emergency room with a two-weeks history of severe cervical pain accompanied by profound left-sided weakness. Three months prior, she had been diagnosed with myasthenia gravis after an episode of ptosis and respiratory failure. In the emergency department, her initial neurological examination was consistent with left upper extremity radiculopathy at C5-C8 with concomitant myelopathy. On MRI, patient was found to have an intramedullary ring enhancing, longitudinally extending lesion with surrounding edema. The differential diagnosis included a primary neoplasm of the spine with a cystic component, a metastasis or an abscess. Her primary investigations were negative, including neoplastic, infectious and inflammatory work up, a full body PET scan and an analysis of cerebrospinal fluid. Upon repeating the neuroimaging, there was presence of diffusion restriction in the core of the intramedullary cervical lesion on spinal diffusion-weighted images. This was highly suspicious for an intramedullary abscess. In light of this finding, a posterior myelotomy was performed which confirmed the radiological diagnosis with the presence of an isolated intramedullary Nocardia abscess on the cultures obtained from the intramedullar fluid collection.

Results
The diagnosis of spinal cord abscess, suspected on the MRI of spinal, mainly after the use of the diffusion technique, was confirmed by the cultures obtained in the cystic cavity after the myelotomy, showing Nocardia species. The patient did well after months of antibiotics and was able to go to a rehab facility, able to ambulate with a walker and assistance at the time of discharge. She was treated with a total of six months of parenteral broad spectrum antibiotics followed by four months of oral antibiotics. Her multiple repeat spine MRI showed an almost complete normalization of the spinal cord with only mild residual myelomalecia.
Conclusions
In this case, the diagnosis of spinal cord abscess was made after clinical input and effort of a multidisciplinary team including neurology, neuroradiology and neurosurgery. The use of advanced neuroradiologic technique, mainly diffusion-weighted images of the spine, were crucial in the clinical care. Intramedullary abscesses, being a rare pathology, always represent a clinical challenge to physician in both the diagnostic and treatment. In this case, the patient had a good outcome as the etiology of her myelopathy was recognized and treated promptly.

KEYWORDS: Abscess, MRI Spine, Spinal Cord

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P-53

A step towards absolute blood volume mapping using steady state ferumoxytol MRI in glioblastoma patients

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Purpose
Cerebral blood volume (CBV) values in brain tumors usually are normalized to normal appearing white matter (NAWM) and expressed as relative CBV (rCBV). The selection of NAWM as well as its potential disease involvement makes this technique less objective. In this study we are proposing the use of steady state CBV mapping using ferumoxytol, a blood pool contrast agent, and normalization of the CBV maps to intravascular ferumoxytol concentration.

Materials and Methods
Forty-two patients with CNS pathologies underwent MR imaging using 510 mg ferumoxytol administered in three consecutive bolus injections in doses of 75 mg, 150 mg and then 285 mg. At baseline as well as following each injection T2*-weighted echo planar gradient echo images were acquired and steady state CBV maps were created by calculating the changes of transverse relaxation rates (deltaR2*) to baseline. The relationship between deltaR2* and injected doses were tested in normal appearing brain areas (white matter, thalamus and putamen). Doses were expressed as mg Fe/kg body weight and also as mg Fe/L total circulating blood volume (TBV, obtained using the Nadler’s formula), the latter one indicating intravascular ferumoxytol concentration [Fe]. We calculated rCBV as well as CBV expressed as deltaR2*/[Fe] in the normal appearing brain areas and in enhancing tumors and hotspots (in patients with glioblastoma) for each injection.

Results
The dose range of ferumoxytol was 0.54 to 10.29 mg/kg. This resulted an intravascular [Fe] between 9.81 and 151.42 mg/L. A good linear relationship was found between deltaR2* and injected ferumoxytol dose in each of the normal brain areas. In white matter, thalamus and putamen the coefficient of determination (R2) was higher when [Fe] was used (R2: 0.878, 0.875 and 0.88 respectively), compared to the dose expressed as mg/kg, resulting R2 of 0.832, 0.803 and 0.83 respectively. Figure 1 shows the comparison of rCBV and deltaR2*/[Fe]. (Error bars indicate 95% CI). DeltaR2*/[Fe] values show better consistency between doses.

Conclusions
The good linear relationship between deltaR2* and [Fe] is promising for quantifying ferumoxytol CBV mapping in brain tumors. The deltaR2*/[Fe] maps could eliminate the need of NAWM selection, which would make CBV mapping more objective and consistent, this technique also would allow the assessment of the white matter. Steady state CBV mapping using ferumoxytol has the potential of absolute CBV assessment, which would be beneficial in longitudinal studies, and would allow comparison of CBV between patients.

KEYWORDS: Cerebral Blood Volume, Glioblastoma, MR Imaging Brain
P-37

**Automatic Resting State Network Decomposition using ICA and Classification in a Clinical Population**

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¹University of Wisconsin Madison, Madison, WI, ²University of Wisconsin Madison, Pewaukee, WI, ³Prism Clinical Imaging, Elm Grove, WI, ⁴Medical College of Wisconsin, Wauwatosa, WI

**Purpose**

Our goal is to decompose a subject's resting-state fMRI spatiotemporal signal into independent components that are anatomically and functionally representative of known resting-state networks (RSNs) and then accurately classify each component as belonging to one out of seven RSNs as defined by a template previously compiled by Allen et al. The overall goal is to create a clinically oriented, automated component classification method using resting-state fMRI that could complement or substitute task fMRI for patient diagnostic and presurgical procedures.

**Materials and Methods**

Resting-state fMRI scans from 23 patients (17 epilepsy, six vascular/tumor, 10 male, mean age = 39 years) were acquired on GE MR750 3 T and GE MR450 1.5 T scanners with a gradient echo
EPI sequence (28 slices, 150 volumes, 2s TR, 30ms TE, 3.75×3.75×5 mm). Data were preprocessed, consistent with Allen et al's study, using AFNI and FSL which included slice-timing correction, motion correction, transformation into standard MNI space (3×3×3 mm), and spatial smoothing (Gaussian 10 mm FWHM). The patients had no gross structural abnormalities and the resultant registration was satisfactory. Data were decomposed into functional networks using individual, spatial independent component analysis (ICA), a MVPA technique, implemented in the GIFT toolbox (Figure 1). Components for the visual, sensorimotor, default mode, and auditory networks were identified visually. Each resultant component was spatially correlated with 28 ICs of the template and a ranking by correlation was used for the classification step (using MATLAB). The most correlated component was chosen to represent the subject's component, and its network membership was inherited. The metric used for measuring classification performance was a matching rate to the researcher's network identification.

Results
The analysis of the patient data set revealed clear and adequate functional components. For the components which the researcher identified as the visual network, the classifier achieved 88.7% agreement (of 62 visually identified network components, the classifier matched 55, p-value < 1 × 10-16 (binomial test)). For the sensorimotor network, the classifier was in 57.9% agreement (38 visually identified components, 22 classifier matched, p-value < 1 × 10-6). For the default-mode network, the classifier was in 48.9% agreement (139 visually identified components, 68 classifier matched, p-value < 1 × 10-16). For the auditory network, the classifier was in 65.2% agreement (46 visually identified components, 30 classifier matched, p-value < 1 × 10-16).

Conclusions
The automated classifier showed promising performance [significantly better than random guessing (roughly 1 out of 7, ~15%)] for the visual, sensorimotor, default-mode and auditory networks of clinical patients. Further development and validation will be done to make this method available as a clinical software tool for automated functional network component extraction and classification.

KEYWORDS: Classification, Independent Component Analysis, Resting-State FMRI
Automatic Vascular Territory Mapping for Quantification of Cerebral Ischemia

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Purpose

MR perfusion imaging has emerged as an important tool in the evaluation of cerebral ischemia. While it is relatively straightforward to visually inspect images of cerebral blood flow and blood volume to look for relative deficits, quantifying these results can be difficult. One commonly used approach is to manually draw ROIs and extract average values from these ROIs. However, because these ROIs are drawn manually, often with prior knowledge of clinical history, this approach can introduce bias in the measurement. Similarly, when tracking longitudinal changes in a single person, it is difficult to draw identical ROIs. Also, because they are drawn by hand one at a time and correct placement of ROIs requires familiarity with cerebrovascular anatomy, manual ROI drawing can be a time intensive process. Both shortcomings are especially noticeable when conducting research because it is critical to avoid bias and studies can involve large numbers of patients. A more automated approach that has been used recently is quantifying...
the volume of tissue above a specific Tmax threshold. However, this approach does not take advantage of incorporating information about underlying cerebrovascular anatomy. For example, a lesion localized entirely to the MCA territory may be interpreted differently than one spanning both the MCA and ACA territories, but a single number specifying lesion size would ignore this difference. To attempt to address these concerns, we propose an automated approach to evaluating regional ischemia based on automatic drawing of vascular territory ROIs.

Materials and Methods
Twenty-three patients with ischemic stroke were identified by retrospective chart review. Maps of cerebral blood flow were reconstructed offline using automatic AIF selection (1) and SVD deconvolution. These images then were read independently by two neuroradiologists blinded to the patients' history, who rated the perfusion in each vascular territory as hyperperfused, normal, mildly hypoperfused, or severely hypoperfused. Ischemic regions were defined as those that were mildly or severely hypoperfused. In this cohort, 18 MCA (six inferior division, one superior division, 11 both), five ACA, and one PCA ischemic regions were identified. Twenty-one of these ischemic territories were verified by MR or x-ray angiography of the corresponding vessel. Additionally, 10 healthy volunteers were scanned with identical DSC perfusion scans (2). All volunteers and patients received anatomical imaging for reference. A single vascular territory ROI template map including superior and inferior MCA divisions, the ACA, and PCA territories was drawn by a neuroradiologist on a canonical image in MNI space. Cerebellar ROIs were omitted due to inadequate coverage in volunteers and patients. The template ROI map then was used to automatically generate subject specific vascular territory maps. For each patient, the anatomical reference image was coregistered to the patient's perfusion image and normalized to MNI space (SPM 8). The normalization parameters then were used to transform the vascular territory template into subject specific vascular territory ROIs. For each ROI, an asymmetry index was calculated by dividing by the contralateral ROI (for healthy volunteers, asymmetry was instead defined as left/right). The theoretical normal asymmetry index in an ROI is one with lower indices indicating greater relative perfusion deficits.

Results
Mean values in affected regions in patients, unaffected regions in patients, and volunteers are shown Table 1. Due to an insufficient number of patients with PCA ischemia, the PCA was excluded from analysis. Perfusion deficits were greatest in patients with confirmed stroke and smallest in healthy volunteers. In the ACA and both MCA territories, asymmetry index was decreased significantly (meaning increased asymmetry) in affected regions compared to unaffected regions (p<.001 for MCA territories, p<.05 ACA) or volunteers (p<.001 all territories).

Conclusions
Using a completely automated process, we calculated quantitative measures of regional perfusion deficits in different vascular territories. In the ACA and both major territories of the MCA, these measures showed significantly decreased perfusion when the territory was identified by neuroradiologists as being hypoperfused. This agreement between the automated and manual approaches suggests that this method may be feasible for rapid, automated, and unbiased analysis of MR perfusion images.

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<th>MCA inferior</th>
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<td>affected</td>
<td>.68 +/- .17</td>
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KEYWORDS: Ischemia, Postprocessing, Stroke
L Kirk¹, A Krishnan¹, R Silbergleit¹, S Margiewicz¹
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Purpose
Parenchymal hemorrhages including micro-hemorrhages are a known finding in traumatic brain injury and frequently accompany diffuse axonal injury. As a result, their detection is important, especially as a prognosticator. These hemorrhages are detected best by MR imaging (MRI) sequences optimized in assessing the susceptibility difference between blood products and neighboring tissue. A commonly used sequence is the T2* gradient recalled echo (GRE) sequence which allows detection via the "blooming" effect of blood products. Increasingly, studies have looked into methods such as susceptibility-weighted imaging (SWI), as well as scanning with higher magnetic field strength, to improve detection of hemorrhages. We however attempted to evaluate a much more common sequence done in all our patients, namely the diffusion-weighted sequence. This echo planar sequence is a routine sequence in most centers and is extremely fast. The B0 part of this sequence (routinely obtained and utilized in determination of the apparent diffusion coefficient) is often referred to as "poor man's version of susceptibility". Our aim was to compare this routine B0 sequence with the T2* GRE sequence in detection of parenchymal hemorrhages in patients with trauma. Our hypothesis was that the routine B0 sequence detected many of the hemorrhages.

Materials and Methods
The study was approved by our institution's Human Investigation Committee. MR imaging brain studies performed for trauma at our institution, from January 1, 2010 to October 4, 2013 were reviewed for the presence of intraparenchymal hemorrhages. Fifteen consecutive post-traumatic brain MRI studies were selected that had diagnostic T2* GRE and diffusion-weighted images (DWI) and demonstrated intraparenchymal hemorrhages. An additional 15 patients scanned in the same time frame and with similar scanning technique (1.5 T) with MRI images not demonstrating parenchymal hemorrhages were used as controls. The B0 map images and T2* sequences were separated from the rest of the study and were anonymized and randomized. In order to prevent bias, the randomized B0 images of the 15 patients and 15 controls were first reviewed by a CAQ neuroradiologist with over eight years of experience. The images were reviewed to identify if hemorrhage was present and the number and sites of hemorrhage. Confidence of the reviewer also was recorded (questionable lesions marked separately from definite lesions). In a similar fashion the T2* images of the 30 study patients also were reviewed.
The data then were analyzed by a bio-statistician. The original studies including other relevant sequences also were reviewed.

Results
The B0 was a fairly good surrogate test for the presence of hemorrhage. Using the T2* sequence as the "gold standard", the sensitivity to detect hemorrhage on the B0 map was 80% with a p-value of 0.352 and the specificity was 93% with a p-value of <0.0001. The positive predictive value was 92% with a p-value of 0.0034 and the negative predictive value was 82% with a p-value of 0.0127. The accuracy was 87% with a p-value of<0.0001. However, the B0 underestimated both the number and location of hemorrhagic lesions and only on three of the cases was the correct number of hemorrhages seen on the B0 map. In particular, the B0 map was poor in detecting hemorrhages in the corpus callosum and brain stem.

Conclusions
In conclusion, while the B0 map is sensitive in detecting hemorrhages, it underestimates both the number and locations of hemorrhages. The B0 map was limited especially in detecting hemorrhages in the corpus callosum and midbrain, which are both important sites in grading diffuse axonal injury. This is understandable as other studies have demonstrated that even T2* GRE imaging is deficient as compared to 3D SWI in detection of hemorrhages of the corpus callosum. Distortion and less prominent "blooming" artifacts made detection of hemorrhages more difficult on the B0 EPI sequence. Therefore, while the B0 sequence does detect hemorrhage, it cannot replace the T2* sequence in accurate staging and evaluation of hemorrhage in trauma.

KEYWORDS: Diffusion-Weighted Imaging, Hemorrhage, Traumatic Brain Injury

P-01

Can Permeability Imaging be Another Predictor to Assess Leptomeningeal Collateral Flow in Patients with Severe Intracranial Arterial Stenosis: A Pilot Study.

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Purpose
Leptomeningeal collaterals are anastomotic vessels, which provide cerebral blood flow if primary collateral flow is insufficient. At present, digital subtraction angiography (DSA) remains the method that can best measure collateral extents, but it is relatively time-consuming, invasive, and costly. Leptomeningeal anastomotic vessels due to chronic hypoperfusion are accompanied with new vessel formation as transferal anastomoses. These immature vessels are more likely absent of vessel stabilization and have incomplete blood-brain barrier (BBB). Permeability imaging could be a promising tool to investigate leptomeningeal collaterals indirectly.

Materials and Methods
Seven adult patients with severe intracranial arterial stenosis or occlusion were included. All patients underwent a complete MR stroke imaging workup. MR imaging (MRI) included these sequences: conventional sequences, ASL, and DCE T1. Ktrans maps from DCE T1 were derived according to the method described in detail by Johnson et al (5). All patients also received CTA
and DSA. Collateral flow assessments on DSA, Ktrans maps, ASL, CTA-SI were evaluated using a grading system at 15 anatomical sites based on regional vascular territories. Statistical analyses on the diagnostic information of Ktrans maps, ASL, and CTA-SI comparing with DSA respectively were performed using contingency test. McNemar-Bowker test and Kappa coefficient were calculated from a $\chi^2$ statistics with SPSS.

Results
Of seven patients, three presented with unilateral MCA stenosis or occlusions, two with unilateral distal internal carotid artery stenosis or occlusions, and two with multiple intracranial arterial stenosis. A reasonable contingency was found between DSA and Ktrans maps if all 15 sites included (Contingency coefficient, Kappa=0.502, estimated P<0.001). When 10 sites (A1-2; M1-6; P1-2), but without perforating territories, were included, better contingency was found after separation between cortical and perforating arteries (Kappa=0.766, estimated P<0.001). The contingencies between CTA-SI and DSA were not good on all 15 sites (Kappa=0.413, estimated P<0.001) and 10 sites (Kappa=0.329, estimated P<0.001). Our results showed the worst contingencies between ASL and DSA. One case example was used to illustrate our result.

Conclusions
Collaterals can provide alternate routes for circulation, both acutely and progressively when an artery is occluded pathologically. It preserves perfusion and stabilizes cerebral blood flow in acute occlusion and chronic atherosclerosis. But no ideal or specific imaging modality is available for demonstration and accurate measurement of leptomeningeal collateral flow. Angiogenesis is a complex triggered by hypoxia that consists of the sprouting of new blood vessels from pre-existing vascular structures. It is correlated with the development of leptomeningeal anastomosis and can be detected by permeability imaging. In our study, we investigate the consistencies of the results in DSA, CTA-SI, ASL, and Ktrans maps. We find Ktrans maps have the best consistency with the collateral score in DSA, especially those patients who have multiple occlusion sites and complex collateral flow. Higher Ktrans signs may indicate better collateral flow. More specifically, Ktrans maps seem more sensitive to LMF. Further studies are needed to investigate its validity in a large registry of patients.

KEYWORDS: Collateral Circulation, Intracranial Steno-Occlusive Disease
Carotid Plaque Ultrasonography and Stroke Risk: A Systematic Review and Meta-Analysis.

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Purpose
Ultrasound-based characterization of carotid plaque composition has high accuracy compared to histopathology and recently has been studied as a potential tool to predict ischemic events in carotid atherosclerotic disease. Echolucency (EL) and plaque heterogeneity (PH) are two commonly studied characteristics of plaque morphology. We've initiated a systematic review and meta-analysis to summarize the association between these two plaque characteristics and future ischemic events in patients with carotid atherosclerotic disease.

Materials and Methods
We performed a comprehensive literature search evaluating the association of ultrasound-based characterization of carotid plaque composition with stroke. The included studies were prospective or retrospective studies examining EL and PH with mean follow-up of at least one year assessing for development of ipsilateral ischemic event [stroke or transient ischemic attack (TIA)]. Pooled hazard ratios (HR) for EL and PH as predictors of future stroke/TIA will be determined.

Results
Of the 4250 manuscripts screened five have met eligibility for systematic review including a total of 3276 patients. Four of the manuscripts studied EL and three studied PH. All but one study are prospective. Either (or both) EL and PH was associated with higher rates of downstream ischemic events in all of the eligible studies included to date.

Conclusions
The presence of EL and PH in carotid plaque increases the risk of future ipsilateral ischemic event in patients with carotid atherosclerotic disease. Dedicated imaging to characterize plaque composition may offer information beyond luminal stenosis to further risk stratify patients with carotid atherosclerotic disease.

KEYWORDS: Carotid, Cerebrovascular Disease, Ultrasonography

P-08  
6:30AM - 9:00PM

Cerebral venous thrombosis as a rare cause of subarachnoid hemorrhage: case report and literature review

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Purpose
The clinical diagnosis of cerebral venous thrombosis (CVT) can be difficult because of a wide spectrum of clinical presentations and variable etiologies. The diagnosis of CVT is complicated further when patients initially present with subarachnoid hemorrhage (SAH). Our objective is to discuss the role of imaging for diagnostic work-up of SAH in the setting of CVT with the literature of documented cases and to summarize the possible pathophysiologic mechanisms.

Materials and Methods
We performed a literature review of the presentation of CVT with SAH. In addition, we reported a 48-year-old woman presenting with SAH as the first manifestation of superior sagittal sinus thrombosis.
Results
In a review of 38 articles with a total of 73 cases, the distribution of SAH associated with CVT was different from that of SAH with arterial origin, which usually was seen at the cerebral convexities sparing the skull base and basal cisterns. The most commonly involved sinus was superior sagittal sinus and usually associated with SAH at the frontoparietal convexity, interhemispheric fissure, and sylvian fissure. Subarachnoid hemorrhage usually was adjacent to the thrombosed venous structures. Therefore, the most possible explanation seems to be the rupture of dilated cortical veins due to extension of thrombosis and subsequent venous hypertension. Nonenhanced CT was effective for the diagnosis of SAH in 91% of the cases and for the diagnosis of CVT in only 32%. Hemorrhagic infarct, edema, and parenchymal hemorrhage were the most commonly associated findings that were detected in 33 (45%) of the 73 patients.

Conclusions
Cerebral venous thrombosis presenting with SAH is rare. Because the clinical management of this presentation is quite different from that of arterial SAH, CVT should be considered especially when SAH is limited to cerebral convexities and imaging with MRI and MR venography should be included in the diagnostic workup of SAH.

KEYWORDS: Cerebral Venous Thrombosis, Hemorrhage, MR Venography
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Purpose
Primary lateral sclerosis (PLS) is a form of motor neuron disease characterized by progressive spasticity and weakening of voluntary muscles caused by the relatively selective degeneration of corticospinal neurons. Resting state functional magnetic resonance imaging (RS-fMRI) and diffusion tensor imaging (DTI) are methods for assessing functional and structural brain networks. To assess whether PLS patients demonstrate increased or decreased connectivity, RS-fMRI and DTI studies were obtained on a group of PLS patients and compared to age-matched healthy controls.

Materials and Methods
Fourteen healthy controls and 19 PLS patients (16 with RS-fMRI and 19 with DTI studies) were included in this study. Network analysis was conducted in two ways. First, functional connectivity was calculated for each voxel by extracting its time series and then correlating it with all other voxels' time series. The individual maps were averaged within each group and compared using t-tests. The results then were cluster size corrected for multiple comparisons (p<0.005) and regions surviving correction then were used as individual seeds to find other functionally connected areas in order to generate a functionally connected brain network, eg., data-driven approach. Region x region correlation matrices were then calculated for patients and healthy controls and were compared using a t-test to assess connectivity differences. The second, structural DTI connectome, where 108 cortical nodes were defined with the AAL template and edges were defined with probabilistic tractography. The resulted connectivity matrices, were compared between groups with network-based-statistics (NBS), which can detect interconnected sub-network as a whole.

Results
Primary lateral sclerosis patients had increased functional connectivity in both motor and extra-motor brain regions compared to healthy controls. A total of 12 distinct regions were found that contributed to this increase in connectivity. These areas then were sorted into three separate clusters of regions using a k-means clustering algorithm. The most prominent cluster contributing to the increases in functional connectivity included the right and left cerebellum as well as the right middle temporal and superior frontal gyri. Areas from this cluster showed a significant increase in connectivity with regions from the other clusters including bilateral premotor cortex and supplementary motor areas, right putamen, and the middle cingulate gyrus. Network-based-statistics identified three structural networks with higher connectivity in PLS patients compared to controls (p<0.05). The first network included fronto-parieto-cerebellar regions. The second, right interhemispheric, included frontal/precentral-cerebellar regions, and the third, included posterior-parietal-cerebellar regions.

Conclusions
In PLS patients, changes in functional and structural connectivity occur among brain regions outside the motor cortex, such as the cerebellum, putamen, fronto-parietal and temporal gyri, that often are overlooked in motor neuron disease. We observed a good correspondence between the structural and functional networks. Increased connectivity in these regions may suggest plasticity
in which other motor regions are now accounting for functions previously attributed to the primary motor cortex. Alternatively, the increased connectivity may be due to widespread reduced intra/inter-hemispheric inhibition due to the degeneration of inhibitory interneurons.

KEYWORDS: Functional Networks, Network Anatomy, Neurodegenerative

P-17
6:30AM - 9:00PM

Combined evaluation using noncontrast CT ASPECTS and CT angiography collaterals improves clinical detection of large DWI infarcts

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Purpose
Diffusion-weighted imaging (DWI) is the most accurate technique for delineating acute infarct core. Large DWI infarct volume (>70 cc) is associated with poor outcome despite treatment, and has been used as a treatment exclusion criterion. CT is more widely available than MRI, but suffers from poor sensitivity for infarct detection. We sought to determine whether a combined approach using noncontrast CT (NCCT) and CT angiography (CTA) improves prediction of large DWI infarcts.

Materials and Methods
In a single-center, retrospective study, we identified consecutive acute ischemic stroke patients with anterior circulation proximal artery occlusions who underwent both CT and MRI. Patients were categorized into two groups based on DWI lesion volume (≤ versus >70 cc). Because patient exclusion from treatment requires high certainty for the presence of a large infarct, we utilized thresholds previously reported to have high (>95%) specificity for DWI infarct volume >70cc for NCCT ASPECTS (scores 0-4) and CTA collateral evaluation (malignant collateral profile: absent collaterals in >50% of MCA M2 division territory). We determined the test characteristics of these prespecified thresholds in this dataset, and evaluated whether these thresholds in combination would improve the diagnostic yield for identifying patients with large infarcts.

Results
Fifty-five patients satisfied study criteria. The mean patient age was 66.9 ±15.2 years. Fifty-four percent of patients were male and 41.8% of strokes were right-sided. The median NIH Stroke Scale (NIHSS) was 14 (IQR 6-18). Eighteen of 55 patients (32.7%) were treated with intravenous (IV) tissue plasminogen activator (tPA) alone, 14 with intra-arterial (IA) with or without IV tPA, and 23 (41.8%) without any treatment. At three months the median modified Rankin Scale (mRS) was four(0-6). Thirty-two of 55 (58.1%) patients had good outcome (mRS>2). The median NCCT ASPECTS was eight (2-10). Of the 55 patients eight (14.5%) had ASPECTS 0-4. The median CTA collateral score was two (1-3); nine cases (16.4%) were categorized as CS=0. In combined approach, 12 (21.8%) patients belonged to collateral score =0 or ASPECTS =0-4. They had larger admission DWI infarct volumes and worse outcomes (3-month mRS) (P<0.001, P=0.002 respectively), whereas there were no significant differences in age, sex, side of infarct, treatment and the time between ictus and CTA. Fifteen (27.2%) patients had a baseline DWI infarct volume >70 cc. Of the 15 patients with large DWI infarcts, seven
were missed using each threshold alone, while only four were missed using the combined thresholds. ROC analysis demonstrated high specificity of the CTA malignant collateral profile (97.5%) and ASPECTS 0-4 (100%) for determining DWI lesion volume >70 cc, but both of these methods suffered from poor sensitivity (both 53.3%). In the combined approach, the sensitivity improved significantly to 73.3%, while maintaining a high specificity (97.5%). The area under the curve (accuracy) of the combined methods increased dramatically to 0.854 (P<0.001).

Conclusions
Combining NCCT and CTA collateral evaluation improves the sensitivity for identifying patients with large DWI infarcts while preserving the high specificity required for treatment exclusion.

KEYWORDS: Acute Stroke, ASPECTS, Contrast-Enhanced CT

**Table: Analysis for combined approach**

<table>
<thead>
<tr>
<th></th>
<th>Total (n=55)</th>
<th>Collateral score =0 or ASPECTS 0-4 (n=12)</th>
<th>Collateral score &gt;0 or ASPECTS &gt;4 (n=43)</th>
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</thead>
<tbody>
<tr>
<td>Age mean±SD</td>
<td>66.9±15.2</td>
<td>68.3±13</td>
<td>66.5±15.8</td>
</tr>
<tr>
<td>Sex (male), n(%)</td>
<td>30(54.5)</td>
<td>7(58.3)</td>
<td>23(53.4)</td>
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<tr>
<td>Stroke laterality (Rt)</td>
<td>23</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Onset to CTA (min)</td>
<td>228.6±107.5</td>
<td>248.5±74.9</td>
<td>223±115.1</td>
</tr>
<tr>
<td>NIHSS score median(IQR)</td>
<td>14 (6-18)</td>
<td>18(14-23)</td>
<td>11(5-17)</td>
</tr>
<tr>
<td>DWI lesion volume</td>
<td>57.7±79.8</td>
<td>166.8±107.3</td>
<td>27.3±28.9</td>
</tr>
<tr>
<td>DWI&gt;70 mL, n(%)</td>
<td>15 (27.2)</td>
<td>11 (91.6)</td>
<td>4(9.3)</td>
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<tr>
<td>3-month mRS median(IQR)</td>
<td>4(1-5)</td>
<td>5(3.2-6)</td>
<td>2(1-5)</td>
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<tr>
<td>mRS&gt;2, n(%)</td>
<td>32(58.1)</td>
<td>11(91.6)</td>
<td>21(48.8)</td>
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<tr>
<td>Tx (IV,IA±IV,None)</td>
<td>(18,14,23)</td>
<td>(6,1,5)</td>
<td>(12,13,18)</td>
</tr>
</tbody>
</table>
Comparison of Quantitative versus Qualitative Evaluation of MR Perfusion Images in Acute Stroke
Purpose
Stroke is a leading cause of morbidity and mortality world over. Qualitative evaluation of MR perfusion to demonstrate salvageable ischemic penumbra has been used to guide clinicians in deciding interventional management options beyond iv TPA. However, the role of "penumbra imaging" in management of stroke is an area of current debate. This study aims to compare the quantitative mismatch measurement vis-a-vis visual qualitative interpretation by radiologists and thus ascertain the reliability of qualitative interpretation.

Materials and Methods
This IRB approved, retrospective study will analyze data from 200 consecutive patients presenting with clinical diagnosis of stroke to our radiology department over a period of five years (2008-2013) with available emergent MRI including perfusion-weighted imaging (PWI). Only patients with a clinical diagnosis of acute ischemic stroke after excluding patients with hemorrhage are included in the study. Perfusion-weighted imaging sequences were reanalyzed for the purpose of this study using the FDA approved Olea software. Imaging was done in clinical 1.5 and 3 T scanners including T1- and T2-weighted spin echo, FLAIR, gradient echo, and EPI DWI (b values of 0 and 1,000) and dynamic susceptibility PWI sequences. Stroke volume was measured on diffusion-weighted imaging with a cut-off ADC value of 0.6 mm²/s. For measuring perfusion abnormality, a Tmax value of 6 sec was considered as lower limit of normal. A significant quantitative diffusion-perfusion mismatch was defined as mismatch ratio (ratio of perfusion abnormality volume to lesion volume on ADC) of > 1.5. The results were compared with visual qualitative dichotomized interpretation of the Tmax and ADC color maps into either significant mismatch or no mismatch. The quantitative mismatch calculation was used as gold standard with a cutoff value of 1.5.

Results
In our initial evaluation of 50 patients, four patients were excluded because of poor quality motion degraded study. Out of the 46 patients (24 females and 22 males; mean age: 72.4 years; range 29-97 years) with acceptable imaging quality, the following results were obtained: 1. Twenty-three patients (50%) were interpreted to have qualitatively positive mismatch. 2. Twenty-two patients (47.8%) were interpreted to have quantitatively positive mismatch (mismatch ratio >1.5). 3. Four patients out of 23 patients with qualitative mismatch did not have significant quantitative mismatch. (False positives = 17.39%). 4. Five patients out of 23 patients with no significant qualitative mismatch were indeed found to have quantitative mismatch. (False negatives = 21.74%).

Conclusions
Initial results suggest that qualitative interpretation leads to false positive interpretation of mismatch in approximately 1 of 6 cases. Also qualitative interpretation missed almost 1 of 5 cases of quantitatively significant mismatch. We wish to further evaluate our data of 200 patients to attain statistical significance to our preliminary results and to determine the clinical relevance of this discrepancy between qualitative and quantitative evaluation of PWI. On the basis of initial results, we propose that quantitative interpretation should be undertaken to reduce false positive as well as false negative results.
Comparison of Whole Brain Perfusion Computed Tomography Performed on 320-Detector Row CT with Diffusion-Weighted Imaging for Evaluation of Acute Infarct.

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Purpose
We aim to compare sensitivity of acute infarct as detected on 320-detector row whole-brain perfusion CT with diffusion-weighted magnetic resonance imaging (DWI). To our knowledge, this is the first study done comparing 320-detector row brain perfusion CT to conventional DWI.

Materials and Methods
In this retrospective study, 149 patients with symptoms suggestive of acute stroke were evaluated using whole brain perfusion CT and DWI. All patients underwent 320-detector row dynamic volume CT angiogram with slice thickness of 0.5 mm and gantry rotation time of 350ms. Cerebral blood flow thresholds were used to delineate the ischemic lesion, penumbra, and infarct. Magnetic resonance imaging (MRI) studies were performed within 48 hours symptoms onset and results were correlated with perfusion CT.

Results
Eighty of the 149 (54%) patients were found to have either an ischemic or hemorrhagic infarct. Sixty-nine of 149 (46%) patients had ischemic infarct as confirmed by DWI and 65 of 149 (44%) were detected on perfusion CT. Forty percent were transcortical infarcts all of which were seen on both DWI and perfusion CT. Nine of 149 (6%) were lacunar infarcts, which were all detected on DWI. However, only five of nine (56%) lacunar infarcts were seen on both perfusion CT. Perfusion CT had sensitivity of 94% for detection of all ischemic infarcts (including lacunar). Sensitivity of transcortical infarct detection was 100% and sensitivity for lacunar infarcts was 56%. Eleven of the 149 (7%) patients had hemorrhagic infarct. Ten of these 11 (91%) patients showed associated perfusion CT defect. Eight of the 149 (5%) patients did not have any significant DWI abnormalities noted; however, these patients had perfusion CT defects noted which corresponded to patients' symptoms.

Conclusions
Detection of acute transcortical infarct on dynamic volume whole brain CT perfusion images is equivalent to DWI with sensitivity of 100% and negative predictive value of 100%. The detection of lacunar infarcts is lower with sensitivity of 56%. Additionally, perfusion CT appears to detect perfusion defects which do not have correlative DWI abnormality. These findings are suggestive of vascular insufficiency to the brain analogous to that seen in unstable angina where decreased tissue perfusion leads to symptoms and perhaps can be a sign of impending stroke.

KEYWORDS: Hemorrhage, Infarct, Ischemia

Total Cases
4D-CTA Findings

Ischemic infarct

Ischemia without infarct (Perfusion+ MRI -)*

Hemorrhagic infarct

Hemorrhagic infarct with perfusion defect

Lacunar infarct

Infarct missed on CT

Total Lacunar Infarct

Lacunar Infarct seen on CT and MRI

Lacunar infarct only seen on MRI
Correlation of Abnormal Diffusion Properties with Regional Volume Reduction: In Temporal Lobe Epilepsy with Unilateral Hippocampal Sclerosis

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Purpose
The most commonly described pathology in temporal lobe epilepsy (TLE) is hippocampal atrophy. However, there is evidence for more widespread damage in the mesial temporal lobe and the limbic network involving the amygdala, the entorhinal cortex, the fornix and the thalamus. In patients with TLE with hippocampal sclerosis (HS), analysis of diffusion tensor imaging (DTI) data provides some indirect radiologic evidence of microstructural changes. We investigated whether the volume changes in mesial TLE could be correlate with water diffusion abnormalities by means of voxel-based DTI analysis.
Materials and Methods
The study population included 19 patients (13 women and 6 men; mean age, 34.1 ± 10.3 years, range 15–48 years) with mTLE (left TLE/right TLE, 12:7) who were undergoing video-EEG monitoring for presurgical evaluation at the epilepsy monitoring unit of St. Mary's Hospital of Korea. The identification of the epileptogenic focus was based on seizure semiology and prolonged ictal and interictal vEEG in all patients. These patients had evidence of unilateral hippocampal sclerosis (TLE-HS) based on the qualitative MR imaging (MRI) assessment of hippocampal atrophy on T1-weighted images and a high signal on T2-weighted or FLAIR images. All patients had been seizure free for ≥24 h before the MRI. The age at onset of epilepsy is 17.1 ± 10.7 years and the duration of epilepsy is 17.0 ± 10.4 years. MR scanning was performed using a 1.5 T magnet. Axial T2-weighted and coronal FLAIR images, and diffusion-tensor images also were acquired.

Results
No brain area showed abnormal diffusion properties correlation with regional volume reduction in right TLE patients. No significant region correlated between diffusion property change and the regional volume change of entorhinal cortex and fornix in left and right TLE patients. Brain area showed reduced FA value correlation with decreased amygdala, hippocampal and thalamic volume in left mTLE. These areas were left cingulate gyrus.

Conclusions
Our results demonstrate that water diffusion abnormalities of left cingulate gyrus is correlated with the left amygdala, hippocampal, and thalamic atrophy in the left mTLE. The present data show that volume loss in left mTLE is associated with a widespread limbic systems atrophy. These findings are helpful to better understand the functional deficit and reorganization often found in temporal lobe epilepsy and also will provide a basis to assess neural plasticity in the limbic system for those patients who will undergo curative temporal lobe surgery.

KEYWORDS: Diffusion Tensor Image, Temporal Lobe Epilepsy
Figure.

(A) Brain area showed reduced FA value correlation with decreased amygdala volume of left mTLE (P<0.051 (unc), Extent threshold k=50 voxels)

(B) Brain area showed reduced FA value correlation with decreased hippocampal volume of left mTLE (P<0.051 (unc), Extent threshold k=50 voxels)

(C) Brain area showed reduced FA value correlation with decreased thalamic volume of left mTLE (P<0.05 (unc), Extent threshold k=50 voxels)
Decrease of Hounsfield Units on CTA in Acute Stroke as a Possible Predictor of Final Brain Infarct: A Retrospective Quantitative Study

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¹Christiana Care Health System, Newark, DE

Purpose
A subtle decrease of attenuation on unenhanced CT (NCT) in acute stroke is considered an early sign of acute infarct, but often can be subtle to be well seen. The decrease in attenuation on CT angiography (CTA) is usually more conspicuous, probably reflecting the combination of early cytotoxic edema and decreased capillary filling in the affected area (1). We theorize that the degree of decreased Hounsfield unit (HU) in the affected area may predict final brain tissue infarct.

Materials and Methods
Fifty-three consecutive subjects who had acute occlusion of M1 segment of the middle cerebral artery (MCA) on CTA from 2009 to 2013 were included in the study. Final infarct area was determined on diffusion-weighted MR images (DWI) obtained within 10 days of initial CTA. The final infarct area was measured on a slice with the largest infarct area on DWI, which was used as a reference to determine the corresponding slice and areas of interest on the initial NCT and CTA exams (2). The area of infarct was traced using the free-hand drawing tool on both the infarcted and the contralateral side of the brain to obtain average HU. The Hounsfield unit also was calculated in a noninfarcted area of both MCA territories as a control.

Results
The mean HU decrease in the area of infarct compared to the contralateral side was 6.13 +/- 3.45 (14.6%) for CTA, and 1.76 +/- 1.49 (4.9%) for NCT, statistically significant for both (P < 0.01) (Figure 1). There is a significantly higher percentage of HU decrease on CTA as compared to NCT (P < 0.001), while no significant difference of HU is present for the control areas in both MCA territories (P = 0.45).

Conclusions
Both the NCT and CTA demonstrate significant decrease in mean HU in the areas of final infarct as compared to the contralateral side. CT angiography has significantly higher sensitivity when compared to NCT. A significant relative decrease of HU on CTA (approximately 15%) may serve as a measurable parameter to predict final infarct, which could provide additional useful information for the management of acute stroke.

KEYWORDS: CTA, Hounsfield, Stroke
Purpose
Common diagnostic modalities for intracranial and extracranial dissecting aneurysms include digital subtraction angiography (DSA) as a gold standard, computed tomography (CT), CT angiography (CTA), magnetic resonance Imaging (MRI) and MR angiography (MRA). It was suggested that the diagnosis of arterial dissections is likely to increase in the next future due to more available and sensitive neuroimaging techniques. The assessment of the incidence as well as the diagnostic and treatment modalities available for dissecting aneurysms is therefore advised. In this study, particular attention is given to high resolution CTA as a newly available diagnostic technique compared to other commonly used radiological modalities.

Materials and Methods
We retrospectively reviewed the charts of all patients referred or diagnosed with aneurysm at the Department of Neuroradiology of the Montreal Neurological Institute and Hospital from 1997 to 2013 in order to select cases presenting with intracranial and extracranial dissecting aneurysms.
We systematically recorded demographic, clinical, radiological and treatment data for each patient.

Results
We identified 28 (3.3%) cases of intracranial and extracranial dissecting aneurysms among 832 cases of aneurysms from 1997 to 2011. The annual incidence of dissecting aneurysms went from four cases or less from 1997 to 2009 to seven cases in 2010 (p < 0.0005). There were respectively five, one and two new cases in 2011, 2012 and 2013. In 2010-2013, the major proportion of diagnoses were made with new generation CTA (8/15; 53.3%) followed by DSA (5/15; 33.3%). Stenosis, vascular irregularity, thrombotic occlusion, saccular dilation, double lumen and calcifications are common morphologic features of dissecting aneurysms that were depicted clearly with CTA. With regards to treatment, a total of 20 (20/34; 58.8%) patients with dissecting aneurysms were treated surgically. These include three (3/10; 30.0%) of the subjects diagnosed with CTA and 17 (17/24; 70.8%) of those diagnosed with other radiological techniques. The average duration of clinical and radiological followup was 19 months (range from 16 to 22 months). After followup, none (0/3) of the patients previously diagnosed with CTA who underwent surgical treatment had a recurrence and none (0/7) of the patients who were only scheduled for clinical and radiological followup had a complication. In the group of patients diagnosed with DSA, MRI, MRA and CT, 35.3% (6/17) of the patients treated surgically had a recurrence and 14.3% (1/7) of those followed up without surgical management had a complication.

Conclusions
In the context of an increased diagnosis of dissecting aneurysms, our study underlines the usefulness and growing importance of noninvasive diagnostic techniques, such as CTA. As expected, dissecting aneurysms diagnosed with CTA are less likely to exhibit a complicated morphology and often do not require a prompt treatment, thus reflecting the less severe and urgent clinical presentation of the patients diagnosed with techniques other than DSA.

KEYWORDS: CT Angiogram, Dissecting Aneurysm

P-34
6:30AM - 9:00PM

Dual-Phase FDG-18 PET Brain Imaging to Evaluate Disease Progression vs. Pseudotumor: Do We Change Clinical Management?

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Purpose
Aggressive intracranial neoplasms often are treated with debulking, radiosurgery, and chemotherapy with close followup to exclude disease progression. The differentiation of a recurrent or progressive tumor from radiation necrosis often is a radiologic dilemma. Early work shows the utility of immediate and delayed PET imaging in potentially differentiating disease progression (wherein neoplastic cells show further radiotracer uptake on latter scans) from radiation-induced pseudotumor. We set out to determine whether clinical management changed based on our radiographic findings.
Materials and Methods
We reviewed the clinical course of 16 adult patients with prior resection of aggressive primary and secondary intracranial neoplasms who had immediate and delayed F-18 FDG PET imaging. All studies utilized standard brain PET/CT protocol at our institution with 10-12 mCi F-18 FDG, performed on a Siemens Biograph or Phillips Gemini PET/CT scanner. Volumetric SUV measurements were obtained on the affected post-resection side and on the contralateral normal side at two timepoints at baseline and four hours using Vitrea software. We hypothesized that the difference in max SUV between timepoints as a percentage of initial max SUV value on affected side of the brain should be within 25% of the change on contralateral side. If the affected side increased greater than this cutoff or decreased less than contralateral brain region by over 25% we correlated this "predictor" with the radiologist's actual report. Neurosurgical management was reviewed retrospectively to determine whether any further imaging or surgery resulted from our imaging findings, and relevant pathology reports where applicable.

Results
Progression of disease was reported in seven of 16 patients. In all seven cases management changed, which entailed additional chemotherapy, additional imaging studies sooner than previously planned, or consultation for surgery or gamma knife. In all seven cases clinical findings or surgical pathology supported the radiologic conclusion. Of the nine of 16 patients reported to have no progression of disease, all were found to be stable on a subsequent imaging study performed at an interval determined before the PET/CT examination. Additional analysis of maximum SUV value in the post-treatment region of brain and corresponding contralateral region of brain at both timepoints correctly predicted progression in five patients, failing to identify two cases, and would incorrectly raise concern for progression in two patients with no visual evidence for disease progression.

Conclusions
Findings do suggest that radiologist interpretation of dual-phase PET/CT is a powerful tool in distinguishing progression of disease from pseudoprogression. Our analysis of maximum SUV value in the post-treatment region of brain and corresponding contralateral region of brain at both timepoints was less sensitive and specific than radiologist interpretation alone. The ability of the radiologist to detect abnormally enhancing or hypermetabolic tissue within or at the margins of resection bed is superior to any fixed mathematical criteria in our experience. We will continue to assess the utility of this modality in future patients.

KEYWORDS: PET/CT, Pseudoprogression
Dynamic Contrast-Enhanced Perfusion MRI to Differentiate Recurrent Malignant Glioma from Radiation Change: Whole Volume or Peak Enhancement, Which Is Better?

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Purpose
It is difficult to differentiate recurrent tumor or post-treatment changes in patient of malignant glioma while enhancing lesions show up during follow-up MR imaging (MRI). The purpose of this study is to evaluate the diagnostic ability of dynamic contrast-enhanced (DCE) MR angiography (MRA) for post-treatment glioma and to test which measurement method reflects the clinical condition well.

Materials and Methods
From 2011 to 2013, patients diagnosed as high grade glioma pathologically received follow-up MRI after treatment for more than three times, were recruited. Dynamic contrast-enhanced MRI was performed on a 1.5 T MRI. The patients were divided into two groups, progression and radiation change, according to clinical, radiological and pathological results. Permeability parameters from the whole tumor volume and from the peak enhancing foci of the lesion were
recorded. Mann-Whitney U test was used to evaluate the difference between two groups and receiver operating characteristic (ROC) curve was applied to compare the diagnostic accuracy with two methods.

Results
In our study, there are 10 patients with disease progression and the other five patients with radiation change. Peak Ktrans (P=0.024) and whole volume Ktrans (P=0.005) show significant difference between disease progression and radiation change. Peak Ve show significant difference (P=0.05) between two groups, but not the whole volume Ve. By using ROC curve, the cut-off value for peak Ktrans and whole volume Ktrans is 66.38 and 47.49 with sensitivity, specificity, and area under curve about 100%, 100%, 1 and 90%, 100%, 0.983, respectively.

Conclusions
Dynamic contrast-enhanced MRI is feasible to differentiate recurrent tumor from radiation changes in patient with high grade glioma. The measurement of peak enhancing area reflects the clinical condition as well as compared with measuring of whole tumor.

KEYWORDS: Dynamic Contrast-Enhanced MR, Glioma Recurrence, Permeability MR Imaging
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Purpose
Recent studies have demonstrated the utility of thin-section noncontrast CT (NCCT) images for visualizing the hyperdense vessel sign (HDVS) and measuring the hyperdense clot length of CT angiography (CTA)-confirmed proximal artery occlusions of the anterior circulation. However, no studies have evaluated whether these thin-section images are sufficient for identifying intracranial vessel occlusion, potentially obviating the need for CTA. We sought to characterize the accuracy of the HDVS on thin-section NCCT for determining the presence of arterial occlusion in acute anterior circulation ischemia.

Materials and Methods
We identified consecutive acute ischemic stroke patients presenting to our institution over a 6-month period (August 2011-February 2012). Inclusion criteria were presumed involvement of the anterior circulation territory and concurrent imaging with CTA and NCCT, the latter having available thin-section images (1.25 mm or thinner) for HDVS determination. Two neuroradiologists, blinded to all clinical information except suspected stroke side, separately evaluated the thin-section NCCT data for the likelihood of a hyperdense clot using the Likert scale (1: definitely absent, 2: probably absent, 3: uncertain, 4: probably present, 5: definitely present). Scores of 4 and 5 were considered positive for the presence of hyperdense clot. The test characteristics of the HDVS for identifying vessel occlusion on concurrent CTA were determined.

Results
There were 115 patients who satisfied study criteria. Mean age was 68.8±16.0 years. Median NIHSS score was 10 (IQR 5-16.5). Vessel occlusions were identified in 60 (52.2%) patients: 13 ICA, 24 M1 MCA, 14 M2 MCA, 4 M3/M4 MCA, and 5 ACA. Hyperdense clots were identified in 55 (47.8%) patients. The sensitivity and specificity of the HDVS were 70% (57-81%) and 76% (63-87%), respectively, for identifying vessel occlusion on CTA. Hyperdense clots were noted in 77% of ICA occlusions, 88% of MCA M1 occlusions, 64% of MCA M2 occlusions, 25% of MCA M3/4 occlusions, and 20% of ACA occlusions.

Conclusions
The hyperdense vessel sign on thin-section noncontrast CT is not sufficiently accurate for identifying intracranial artery occlusions. CT angiography should be performed to assess the neurovasculature in the setting of acute ischemic stroke, and is important when considering patients for possible intra-arterial therapy.

KEYWORDS: Actue Stroke, CT Angiogram, Hyperdense MCA

P-40
6:30AM - 9:00PM

Evaluation of Absolute Brain Temperature Variability in Healthy Adults Using MR Thermometry

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Purpose
Brain temperature in healthy individuals primarily reflects a balance between heat generation from brain metabolism and the dissipation of this heat through cerebral blood flow (1). In disease, an imbalance between cerebral blood flow and metabolic rate, or changes in arterial/core temperature result in local or global changes in brain temperature. The purpose of the study was to characterize the spatial and temporal variability of absolute brain temperature in healthy adults using MR thermometry as a first step toward validating a model of brain temperature that can be applied to neurological diseases.

Materials and Methods
The study was approved by the Research Ethics Board at the Hospital for Sick Children. Four healthy adult males and five healthy adult females (mean age = 26.2 years) were imaged on each of four consecutive days at approximately the same time every day. Body temperature was measured orally before and after scanning. MR imaging (MRI) was performed on a 3T MRI system (Tim Trio, Siemens) using a 12-channel head coil. The scanning protocol included a high-resolution anatomical – T1 MPRAGE (1mm iso; TR/TE/TI/FA=2300/2.96/900/9) and 12 spectroscopy acquisitions – PRESS (20mm iso, TR/TE = 2000/35; 32 averages; Vector = 2048; BW = 1200 Hz; no water suppression) for MR thermometry. MR spectroscopy (MRS) was acquired twice in each of six different regions of interest – left and right posterior frontal centrum semiovale, precuneus and occipital lobe. Water and metabolite peaks were modeled using Lorentzian line shapes following Fourier transformation and zero-order phase correction. Absolute temperatures were calculated based on the proton resonance frequency shift of water relative to reference brain metabolites NAA, Cho, and Cr using a well described methodology (2). Forty-eight temperature estimates were calculated across six brain regions for each of nine subjects. A mixed effects linear regression analysis was employed to evaluate the contribution of subject, visit, and brain region (modeled as random effects) and oral temperature (fixed effect) on brain temperature.

Results
Figure 1 illustrates intra-subject and inter-subject variability in brain temperature. For each subject, the brain temperatures from all brain regions were averaged and plotted for four separate scanning sessions (open circles). The mean of these four measurements is depicted by the horizontal lines and the error bars indicate the standard error. Brain temperature varied significantly across subjects (Friedman Test, p<0.01). For a given subject, the brain temperature changes very little over four consecutive days. These results are confirmed by the mixed effect analysis which showed a larger standard deviation for subject (0.3 C) versus visit (0.09 C). The standard deviation for brain region was 0.11 C indicating a small contribution of brain region to overall brain temperature variability. An analysis for sex also showed a small standard deviation. The t-value for oral temperature was 0.945 and therefore could not account for significant temperature variability.

Conclusions
MR thermometry can provide reproducible measurements of brain temperature. Using this methodology, it is shown that brain temperature does not significantly differ between frontal white matter, precuneus and the occipital lobes. For healthy subjects, brain temperature does not change significantly from day-to-day but measurable differences between subjects are shown. The differences in brain temperature correlate poorly with oral temperature and the reason for the small brain temperature differences between healthy subjects is presently not known. An
explanation for the observed inter-subject temperature variability may ultimately provide validation for a brain temperature model that can be used to diagnose and study disorders of blood flow and metabolism in neurological disease.

KEYWORDS: Brain, Temperature

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Evaluation of MR Angiography Follow-Up of Intracranial Aneurysms Treated with Primary Coiling: Comparison Between Conventional Angiogram, MRA Time-Of-Flight, MRA Contrast-Enhanced and MPRAGE.

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Purpose
MR angiography (MRA) has become used more regularly as a method to evaluate intracranial aneurysms after primary coiling. Digital subtraction angiography (DSA) remains the gold-standard for follow up of these patients, given the concerns for artifactual limitations associated with MRA time-of-flight (MRA TOF) and MRA contrast-enhanced (MRA CE) (1, 2). However, even in the cases where complete aneurysmal occlusion is achieved by primary coiling, it is not uncommon for the aneurysm to recanalize (3). The invasiveness of DSA as a routine assessment tool for the evaluation of coiled aneurysm recanalization stands in contrast with the noninvasive nature of MR. Whether MRA could potentially substitute DSA in the follow up evaluation of patients after primary coiling of intracranial aneurysms remains incompletely evaluated (4). Our goal is to use a large database of patients that have undergone primary coiling of intracranial aneurysms, as well as follow up evaluation with DSA, MRA TOF, MRA CE and MPRAGE sequences to determine whether any or all of these noninvasive methods have the potential to substitute in some cases DSA as the primary method of follow up.

Materials and Methods
We are performing a retrospective study spanning from October 2007 through July 2013 and selected the cases that have only primary coiling, follow up MRA and DSA. Fifty-four patients from this cohort have been identified who meet these criteria and were evaluated. The study includes at total of 63 aneurysms to this point. Our studied patient population consisted of 62% of females and 37% of males, and an average age of 59.2 years (a range of 32-82 years old). In our group of patients, 46% presented with ruptured aneurysms and 54% presented with unruptured. We classified the aneurysms based on location, and found that the most common aneurysms in our study group were anterior communicating artery (27.1%), middle cerebral artery (15.7%) and right internal carotid artery ophthalmic segment (12.9%). MR angiographies were performed on a 1.5 T and 3.0 T scanner and filling was compared to a follow-up DSA. An interventional neuroradiologist interpreted the DSA independently from the two neuroradiologists who independently also evaluated MRA TOF, MRA CE and MPRAGE. Following the Raymond criteria, the aneurysm residual is categorized into one of three classes: 1) complete occlusion, 2) residual neck and 3) residual aneurysm. We calculated sensitivities and specificities for each of the MRA sequences, compared to DSA.

Results
Follow-up digital subtraction angiography (DSA) demonstrated 40 (63.5%) complete occlusions (class 1), 16 (25.4%) residual necks (class 2) and 7 (11.1%) residual aneurysms (class 3). Cases were evaluated by the MRA sequences listed under methods (TOF, CE and MPRAGE). When analyzing the aneurysm residual by MRA TOF, 27 of the occluded aneurysms (by gold-standard DSA) were identified as occluded. The sensitivity and specificity of MRA TOF to accurately identify class 1 aneurysm was 68% and 86%, respectively. In terms of the category of residual
necks (class 2), the sensitivity and specificity of MRA TOF compared to DSA were 64% and 66%. For class 3, MRA TOF had 43% sensitivity and 94% specificity. The calculations of sensitivity and specificity for MRA CE when the aneurysm was completely occluded (class 1 with DSA once again as the gold-standard), revealed a 65% sensitivity and 94% specificity. For class 2 aneurysms, MRA CE had a sensitivity of 73% and specificity of 61%, while class 3 aneurysms demonstrated 20% sensitivity and 93%. The MPRAGE sequence was once more compared to DSA as the gold standard. When the aneurysms were completely occluded (class 1), the sensitivity and specificity of MPRAGE were 72% and 88%, respectively. For aneurysms with a residual neck (class 2), the sensitivity was 70% and specificity was 71%. When the aneurysms had a residual aneurysm that is more than the neck (class 3), the sensitivity and specificity of MPRAGE is 33% and 92%.

Conclusions
Our study included a relatively large number of aneurysms (63). The specificity of all sequences (TOF, CE, and MPRAGE) to detect complete occlusion (class 1) or residual aneurysm (class 3) was very high, in the range 85% (class 1 for TOF versus DSA) to 94% (class 3 for TOF vs DSA). Sensitivity of the modalities was less robust, as described in the results section, mostly in the range of 0.6-0.7, although class 2 (residual neck) demonstrated particularly poor sensitivity across all sequences (0.2-0.4), compared to DSA as gold standard. These findings suggest that MRA TOF, MRA CE and MPRAGE are very reliable (high positive predictive value (PPV) above 0.9) at identifying patients with complete aneurysmal occlusion and may be used to follow a subset of patients after aneurysm coiling. We will continue to evaluate more patients from our database and expand on these findings.

KEYWORDS: Aneurysm Embolization, Aneurysm Rupture, Aneurysm Treatment

P-11

Evaluation of peritonsillar abscess using reconstructed enhanced CT images: classification and lesion extent

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Purpose
Peritonsillar abscess is a commonly encountered emergency in the daily clinical setting. Formation of the abscess beside the tonsillar capsule promotes extension of inflammation into the surrounding tissues, requiring antibiotic administration and/or surgical drainage without delay. In particular, CT images are examined, since in the peritonsillar abscess at the lower pole, inflammation that is difficult to appreciate on inspection may spread downwards and complicate treatment. Few studies have reported on peritonsillar abscess in which the coronal and sagittal images were examined as well. This study is to evaluate the CT findings of peritonsillar abscess, comparing between lower and upper types with reconstructed coronal and sagittal images.

Materials and Methods
We retrospectively studied 100 consecutive case (from August 2008 to August 2013) who had
undergone contrast-enhanced CT and been diagnosed with peritonsillar abscess. Their age ranged from 15 to 84 years (mean 42.0 years), and there were 78 men and 22 women. Contrast-enhanced CT imaging from the skull base to superior mediastinum was begun from 100 sec after contrast administration (2 ml/sec). From these 3D volume transverse images, coronal and sagittal images were reconstructed. On CT, the distance from the hard palate to base of epiglottic vallecula was divided into two, with the peritonsillar abscesses mainly at the upper side classified as the upper-portion type, the lesions mainly at the lower side as the lower-portion type, and lesions that covered both the upper and lower sides as the upper-lower type.

Investigated items included morphology, which was classified into four types: lunar～crescent-shaped, elliptic～circular, lobular, and irregular, largest measured diameter on transverse and coronal and sagittal images and degree of edema.

Results
Peritonsillar abscess was bilateral in six cases, and unilateral in 94 (right; 44 left: 56 cases). Upper-portion type was seen in 51 cases, lower-portion type in 30, and upper-lower type in 13. Mean age of the cases with lower-portion type was higher (51.9 y) than those with upper-portion type (38.4 y). Regarding morphology, in the upper-portion type 68.6% of cases showed a lunar～crescent-shaped or elliptic～circular shape, whereas in the lower-portion type 70.0% showed a lobular or irregular one. Edema was absent or only somewhat present in 78.4% of the upper-portion type, in contrast to being present or marked in 73.3% of the lower-portion type.

Conclusions
By evaluating coronal and sagittal images in addition to transverse ones, the abscess morphology, range of involvement, and degree of edema could be investigated in greater detail. The lower-portion type tended to be more severe, show surrounding edema extending easily to the larynx and hypopharynx, be irregular in shape, and show an irregular lobular border. Reconstructed coronal and sagittal images were useful in evaluating the extent of lesion involvement.

KEYWORDS: Abscess, CT, Oropharynx

P-29 6:30AM - 9:00PM

Fate of diffusion restricted lesions in primary intracerebral hemorrhage

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Purpose
Primary intracerebral hemorrhage (ICH) is associated with greater mortality and more severe neurological deficits than any other stroke subtype. Prior studies have found that lesions with restricted diffusion on diffusion-weighted imaging (DWI) were observed in 13-41% of patients with acute ICH. In this study, we aimed to find out the fate of the DWI lesions in ICH patients and determine whether the presence of DWI lesions is associated with functional outcome in patient with ICH.

Materials and Methods
This prospective study enrolled 153 patients with acute ICH. Baseline MRI scans were
performed within two weeks after ICH for detecting DWI lesions and imaging markers for small vessel disease (SVD). Follow-up MRI scans were performed at three months after ICH for estimating the fate of the DWI lesions. We evaluate the associations between the DWI lesions with several clinical features and functional outcome.

Results
Seventeen of 152 patients (11.1%) had a total of 25 DWI lesions. Factors associated with DWI lesions were high initial systolic and mean arterial blood (MAP) pressure at emergent department, more lowering of MAP within 24 hours, presence of white matter hyperintensity and cerebral microbleeds. Thirteen of 25 DWI lesions (52%) were not visible on follow-up T2-weighted or fluid-attenuated inversion recovery images. An illustrated case of ICH patient with DWI lesion is shown in the figure.

Conclusions
Diffusion-weighted imaging lesions in ICH patients are associated with rapid blood pressure reduction as well as MRI markers of SVD such as cerebral microbleeds and white matter hyperintensity. More than half of the DWI lesions in ICH patients did not leave visible, long-term infarction. The DWI lesion may be regarded as a marker of SVD or a silent ischemia and not always indicates an absolute cerebral infarction or permanent tissue injury.

KEYWORDS: Diffusion MR Imaging, Intracerebral Hemorrhage, Stroke
Getting Off the Couch: CT Head Imaging for the Obese Patient

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Purpose
The increase in obesity in the general population brings more frequent challenges in imaging, as an increasing number of patients exceed the weight or girth limits of existing computed tomogram (CT) scanners. We describe a technique used for plain CT and CT angiogram of the head in the morbidly obese patient.

Materials and Methods
Patients imaged stood behind the CT gantry while bending forward and placing their head, prone in the head holder. The patients were alert, oriented and very cooperative. To better enable the patient to do this, we chose the CT scanner which had a narrower gantry (Siemens Sensation 64). The patients were able to support themselves with strategic placement of their hands on the gantry. The patient was told about the table movement with the scan, and allowed his head to move with the slow movement of the table. The images were acquired in the caudo-cranial direction, with the patient position designated as face down and leg first. Helical imaging was used to reduce motion artifact. Both a CT head and CTA angiogram have been acquired utilizing this method.

Results
The CT head images showed minimal motion artifact but were adequate for the diagnosis of hemorrhage in the suprasellar cistern and anterior interhemispheric fissure, along with a large sellar-suprasellar mass, possibly pituitary macroadenoma, extending towards the left cavernous sinus. The hemorrhage could be secondary to pituitary apoplexy, or could still be aneurysmal. A CT angiogram was felt necessary to answer this question. The table movement and expected sensation during the CT angiogram was discussed with the patients before proceeding. The patient was placed in the same position behind the gantry and intravenous contrast media was injected to acquire the CT angiogram. Timing had to be estimated. The images were suboptimal due to motion artifact. A possible anterior communicating (ACom) artery aneurysm was suspected, which in retrospect was not present.

Conclusions
The current CT scanners have a weight limit of 485 lbs. With the increasing incidence of obesity in North America, we require new imaging solutions for patients who exceed these limits. Our method can be used with existing CT scanners to obtain a plain head CT as well as more elaborate imaging such as CT angiogram of the head. Getting off the couch was the solution to imaging the obese patients and providing information to aid in their healthcare.

KEYWORDS: CT, CT Angiogram, CTA

P-22

Haemorrhage in adult pilocytic astrocytoma; an under-recognised radiological feature

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Purpose
A study of 138 cases of histologically proven pilocytic astrocytomas, which included both pediatric and adult patients, reported hemorrhage on pre-surgical imaging in 11 (8%) of patients (1). This is higher than previously thought. No distinction was made between pediatric and adult cases. This current study aims to assess the radiological presence of hemorrhage in adult pilocytic astrocytoma on pre-operative imaging.

Materials and Methods
Patients with histological confirmation of pilocytic astrocytoma were identified on the neuropathology database. Clinical records were reviewed to identify patients with a de novo pilocytic astrocytoma diagnosis and pre-operative imaging was reviewed to assess for features of recent or previous hemorrhage. The relationship between the location of tumor and hemorrhage also was assessed.

Results
Seventy-six cases of histologically proven pilocytic astrocytoma were identified. Clinical records were retrieved for 52 patients and 46 of these were reported to be de novo pilocytic astrocytomas. Appropriate pre-operative imaging was available for review in 37 cases and 11 cases were found to have evidence of recent or previous hemorrhage. Tumor location (supratentorial versus infratentorial) did not show any difference in rate of hemorrhage.

Conclusions
A significant number of pilocytic astrocytomas show evidence of hemorrhage on pre-operative imaging and this may reflect a difference between adult and pediatric populations. Further work is required to evaluate this.

KEYWORDS: Hemorrhage, Pilocytic Astrocytoma, Prevalence

P-33
6:30AM - 9:00PM

Hemophagocytic Syndrome: Report of 5 cases (Including a Pair of Twins) Admitted to two Brazilian Tertiary Care Hospitals.

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Purpose
Hemophagocytic lymphohistiocytosis (HLH) is a rare and potentially lethal multisystemic disease that affects all age groups and is characterized by fever, splenomegaly, jaundice, pancytopenia, cutaneous rash and pathological findings of hemophagocytosis in the bone marrow and other tissues, including the central nervous system. This condition, which shares features with sepsis and systemic inflammatory response syndrome (SIRS), has received increasing attention in recent years such that 85% of the 1500 or so publications on HLH have appeared in the last decade. This paper aims to present the radiological manifestations of brain disease in five patients (including two twin sisters) with hemophagocytic syndrome and review the available literature on educational purposes.

Materials and Methods
The primary form can be sporadic or familial (genetic or autoimmune), and the secondary form
can be diagnosed in association with infection (Epstein-Barr virus, HHV-6, CMV, bacteria, viruses and parasites), malignancies or prolonged immunosuppression. Clinical manifestations of the disease in the central nervous system are frequent (10-73%), such as seizures, altered level of consciousness, hemiparesis, nuchal rigidity and ataxia, and result from infiltration by lymphocytes and histiocytes. Radiological manifestations are variable and include leptomeningeal or parenchymal involvement, hemorrhage, tissue necrosis and demyelination, which may be represented by diffuse white matter changes, parenchymal atrophy, extra-axial hemorrhages, calcifications and enhancing leptomeningeal, perivascular or parenchymal lesions. Treatment options include chemotherapy, immunosuppression and, eventually, bone marrow transplantation. We review the images of brain disease in five patients admitted to two tertiary care services in the last years.

Results
We present the radiological manifestations of brain disease in five patients (including two twin sisters) and review the available literature on educational purposes.

Conclusions
It is important for the radiologist to be familiar with the diagnostic findings of Hemophagocytic syndrome, since neuroimaging may mimic other diseases and can have patterns that represent a diagnostic challenge, especially in immunocompromised patients.

KEYWORDS: Brain, Inflammatory

P-49

Hippocampal sclerosis of aging may be distinguishable from other causes of dementia with in vivo MRI imaging.

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Purpose
Hippocampal sclerosis of aging (HSA) is a recently described pathological condition associated with dementia in elderly patients (1). Hippocampal sclerosis of aging is diagnosed postmortem by pathologic analysis that demonstrates hippocampal neuronal loss and gliosis out of proportion of Alzheimer (AD) pathology. Patients with HSA are older than patients with other causes of dementia. Previous studies have shown that changes related to HSA can be evaluated in vivo via MR imaging (MRI), with more severe atrophy and deformation of the hippocampus compared to AD (2). Hippocampal sclerosis (HS) is a well known MRI finding in patients with epilepsy, but also can be seen in dementia. The purpose of this study was to assess the prevalence of HS on clinical MRI performed for evaluation of dementia as well as to evaluate distinguishing features between HSA patients and other demented patients.

Materials and Methods
A retrospective review of the patients who received a clinical brain MRI protocol indicated for cognitive impairment showed 129 patients with exams dated from 9/27/2010 to 6/6/2013. Patients were scanned using 1.5 and 3 T scanners with conventional T1- and T2-weighted, 3mm FSE coronal T2-weighted perpendicular to the hippocampus, FLAIR, GRE and diffusion-weighted imaging (DWI) sequences. A clinical and demographic review was performed
excluding patients under age 50 or without a clinical diagnosis of dementia. Fifty-one patients remained after this exclusion. Mean age and gender distribution were 73.4 years, 53% female, 47% male. A review of the MRI images then was performed to evaluate for hippocampal sclerosis (defined by selective atrophy, T2 hyperintensity and loss of internal architecture of the hippocampus) and other findings related to dementia, including hippocampal atrophy, leukoaraiosis, hydrocephalus and subcortical ischemic vascular disease (SIVD) with chronic lacunes. Differences in the subset of patients with HSA in comparison to the larger set of patients with dementia without HSA were assessed.

Results

Of the 51 patients, 10 had findings consistent with HSA on MRI. Four had bilateral HS, while in the remaining six HS was unilateral. Clinical diagnoses of these patients included vascular, AD, mixed, and frontotemporal dementia. The average age of HSA patients was 79.5 years in comparison to 71.9 years in those without HSA. Independent measures t-test assuming unequal variance found a significant age difference (p = 0.00158). Furthermore, all of the patients with HSA had at least mild or moderate leukoaraiosis and SIVD while the larger subset of demented patients had a more even spread of leukoaraiosis and SIVD.

Conclusions

Clinical imaging findings consistent with HSA were identified in almost 20% of demented patients over 50 years of age. Hippocampus sclerosis of aging was unilateral in half of the cases, while AD changes are more frequently bilateral. Demented patients with HSA were significantly older than demented patients without HSA. The latter patients are also more likely to have moderate leukoaraiosis and SIVD. Although further studies with increased sample size and pathologic correlation will need to be performed, this initial study suggests that there is likely an in vivo imaging correlate of pathologically defined HSA that may identify a distinct subset of demented patients.

KEYWORDS: Aging, Hippocampus, MR Imaging Brain

P-42

Identification of risk groups in mechanical thrombectomy using the pRESet-Stent-retriever: Are there risk-groups for procedure-related complications?

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Purpose

Mechanical thrombectomy is an established method of recanalization in patients with acute stroke. Stent retriever represents a new kind of device. Our purpose was to identify patients with higher risk of periinterventional complications.

Materials and Methods

In our database of 159 interventional treated strokes, we identified 59 patients (ø66 ± 16 yrs) with acute thromboembolic occlusion of MCA, who underwent mechanical thrombectomy using the pRESet device (Phenox, Bochum, Germany). Time from stroke onset to hospitalization was less than six hours. All patients presented with NIHSS ≥ 8. In all patients NECT, CTA and PCT
were performed immediately before intervention. Grade of recanalization was measured using the TICI score. Duration of interventional procedure was represented by the time from first diagnostic angiography to revascularization. Density of the occluding thrombus was measured in NECT in relation to the contralateral MCA.

Results
Successful recanalization (TICI 2b or higher) was achieved in 56 patients (94.9%). In two patients the thrombus could not have been passed by micro wire. In one patient a major part of the thrombus could not have been mobilized by the stent retriever. In nine patients thromboembolic complications occurred. Thrombus material migrated into ACA territory (n = 5) and into distal MCA territory (M2/M3, n = 4). Lower relative density of the occluding thrombus led significantly more often to periinterventional complications (0.9 ± 0.2 vs 1.5 ± 0.5, p < 0.01). Thromboembolic complications occurred significantly more often, if the patients age was ≥ 75 yr (p = 0.01). Angio-to-recanalization time tended to be longer in patients with higher vascular risk score but did not show significance (p = 0.086). Thrombus length, number of passes of the device and vascular risk score had no influence on the number of complications.

Conclusions
Mechanical thrombectomy using the pRESet stent retriever device is an effective method of recanalization in patients with acute thromboembolic occlusion of MCA. Complications associated with thrombectomy occur, in our study significantly more often in patients with higher age or lower density of thrombus. The dependence of thrombus density and complication rate may originate from thrombus composition. The knowledge of risk factors may influence interventional options in patients with acute occlusion of the middle cerebral artery.

KEYWORDS: Acute Ischemic Stroke, Acute Stroke, Thrombectomy

P-15 6:30AM - 9:00PM
Increased Cerebrovascular Reactivity in the Days Following Sports-Related Concussion in College Athletes.

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Purpose
Sports-related concussion has entered the national conversation through widespread coverage by multiple media outlets in recent years. Despite this growing national interest, the role of traditional imaging remains limited in the management of this important clinical condition. While many researchers have investigated alterations in functional activation and connectivity using functional MRI (fMRI), relatively little research has been published regarding cerebrovascular alterations. Cerebral blood flow (CBF) is known to increase as a physiologic response to hypercapnia through cerebral arteriolar dilatation and cerebrovascular reactivity (CVR) is a measure of this response. To date, no study has been published using fMRI to assess CVR following sports-related concussion and what little has been published using other modalities has been inconclusive. The purpose of this study is to evaluate CVR using fMRI in college athletes in the days following a sports-related concussion.
Materials and Methods
Thus far, we have enrolled six college athletes (3M/3F, 18-21 yrs.) two-six days after suffering a sports-related concussion diagnosed by an athletic trainer and six healthy (3M/3F, 18-21 yrs.) college students who have never suffered a concussion. Cerebrovascular reactivity was measured by resting functional echo-planar imaging on a 3T MRI scanner. Subjects alternated breathing room air and room air with 5% CO2 via mask at intervals of two minutes. The average percent signal change between these intervals was divided by the average change in the partial pressure of expired CO2. Baseline CBF was quantified using arterial spin labeling techniques. A total of 18 regions of interest (ROIs) were evaluated across the brain.

Results
Figure 1 is a graph demonstrating the average CVR of college athletes within two-six days following a sports-related concussion (y-axis) and gender/age matched college controls (x-axis) with each data point representing a separate ROI. The black line represents a 1:1 relationship and any data point that falls on this line indicates that there is no difference in the average between patients and controls for this ROI. Figure 2 is a similar graph which shows the average CBF of the same 18 ROIs shown in Figure 1 with patients again represented on the y-axis and controls represented on the x-axis. Our data indicate that CVR is increased approximately 37% (average across all ROIs) in patients compared to controls (Figure 1). This is compared to baseline CBF values which differ less than 1% (Figure 2). These findings strongly suggest that the difference observed is the result of an increased vasodilatory response to increasing levels of carbon dioxide and not alterations in baseline CBF. Several ROIs have reached or are approaching statistical significance despite our study's current lack of power (6 patients and 6 controls). Because CVR is increased across all 18 ROIs in patients compared to controls, we suspect that our data represents a global process that is not limited to the ROIs that have already reached statistical significance.

Conclusions
We have observed markedly increased CVR in college athletes in the days following a sports-related concussion while baseline CBF remains unchanged. While the exact pathophysiology is unclear, we suspect that this hypereactive vasodilatory response is potentiated by the local metabolic environment surrounding cerebral arterioles following concussion. Furthermore, we believe our results suggest hypercapnia and the exaggerated vasodilatory response that ensues may represent a potential etiology for recurrent symptoms upon an athlete's return to play who is otherwise asymptomatic at rest. To our knowledge, this is the first set of data presented using fMRI to evaluate CVR in concussion patients. Additionally, our finding of increased CVR in the days following sports-related concussion has not been suggested previously in any published study regardless of modality. This work was supported in part by the Vanderbilt CTSA grant UL1 TR000445 from NCRR/NIH.

KEYWORDS: Cerebral Blood Flow, Concussion, FMRI
Purpose
New C-arm angiography systems allow acquiring CT-like images of brain parenchyma and intracranial vasculature, and measuring cerebral blood volumes (C-arm CBV) during diagnostic angiography or endovascular treatment. C-arm CBV examinations require two rotational acquisitions: a noncontrasted "mask run" and a contrasted "fill run", generating volumetric datasets that provide both CBV maps and anatomical images. To reduce the contrast medium necessary for these examinations, we investigated different injection parameters of the diluted contrast medium, injected via aortic arch route to obtain exploitable CBV maps. Our aim was to evaluate the influence of these parameters on C-arm CBV maps and volumetric anatomical images in clinical cases.

Materials and Methods
Thirty-eight patients with normal perfusion, detected through CT perfusion (CTP) studies, were investigated. For each, C-arm CBV images (syngoNeuroPBV-IR, Siemens, Forchheim, Germany) and anatomical images were acquired using a flat-detector angiographic system (ArtisZee-BA, Siemens, Forchheim, Germany). Patients were divided into three groups with different contrast concentrations and injection rates: group A (17 patients, 50%, 5ml/sec); group B (10 patients, 30%, 5ml/sec); group C (11 patients, 25%, 7ml/sec, fixed 9sec scan delay). In groups A and B, the scan delay time was individually determined for each patient via a test bolus injection. All studies featured an aortic arch injection with 4F diagnostic catheter positioned above the aortic valve. Depending on the delay, 75-119 ml of diluted contrast medium were...
injected continuously along the fill run. The C-arm CBV data were reconstructed on a separate workstation (syngoXWP-VB15D, Siemens, Forchheim, Germany). C-arm CBV and CTP-CBV were manually co-registered, and regions of interest (ROI) were placed in the anterior (ACA), middle (MCA) and posterior (PCA) cerebral artery territories and basal ganglia (BG). We calculated mean CBV values for each territory and the correlation coefficient between the three groups. We assessed the agreement between CTP-CBV and C-arm CBV clinical measurements through Bland-Altman analysis. Additional reconstruction of the fill run dataset was performed to evaluate the cerebral vasculature using slab maximum image projection (MIP) images, and compare the influence of the contrast medium concentrations.

Results
All studies were successful, without complications. Cerebral blood volume maps and cerebral vasculature images were obtained for all groups. No significant differentiation of C-arm CBV image quality was observed in the three groups. C-arm CBV values for all groups were higher than CTP-CBV values (p<0.01), with no significant differences in Right/Left ratios for C-arm CBV compared to CTP-CBV for PCA and BG (p>0.05). C-arm CBV Right/Left ratios in ACA and MCA for Group A and B were slightly higher compared to CTP-CBV, (p<0.01). The same tendency was observed in Group A and B. However, this laterality was slightly improved in Group C. For cerebral vessels, the noise was increased according to the high contrast concentration in the slab MIP images.

Conclusions
Preliminary results indicate that aortic-arch injections of 25% diluted contrast medium generate C-arm CBV maps and vascular images comparable to those obtained with 30% or 50% concentrations. C-arm CBV with 25% diluted contrast medium (9 sec delay) is easy to perform and may provide clinically useful information for patient management.

KEYWORDS: C-Arm CT CBV, C-Arm CT Imaging, Contrast Agents

P-07

Intraclass Correlation Coefficients for the CTA Measurement of Carotid Plaque Thickness Performed on Axial and Orthogonal images

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Purpose
CT angiography (CTA) of the carotid arteries is performed routinely for the evaluation of carotid bulb stenosis. Recent studies have pointed towards increased cardiovascular risk related to soft plaque component thickness. It has been suggested that this thickness should ideally be measured on reformatted images which are orthogonal to the lumen. However, this reformattting is time consuming and therefore not applicable in clinical routine. The purpose of this study is to compare measurements of carotid plaque thickness based on axial and orthogonal CTA images. Materials and Methods
Twenty patients with suspected ischemic stroke or TIA with carotid CTA from April 2008 to December 2010 were reviewed. The maximum wall thickness and the maximum soft plaque
Component thickness was obtained from the CTA axial images by two experienced radiologists, blinded to each other's results using axial images. On a second sitting the measurements were repeated by one of the radiologists using images reconstructed orthogonal to the lumen of the internal carotid artery.

Results
A total of 40 vessels were evaluated. There was no significant difference of thickness measurements between reader 1 and 2 for axial images and between axial versus orthogonal measurements (p>0.05). The intraclass correlation coefficients (ICC) between reviewer 1 and 2 for axial measurements of maximum plaque wall thickness and maximum thickness of soft plaque component were 0.94 (0.89 - 0.97) and 0.95 (0.91 - 0.98) respectively. When comparing measurements obtained using axial and orthogonal images, the ICC were 0.93 (0.87 - 0.96) and 0.97 (0.94 - 0.98).

Conclusions
This study showed no systematic differences of measurements of plaque thickness when obtained on axial CTA images compared to images orthogonally reconstructed to the lumen. In addition excellent intra- and inter-reader reproducibility was obtained for plaque thickness measurements.

KEYWORDS: Atherosclerosis, Carotid Plaque

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P-46

6:30AM - 9:00PM

Leukoaraiosis, hippocampal atrophy and Mean Diffusivity in differential diagnosis between subcortical vascular dementia and Alzheimer's disease.
Purpose
Considerable overlap exists between subcortical vascular dementia (SVD) and Alzheimer disease (AD) (Gorelich 2011), because subcortical white matter lesions occur even in AD, such that mixed pathology (AD+SVD) frequently is found in autopsic studies (Kovacs 2013). In clinical practice, some patients can fit both SVD (Ernikutti 2000) and AD (McKhann 2011) criteria. In this pilot study, with the purpose of differentiating vascular and degenerative factors in mixed dementias, we tested simple MRI indexes of cortical and subcortical abnormalities in clinically definite SVD and AD patients. Leukoaraiosis and hippocampal atrophy were rated by visual assessment scales (Fazekas 1987, Scheltens 1992), and mean diffusivity (MD) was measured in selected regions of interests (ROIs) known to be differently affected by vascular and degenerative factors (Fu 2012).

Materials and Methods
Nine patients with moderate SVD (77.7±7 yrs, 7 females) and nine with moderate AD (71.7±9.6 yrs, 5 females) were compared to 18 elderlies normal controls (NC, 72.4±6.7 yrs, 10 females). In patients, vascular risk factors by Hachinski scale (SVD: 7-10, AD: 2-5) and global cognitive impairment by Mini-Mental Examination (SVD: 18,5±3,8, AD: 16,6±5.8) were assessed. By a Siemens 3 T Skyra scanner equipped with a 32 phase-array head coil, each subject was scanned with a protocol including volumetric FLAIR (TR/TE: 5000/389, TI 1800, voxel size 0.7x0.7x1.1), high-resolution DTI (10000/97, 2x2x2, 64 directions, bvalue 1200 s/mm2), high resolution coronal T2 (8400/71, 0.4x0.4x2), total scan time 24 minutes. MPR axial planes of volumetric FLAIR were employed to evaluate leukoaraiosis by Fazekas scale (sum of periventricular and deep white matter:0-6). High resolution T2 coronal slices, perpendicular to the long axis of hippocampus, were employed to evaluate hippocampal atrophy by Scheltens scale (sum of left and right:0-8). In one SVD patient, DTI data were too affected by motion to be analyzed successfully. In the other 17 patients and in all 18 controls, from MD (calculated by Siemens Syngo built-in software) sagittal and coronal 2mm-planes were obtained. Then, nine circular (12mm2) ROIs were manually placed on midline sagittal plane in corpus callosum (genu, body, splenium) and on three coronal planes in each hippocampus (head, body, tail) (see Figure).

Results
Although visually assessed leukoaraiosis was significantly (p<0.005) higher in patient with SVD (4.6±1.4) compared to AD (2.5±1.1), most SVD patients overlapped with AD patients. Visually assessed hippocampal atrophy did not significantly differentiate SVD (5±1.3) from AD (5.9±1.9). MD in hippocampi was increased more in AD (952.2x10-6 mm2/s +92.4, p<0.01) than in SVD (929.3x10-6 mm2/s+66.1, p<0.05) compared to NC (880.1x10-6 mm2/s+37.7). MD in corpus callosum was increased in SVD (921.7x10-6 mm2/s+127.3, p=0.01), not in AD (835.9x10-6 mm2/s+84.4), compared to NC (831.3x10-6 mm2/s+43.3). Ratio between MD in hippocampi and MD in corpus callosum was lower in SVD (1.02±0.1) intermediate in NC (1.06±0.07), higher in AD (1.15±0.1), and differentiated SVD from AD (p=0.05).
Conclusions
By applying in a clinical setting the proposed protocol, the crucial features to differentiate SVD from AD can be assessed. MD in corpus callosum and hippocampi appears to be promising in differentiating vascular and degenerative factors in dementia.

KEYWORDS: Degenerative, DTI

(Filename: TCT_P-46_Vitali_Anzalone ASNRT2014_fig1.jpg)

P-32
6:30AM - 9:00PM

Morbidity in brain tumor patients correlates with lesion distance to DTI

W Gaggl1, V Nair2, D Huss2, T Meier2, E Meyerand2, A Field3, V Prabhakaran2
**Purpose**
Language and motor deficits in patients following brain tumor resection frequently are observed. Even with presurgical planning using functional MRI (fMRI) and diffusion tensor imaging (DTI) there can be new postsurgical functional deficits. It has been suggested that the probability of occurrence of such new deficits is related to the proximity of the surgical lesion to eloquent brain structures. This lesion proximity related morbidity is not well understood and varies considerably even when controlling for tumor grade and stage. Our objective is to correlate the distance of the surgical lesion to eloquent language and motor brain areas and investigate their relationship to surgical functional deficits.

**Materials and Methods**
Adult patients with brain tumors (n=60) underwent pre-operative DTI scanning. The major language and motor white matter pathways (right and left superior longitudinal fasciculi and the cingulum, arcuate fasciculi, left and right motor fibers) were identified from the DTI images and their distance to the lesion measured. Postsurgical morbidity and mortality information for each of the included patients were collected from their medical records.

**Results**
Analysis of the patients' DTI showed that the lesion-tract-distances (LTD) from the DTI were significantly correlated to the occurrence rate of new surgical functional deficits. A significant linear relationship between the distance of the tumor to the right (p=0.013) and left (p=0.002) superior longitudinal fasciculi and language deficits was observed, with greater distances resulting in lesser impairment.

**Conclusions**
There are significant relationships of the proximity of the surgical lesion to the white-matter tracts. Patients with their surgical lesion further away from these structures showed a significantly decreased surgical morbidity. Our results suggest that a distance of 1cm or greater from white matter structures is indicated to avoid new deficits. The benefit of using FMRI to reduced new surgical deficits has been shown in previous studies. Our data indicate that adding DTI to presurgical planning increases the predictive value substantially.

**KEYWORDS:** Brain Disease, Diffusion Tensor Image, Mortality

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**P-26 6:30AM - 9:00PM**

**Morphometric Analysis and Diffusion Tensor Imaging Investigation in Brain of Alzheimer’s Disease Patients Without and With Depression**

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¹Taichung Veterans General Hospital, Taichung, Taiwan, ²National Yang Ming University, Taipei, Taiwan

**Purpose**
This study is designed to elucidate the brain tissue difference between Alzheimer disease (AD) patients with and without depressive symptoms in the respect of the neuroanatomical volume
analysis and diffusion tensor imaging (DTI) alternations. We use morphometric analysis of brain MR imaging (MRI) in study of the brain tissue loss and use fractional anisotropy (FA) with mean diffusivity (MD) indices of white matter (WM) DTI for exploring the difference in their brain finding.

Materials and Methods

In this study, 21 Alzheimer disease (AD) patients (mean age 76, M/F 13/8) without depressive symptoms and 27 Alzheimer disease with depression (ADD) subjects (mean age 74, M/F 17/10) were enrolled. The MRI was performed by Siemens Magnetom Area 1.5 T MR scanner. The imaging protocol included T1-weighted imaging (T1WI) with 3D MPRAGE sequence, T2WI and fast FLAIR with SPACE technique. The DTI images were obtained by the single-shot EPI sequence with diffusion gradients in 30 directions and voxel size 2x2x2mm. Multispectral MRI segmentation was processed with the SPM8 software package. The region-of-interest (ROI) masks encompass the frontal lobe, temporal lobe, parietal lobe, occipital lobe, limbic lobe and sub-lobar region, derived from the International Consortium of Brain Mapping (ICBM) atlas using the WFU Pickatlas. Global and regional volume fraction of gray matter (GM) and white matter (WM) were calculated by using the volumes of GM and WM divided by the whole brain volume for correction of variant head sizes in different subjects in order to perform ROI analysis of brain morphometry. Diffusion-tensor imaging analysis was performed by using DTI Studio software for image processing and was registered to T1-weighted MPRAGE image. The aforementioned segmented ROI masks of GM and WM maps then were used to define the ROI in DTI. Then, the quantification of the microstructural alternations for each subject was acquired by averaging the FA, MD values within the ROI.

Results

Concerning regional neuroanatomical volume analysis, WM volume fraction in the sublobar region of the AD patients was significantly lower than that of the ADD patients, while there is no significant difference in other regions between these two groups. The DTI indices revealed significantly higher global FA and lower global MD in ADD patients than AD patients. Further analysis of regional WM integrities, ADD patients appeared to have higher FA and lower MD indices than AD patients in frontal lobe, temporal lobe and sublobar region.

Conclusions

The findings of significantly higher FA and lower MD in frontal lobe, temporal lobe and sublobar region demonstrate some different microstructural characteristics of white matter integrities in AD patients without and with depressive symptoms. According to our experimental results, we propose a hypothesis that there might be the linkage between depression and the network connectivity in the limbic-cortical-striatal-pallidal-thalamic circuit and which needs to be further confirmed. The investigation of morphometric analysis and DTI MRI alternation is helpful in revealing the difference of brain abnormalities in AD without and with depression.

KEYWORDS: Alzheimer Disease, Diffusion Tensor Image, MR Imaging Brain

P-50

6:30AM - 9:00PM

Multimodality imaging features of intracranial blastomycosis – a great mimicker.

P Kochar¹, D Baruah², J Ulmer², A Klein², Z Bhatti², J Anderson², M Agarwal², C Lath²
Purpose
The aim of this exhibit is to explore the imaging appearance and pathophysiology of intracranial blastomycosis, enabling neuroradiologists to consider this entity in the differential of intracranial lesions.

Materials and Methods
Intracranial blastomycosis is an uncommon entity, though not infrequently seen in endemic areas. This easily can be confused with neoplastic lesions as well as other intracranial processes. In this review, we discuss imaging features of intracranial blastomycosis with relevant clinical case examples including computed tomography (CT), MR imaging (MRI) and advanced MR imaging techniques like MR spectroscopy (MRS).

Results
Blastomyces dermatitidis is a fungal pathogen that commonly presents as a pulmonary infection due to inhalation of spores. Central nervous system involvement can occur by hematogeneous spread or by direct extension from the paranasal sinuses or orbits. Though classic imaging findings of intracranial blastomycosis are lacking, careful evaluation of the imaging and the clinical background is crucial.

Conclusions
Blastomycosis is an uncommon infection of the central nervous system. In endemic areas, and even in nonendemic areas with the appropriate imaging and clinical presentation, blastomycosis should be considered in the differential diagnosis. This exhibit will help neuroradiologists understand and manage this uncommon but important entity.

KEYWORDS: Intracranial Infections

P-51
6:30AM - 9:00PM

Neuroimaging of Tuberous Sclerosis

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Purpose
Tuberous sclerosis complex (TSC) is one of the major causes of pediatric intractable epilepsy. Finding epileptogenic zone is challenging. The purpose of this study is to review imaging characteristics of epileptogenic tubers in young TSC patients.

Materials and Methods
From the UCLA epilepsy program TSC cohort, 19 consecutive patients (mean age, 5.91 year old) with 413 tubers were selected retrospectively. All patients underwent preoperative multimodality evaluation including MRI, FDG-PET, and magnetic source imaging. Epileptogenic tuber was defined with presurgery evaluation and result of postsurgical seizure freedom. Imaging findings include T2 signal intensity of the tuber surrounding cortex, tuber signal intensity type A, B and C were compared between epileptogenic tubers and nonepileptogenic tubers. Tubers Type A are isointense on volumetric T1 images and subtly
hyperintense on T2-weighted and fluid-attenuated inversion recovery (FLAIR). Type B are hypointense on volumetric T1 images and homogeneously hyperintense on T2-weighted and FLAIR. Type C are hypointense on volumetric T1 images, hyperintense on T2-weighted, and heterogeneous on FLAIR characterized by a hypointense central region surrounded by a hyperintense rim.

Results
Forty-five epileptogenic tubers and 368 non-epileptogenic tubers were selected. In whole tubers, 205 tubers are located in frontal lobe, 81 in temporal, 68 in parietal, and 50 in occipital. Within the epileptogenic tubers, 20/45 tubers were in frontal lobe. Type A tuber was 190 within the whole tubers, type B was 20, and type C was 10. There could be a tendency that both shole tubers and also in epileptogenic group, type B was the most likely to be identified in three types. Tubers with calcifications were three in whole group, and two of them are epileptogenic. Tubers with T2 low intensity were detected 36 in whole, 28 in epileptogenic.

Conclusions
Conventional MRI can suggest epileptogenic tuber characteristics in young TSC patients (mean age of 5.9 years old) using lobe location, with presence of low T2 signal type A or B tubers.

KEYWORDS: Tuberous Sclerosis

P-45 6:30AM - 9:00PM

Patterns of Dural Venous Sinus Compromise Following Acute Skull Fractures Using Multidetector CT Venography.

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Purpose
Dural venous sinus thrombosis (DVST) has been associated with increased morbidity and mortality in head trauma patients. Prior CT venography (CTV) studies have demonstrated that skull base fractures from blunt trauma that extend through the dural venous sinuses are at an especially high risk for DVST, reported as high as 41% (1). However, the assessment of DVST using CTV can be confounded due to the presence of concurrent traumatic extra-axial hemorrhage or gas, which can cause compression and narrowing of the adjacent dural veins, possibly leading to overestimation of the incidence of DVST. We set out to differentiate the prevalence of traumatic DVST versus dural venous compression.

Materials and Methods
IRB approval was obtained. We retrospectively reviewed all 64-, 128-, and 256-slice multidetector CTV exams performed at a level 1 trauma center between 12/2006-11/2013 for adult acute blunt trauma patients with skull fractures extending through a dural venous sinus (n=107). Three staff neuroradiologists independently reviewed the 0.6mm source CTV data in a minimum of three planes (axial, sagittal, and coronal) on a 3D workstation. Dural venous sinuses were placed into five categories: normal (category 0), solely venous compression (category 1), solely dural venous intraluminal thrombus (category 2), mixed venous compression and thrombosis (category 3), or indeterminate (category 4). Criteria for intraluminal thrombus
included the "delta" sign of an intraluminal filling defect surrounded by contrast, extension into another sinus caudally (e.g., IJV), or enlargement of the sinus with surrounding collateral veins. Criteria for compression included extension of the hematoma beyond the sinus margin, or gas compression the dural sinus.

Results
The most common fracture site was the transverse/sigmoid sinus (TSS=60%) followed by the superior sagittal sinus (SSS=21%) and multiple sinuses (MS=19%). Reviewer ranges for the status of the sinuses were normal (n=33-35), solely compression (n=41-49), solely thrombus (n=5-10), mixed compression/thrombosis (n=8-12), and indeterminate (n=9-14). Category 1 (sole compression) was present with a slightly greater frequency in the SSS (12/23) as compared to the TSS (25/65) and MS (6/19), but the frequency of categories 2-4 types of sinus compromise were much more common in TSS fractures (22/65 patients with TS fractures) and MS fractures (8/19), as compared to SSS fractures (1/23). Interobserver kappa was strong amongst the three readers (kappa=0.610-0.759 (p<0.0001). There was a significant association between the fracture site and the status of the underlying dural sinus (Fisher exact test, p=0.019).

Conclusions
Compromise of the dural venous sinuses following acute skull fracture is common, whether due to venous compression from extra-axial hemorrhage, thrombosis or a combination of the two. Both in TSS and SSS fractures, isolated venous compression was the most common pattern of sinus compromise identified, and the fracture site was associated with the type of compromise. Interestingly, fractures involving the TSS or MS seem more likely to be affected by thrombosis than the SSS, while the SSS seems more likely to undergo direct compression from hematoma.

KEYWORDS: Dural Sinus Thrombosis

(Filename: TCT_P-45 ASNRAbstractpic.jpg)
Performance Metrics of Automated Hippocampal Volumetry for Discriminating Pathologically-defined Alzheimer’s disease from Controls in the national Alzheimer’s Disease Neuroimaging Initiative (ADNI) study

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Purpose
New diagnostic criteria for Alzheimer's disease (AD), mild cognitive impairment (MCI) of the Alzheimer type, and Preclinical disease are based on pathologic (e.g., amyloid and tau positivity) and neuronal loss biomarkers (1). It has been known for over two decades that AD and MCI are associated with significant volume reduction in the hippocampus (2), amygdala, parahippocampal gyrus, and entorhinal cortex (3), suggesting a potential diagnostic role for volumetric MRI of the medial temporal lobe (4). However, one limitation has been that most prior volumetric studies have defined AD and MCI clinically without pathological verification. Further, the lack of standardization and methodologic issues [e.g., inter-user variability, lack of quick and simple volumetric techniques, and lack of nomograms (e.g., age adjusted cut points)] have limited clinical application of this technique. NeuroQuant® is a commercially available, completely automated volumetric software package that generates age-related and general morphometry reports immediately available for interpretation after a patient scan. The purpose of this study was to determine the sensitivity and specificity of this tool for separating pathologically verified AD and MCI from normal controls (NC) in a nationally derived cohort.

Materials and Methods
Three hundred thirty-four subjects (NC=97, MCI=160, AD=77) in ADNI with MRI and CSF biomarker data were subdivided further as pathology positive or pathology negative based on CSF tau to amyloid-beta 1-42 peptide levels (5). Baseline MRI scans were processed with NeuroQuant® to generate hippocampal volumetric data which then was normalized to total intracranial volume and used to obtain age-adjusted hippocampal volume percentiles.

Results
The mean hippocampal volume percentile decreased as a function of cognitive status and amyloid and tau pathology (Clinical grouping, mean, standard deviation: NC with negative pathology, 46.7, 3.3; NC with positive pathology, 39.8, 4.4; MCI with negative pathology, 21.1, 3.8; MCI with positive pathology, 18.5, 2.4; AD with negative pathology, 15.8, 8.6; AD with positive pathology, 11.8, 3.1). Post-hoc testing confirmed hippocampal measures for pathology negative NC were significantly larger than those of pathology positive AD (p<0.001) and pathology positive MCI patients (p<0.05), though there was no significant difference between MCI and AD subjects. Hippocampal volumes did not correlate with the CSF tau to amyloid beta ratio (r = -0.230). When specificity was set to 80%, NeuroQuant (hippocampal volume percentile threshold = 14) separated pathology positive AD from pathology negative NC with a sensitivity of 78%; the sensitivity was 64% for pathology positive MCI versus pathology negative NC. These sensitivities were the same (78% and 64%) when separating clinically defined AD and MCI from NC (Figure 1).

Conclusions
To our knowledge, this is the first study to validate the utility of automated hippocampal volumetric measurement, using NeuroQuant®, to discriminate pathology positive AD from
pathology negative NC. Our study also suggests that hippocampal changes in dementia or MCI may be largely independent of amyloid or tau pathology. We currently are examining the relationship between NeuroQuant® measured volumes and longitudinal outcomes in our sample to determine prognostic effectiveness.

KEYWORDS: Alzheimer Disease, Hippocampus, Volumetric Analysis

![Figure 1: Receiver operating characteristic (ROC) curves assessing ability of hippocampal volume percentiles to separate AD vs. NC patients.](Filename: TCT_P-10_Figure2draftDecember11th.png)

**P-02**

**Perioperative myocardial infarction of carotid artery stenting**

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¹National Hospital Organization Kyoto Medical Center, Kyoto, Japan, ²Hyogo Prefectural Amagasaki Hospital, Amagasaki, Hyogo, Japan, ³Hamamatsu Rosai Hospital, Hamamatsu, Shizuoka, Japan, ⁴Osaka Red Cross Hospital, Osaka, Japan

Purpose

Perioperative myocardial infarction (PMI) has been accepted as one of the most important
complications of carotid artery stenting. Based on our experience, we calculated PMI rate, and analyzed risk factors of PMI.

Materials and Methods
Since 2005, carotid artery stenting with emboli-protection devices was performed in 96 patients for 103 arteries at three institutions. Seventy-seven patients were male, and 19 were female, and the median age is 73 years (50-96 years). There were 46 symptomatic lesions and 57 asymptomatic lesions. Fifteen patients had bilateral lesions or contralateral occlusion.

Results
Perioperative myocardial infarction was observed in one patient preoperatively, in one patient intraoperatively, and in two patients postoperatively: PMI rate was 3.9% in total. Two patients with PMI were presented with chest pain, and two were asymptomatic. Thirteen patients who underwent carotid artery stenting prior to coronary artery bypass graft were not complicated with PMI. Fisher's exact test showed that the presence of contralateral carotid disease was associated significantly with PMI (p=0.013). Mann-Whitney test did not show age as a significant predictor of PMI.

Conclusions
This study showed that myocardial infarctions were not uncommon complications of carotid artery stenting, but they did not affect the prognosis. The presence of contralateral carotid disease is a significant predictor of PMI.

KEYWORDS: Carotid Artery Stenting, Carotid Stenosis, Complications

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P-19

6:30AM - 9:00PM

Prevalence of Incidental Findings on Research Brain MRI in Neurodegenerative Disease and their Impact on Clinical Referrals

S Liu, C Hess, C Glastonbury, M Weiner, W Dillon

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Purpose

With the increasing use of brain MR imaging (MRI) for studies of aging and neurodegenerative disorders, incidental imaging findings are important to the ethical undertaking of research with human subjects. Our goal was to determine the prevalence and potential clinical impact of unexpected brain and head & neck (H&N) findings in a large series of patients and healthy volunteers recruited into clinical trials for neurodegenerative diseases.

Materials and Methods

From July 2006 to November 2013 over 4500 brain MRIs performed on subjects enrolled in multiple neurodegenerative research studies at our institution were reviewed by three CAQ-certified neuroradiologists. Of these, 3574 reports were archived in our electronic database and retrospectively analyzed for this study. Incidental findings were categorized by location (brain, head & neck, or spine) and divided into three groups based on recommendations for referral (no referral necessary, routine referral, urgent/immediate referral). For each group, the range of neoplastic and non-neoplastic lesions and vascular abnormalities was assessed together with age-specific prevalence by decade. Small vessel disease, small lacunes or microhemorrhage, and disk-osteophyte degenerative changes of the cervical spine in elder subjects, as well as mild mucosal inflammation or retention cysts in the H&N, were not accounted as incidental findings in this study.

Results

Mean age was 66.2 years (SD 13.1, range 18-99). Overall, 1131 scans (31.6%) demonstrated incidental findings, of which approximately half (15.0%, 537 of 3574 subjects) required no further evaluation. The 16.6% (594) required referral for further evaluation (11.4% for brain, 4.2% for head & neck and 1.0% spine, respectively). Routine referrals were recommended in 15.2%, and urgent/immediate referrals were recommended in 1.4%. There was no difference in the proportion of incidental findings identified in subjects by age (Kruskal-Wallis test, p=0.554,
mean 17.2% ± 1.6% for ages <90). The prevalence was 35.7% in those over 90 years, most likely reflecting the small sample size in this age group (only 14 participants). Incidental tumors were found in 2.2% (77 subjects), including meningiomas in 0.9% (33), pituitary lesions in 0.7% (25); and head & neck masses in 1.3% (48). Non-neoplastic abnormalities found included Rathke's cleft cyst in 2.0% (72) and arachnoid cysts in 1.5% (55). The overall prevalence of vascular abnormalities was 3.6%, including developmental venous anomalies in 1.8% (65 subjects), intracranial aneurysms in 0.7% (26), and cavernous malformation in 1.0% (36). Urgent referral was recommended for all participants who had finding of intracranial aneurysms.

Conclusions
Review of research brain MRI scans by subspecialty certified neuroradiologists frequently detects abnormalities. In this large series of subjects enrolled in neurodegenerative studies, potentially clinical relevant incidental findings was found in 16.6% in 3574 participants, including unexpected tumors in 3.5% and aneurysms in 0.7%.

KEYWORDS: Incidental Findings, MR Imaging Brain, Neurodegenerative
Incidental Findings on Research Brain MRI in Neurodegenerative Studies

AGE GROUP

- Clinical Referral Recommended
- No Clinical Referral Required
- No Incidental Findings

20s: 17
30s: 16
40s: 27
50s: 73
60s: 215
70s: 163
80s: 78
Quantification of T1Rho and T2 in Cortical and White Matter Plaques in Multiple Sclerosis: A Cross-sectional Study.

J Gonyea¹, R Watts¹, A Applebee², T Andrews¹, S Hipko², J Nickerson², L Thornton³, C Filippi⁴
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Purpose
To determine quantitative T1rho (T1ρ) and T2 values of cortical lesions and white matter plaques in patients with multiple sclerosis (MS) using a novel, volumetric T1ρ sequence (1).

Materials and Methods
This prospective, IRB-approved study of 27 MS patients (8 male) ages 28 to 60 years investigated T1ρ and T2 mapping of MS lesions at 3.0 T. Whole brain axial T1ρ and T2-weighted MR images were acquired using a 3D turbo spin echo (TSE) sequence with fluid suppression (1.8 x 1.8 x 1.8 mm³), TR/TE = 4800/24ms, TI 1650, FOV-250mm and spin lock frequency 500 and 0 Hz, respectively, with spin-lock times of 0, 20, 40, 60, 80, and 100ms. For lesion detection and segmentation 3D T1 turbo field echo, 3D FLAIR, and 3D double inversion recovery were acquired. Whole brain T1ρ and T2 maps were co-registered to the T1. Regions-of-interest measurements were drawn over GM and WM lesions by a CAQ-certified neuroradiologist. T1ρ and T2 values were calculated for cortical and white matter plaques, as well as segmented normal-appearing GM and WM. Spearman correlations with Extended Disability Status Scale (EDSS) were calculated for each measure.

Results
Lesion T1ρ and T2 values are both approximately 20% higher than the surrounding tissue. The T2 values of NAWM in MS are consistent with previous studies (2, 3). Of all the measures listed in Table 1, only the standard deviation of the T1ρ and T2 values of all white matter correlated significantly with EDSS (Spearman r=0.38/0.39, p=0.04/0.04, respectively). The standard deviation represents the heterogeneity of the white matter, including both visible and qualitatively occult lesions, and is weighted by both the total volume of the lesions and their conspicuity.

Conclusions
T1ρ MR imaging may be a useful tool for measuring both global and focal changes in cortex and subcortical white matter lesions. The standard deviation of T1ρ in WM is a simple, but useful measure of MS disease burden that does not require explicit lesion segmentation, and so could be automated relatively easily. Further investigation is needed to determine whether such quantitative neuroimaging techniques may be used as a biomarker for treatment management or prognostication.

KEYWORDS: Multiple Sclerosis Plaques

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<tr>
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<th>T1ρ</th>
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### Table.

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<tr>
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<th>GM</th>
<th>WM</th>
<th>GM</th>
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<td><strong>MS Lesions</strong></td>
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<td>98.6±8.4</td>
<td>75.7±3.3</td>
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<td><strong>MS Normal Appearing Tissue</strong></td>
<td>78.8±1.6</td>
<td>78.0±1.4</td>
<td>64.0±1.5</td>
<td>63.0±1.5</td>
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<tr>
<td><strong>MS All Tissue (Lesions + NAT)</strong></td>
<td>78.8±4.5</td>
<td>78.5±1.7</td>
<td>64.0±4.1</td>
<td>63.3±1.6</td>
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<tr>
<td><strong>Healthy Control All Tissue</strong></td>
<td>78.2±4.3</td>
<td>77.0±4.4</td>
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<tr>
<td><strong>MS vs HC p-value</strong></td>
<td>0.08</td>
<td>0.00004</td>
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**P-41**

6:30AM - 9:00PM

Relationship between the intraplaque calcification on MRI and increase of HDL-C under aggressive LDL-C lowering statin therapy
Purpose
MR imaging (MRI) can noninvasively assess plaque volume, and composition of carotid atherosclerotic lesions. A prospective, open-label blinded end-points trial (CHALLENGER) assessed the effects of rosuvastatin on carotid plaque composition. Because an intraplaque calcification (CA) is considered as stabilized status of the plaque, we aimed to assess the relationships between the intraplaque calcification and clinically available biological serum markers.

Materials and Methods
Prospective, open-label blinded end-points trial was performed using 1.5 T MRI to image carotid plaques with multicontrast images; T1/T2/PD-WI, T1-WI-Gd and TOF-MRA. Patients with maximum carotid intima-media thickness (IMT) > 1.8 mm as measured by ultrasound (US) and a plasma LDL-C of more than 120 mg/dl without statin treatment were recruited from 2007 to 2010. All patients were administered rosuvastatin 5mg/day after baseline MRI. Scan was performed at baseline, after 12 and 24 months of treatment. Each pair of baseline and follow-up MRI assessments was analyzed in a blinded fashion. Then, compared with the laboratory data sets at each visit.

Results
After 24 months, 38 patients had taken MRI scans to compare by reviewers blinded to clinical data, and temporal sequence of scans. LDL-C was significantly reduced from baseline (46.6%, p<.001). HDL-C was significantly increased from baseline (20.2%, p<.001), and there was a significant correlation shift towards increased ratio of CA (r=0.69, p=0.012) and increased volume of CA (r=0.60, p=0.038). No correlation shifts were observed toward eGFR.

Conclusions
Rosvastatin treatment showed marked LDL-C lowering and HDL-C increase. In a present study, it is indicated that an increase in HDL-C can be an indicator for a stabilization of carotid plaque.

KEYWORDS: Calcifications, Carotid Plaque

P-12
6:30AM - 9:00PM
The Majority of Metallic Intracranial Implants and Extracranial Hardware are Compatible with Serial Monitoring of Cerebrovascular Reactivity with Hypercarbic MRI

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Purpose
Cerebral hemodynamic evaluation can be achieved by serial monitoring of cerebrovascular
reactivity (CVR) without exogenous contrast agents by exploiting T2* lengthening secondary to hypercarbia-induced changes in blood oxygenation (i.e., the blood oxygen level-dependent, BOLD, effect) (1, 2). However, for such measurements to be reliable in routine clinical practice, susceptibility-induced influences of endovascular and surgical interventions on the long-TE MRI contrast must be characterized, as BOLD MRI is particularly sensitive to susceptibility variations between different structures (3). The purpose of this study is to calculate the volume and artifact extent arising from different intracranial and extracranial hardware; results highlight that noninvasive CVR monitoring is feasible in the majority of patients with such hardware, and also report which hardware precludes accurate CVR measurements and should be avoided when possible.

**Materials and Methods**

BOLD (3.0T; in-plane spatial resolution=3 x 3 mm2; echo time=35 ms; single-shot gradient echo EPI) MRI was performed in patients (n=32) with metallic implants (n=8) and surgical procedures that required placement of extracranial hardware (n=24). Make, model, and composition of hardware, along with the total artifact volume, were recorded.

**Results**

Intracranial implants included stents or clips composed of titanium or titanium and nickel alloy, as well as platinum embolization coils. The average artifact volume associated with intracranial hardware was 3.7 cm3 +/- 3.4 cm3 (mean +/- standard deviation), with a range of 1.1-9.4 cm3. Extracranial hardware primarily included closure devices composed of titanium alloy, as well as a ventriculoperitoneal shunt with an extracranial programmable valve composed of a combination of 316L stainless steel, unalloyed titanium, tantalum, and neodymium magnets (4). The average artifact volume associated with extracranial hardware was 33.0 cm3 +/- 25.6 cm3 (range 6.1-139.6 cm3). As a point of reference, the average volume of the human brain is approximately 1380 cm3 (5). Cerebrovascular reactivity data were obtainable in all patients, with the exception of the single patient with the extracranial programmable valve and siphon gauge. In patients with intracranial stenosis, results varied asymmetrically with vascular disease burden as quantified by angiography.

**Conclusions**

Reliable CVR maps, including those consistent with lateralizing vascular disease in patients with intracranial stenosis, can be obtained from BOLD MRI performed on patients with a variety of implanted intracranial devices and extracranial hardware, the notable exception being ventriculoperitoneal shunts with a programmable valve and siphon gauge.

**KEYWORDS:** BOLD FMRI, Cerebrovascular Reserve, Metal Artifact

<table>
<thead>
<tr>
<th>Hardware Location</th>
<th>Average Artifact Volume (cm³)</th>
<th>Standard Deviation</th>
<th>Range</th>
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<tbody>
<tr>
<td>Intracranial Implant (n=9)</td>
<td>3.7</td>
<td>3.4</td>
<td>1.1-9.4</td>
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<tr>
<td>Extracranial Closure Hardware (n=32)</td>
<td>29.1</td>
<td>15.0</td>
<td>6.1 - 61.7</td>
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<tr>
<td>VP shunt with programmable valve (n=1)</td>
<td>139.6</td>
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The MR Imaging Findings of Pituitary Abscess

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Pituitary abscess is a rare disorder characterized with central nervous system infection, mass effect and endocrine dysfunction. The correct diagnosis of pituitary abscess is difficult because there are nonspecific symptoms and it often is radiologically indistinguishable from other pituitary lesions. To better understand the imaging findings of pituitary abscess, we conducted a review of patients treated for pituitary abscess in our hospital.

Materials and Methods
A total of six consecutive patients with pituitary abscess were included. All patients underwent surgery and antibiotic therapy and were surgico-pathologically proved to be an abscess. A complete history, a thorough record of signs and symptoms, pituitary imaging and biochemical panels were obtained for each patient.

Results
Most of the patients presented with complaints and symptoms consistent with a sellar mass. Diabetes insipidus, hypopituitarism and headache were the most common clinical manifestations and in three patients, fever was accompanied with headache. A sellar cystic mass with enhancing rim is the most common findings on sellar MRI in patients with pituitary abscess. These findings were indistinguishable from those of the cystic adenoma. However, in four patients irregular thickenings were noted along the cystic wall or pituitary stalk, and these findings were very valuable in differentiation of pituitary abscess from pituitary adenomas.

Conclusions
Presentation of a sellar cystic mass with an enhanced rim and specific clinical manifestations such as diabetes insipidus or hypopituitarism may be suggestive of a pituitary abscess. In addition, irregular thickenings along the cystic wall or pituitary stalk should be very valuable imaging findings in differentiation of pituitary abscess from pituitary adenomas.

KEYWORDS: Abscess, Pituitary Gland

The value of advanced MR imaging techniques in the evaluation of nonenhancing gliomas: Perfusion-weighted imaging compared with proton magnetic resonance spectroscopy and tumor grade

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Purpose
A significant number of nonenhancing gliomas are reported to be malignant. The purpose of this study was to compare the value of advanced MR imaging techniques, including T2*-dynamic susceptibility contrast PWI (DSC-PWI) and proton magnetic resonance spectroscopy (1HMRS), in the evaluation of nonenhancing (NE) gliomas.

Materials and Methods
Twenty patients with NE gliomas underwent MRI including DSC-PWI and 1HMRS. The relative CBV (rCBV) measurements were obtained from regions of maximum perfusion. The
peak ratios of choline/creatine (Cho/Cr) and myoinositol/creatine (mIns/Cr) were measured at a TE of 30 ms. Demographic features, tumor volumes, and PWI- and 1HMRS-derived measures were compared between low-grade gliomas (LGGs) and high-grade gliomas (HGGs). In addition, the association of initial rCBV ratio with tumor progression was evaluated in LGGs.

Results
No significant difference was noted in age, sex, or tumor size between low-grade and high-grade tumors. Cho/Cr ratios were significantly higher in HGGs (1.7±0.63) than in LGGs (1.2±0.38). The receiver operating characteristic analysis demonstrated that a Cho/Cr ratio with a cutoff value of 1.3 could differentiate between LGG and HGG with a specificity of 100% and a sensitivity of 71.4%. There was no significant difference in the rCBV ratio and the mIns/Cr ratio between LGG and HGG. However, higher rCBV ratios were observed with more rapid progressions in LGGs.

Conclusions
Cho/Cr ratios are useful in distinguishing NE LGG from HGG and can be helpful in preoperative grading and biopsy guidance. On the other hand, rCBV ratios do not help in the distinction.

KEYWORDS: Brain Neoplasms, MR Perfusion-Weighted Imaging, MR Spectroscopy

Using CSF as an internal quality control marker in quantitative diffusion MR imaging

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Purpose
Diffusion tensor imaging (DTI) indices such as apparent diffusion coefficient (ADC) and fractional anisotropy (FA) frequently are being used for longitudinal monitoring of a patient’s brain tumor status and assessing treatment response. This requires repeatable, consistent and accurate DTI measurements. The needs of ensuring consistency and accuracy in functional MRI imaging have been well recognized and there are nationwide efforts to address those needs, i.e., Quantitative Imaging Biomarkers Alliance (QIBA) which mostly focuses on phantom work. In this study, we assess the possibility of using CSF as an individualized internal quality control (QC) calibrator for quantitative DTI.
Materials and Methods
Diffusion tensor images of 20 patients with GBM (Group I), (a total of 180 studies; average of nine scans per patient), 47 patients with leptomeningeal disease (Group II), and 40 patients with prior breast cancer but no current active disease (Group III), were analyzed retrospectively. The variations and reproducibility of ADC and FA measurements of the CSF in the lateral ventricles of patients in the three groups were measured. The changes of ADC over time for the patients undergoing treatments also were measured. Regions of interest (ROIs) were placed in the left and right lateral ventricles. Mean ADC and FA values, standard deviations, and coefficients of variation (CVs) were calculated from pixels within the ROIs in two ways. First, individual calculations were made on all exams for each patient; all measurements in the left and right ventricles were included in these calculations for a given patient. Second, mean ADC and FA values, standard deviations, and CVs were calculated for all ROIs and over all imaging exams at 1.5 T and 3.0 T, separately. An unpaired t-test was used to elucidate any differences in mean values of ADC and FA measured before and following treatment with bevacizumab and at different field strengths with statistical significance being defined for P<0.05.

Results
For the GBM (group I), CVs for ADC and FA values calculated across all exams for each individual patient ranged from 2.0% to 9.1% and 8.7% to 20.3%, respectively. Inter-patient CVs for ADC and FA measurements calculated over all imaging exams were 4.2% and 14.2%, respectively, for all patient (Groups I-III) scans at 1.5 T. For studies at 3.0 T, the CVs for these measurements were 6.2% and 19.7%, respectively. The CV of the ADC measurement over all imaging exams was 5.0%, while that of the FA measurement was 16.5%. No obvious changes were seen subsequent to the administration of bevacizumab in Group I, indicating stability in the ADC value of CSF despite possible biological changes induced by treatment. For the entire group of patients (Groups I-III), the mean ADC values of the right and left atria of the lateral ventricles were (3.150 ± 0.20)E-9 mm2/s. Unpaired t-test performed on imaging exams at 1.5 T and 3.0 T showed no statistically significant difference between main field strengths for either ADC or FA.
Conclusions
Our study suggests that both intra- and inter-patient ADC measurements of CSF in the lateral ventricles are reproducible at 1.5 and 3.0 T, even following treatment with the anti-angiogenesis agent bevacizumab. An internal QC marker based on ADC measurements of CSF in the lateral ventricles with this level of reproducibility could provide the framework for establishing comparability of long-term longitudinal or multi-institutional data. However, measured FA values for CSF in the ventricles exhibited notably larger CVs for both intra- and inter-patient measurements, suggesting CSF may be a poor candidate for an internal QC marker for FA.

KEYWORDS: Apparent Diffusion Coefficient, Fractional Anisotropy, Ventricles
Ventricular apparent diffusion coefficient values in patients with glioblastoma

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Purpose
On MR imaging (MRI), the apparent diffusion coefficient (ADC) is a measure of the magnitude of fluid diffusion within a voxel. Restricted molecular movement in a sampled tissue is characterized by a lower ADC value, while free diffusion is characterized by a higher value. The purpose of this study was to evaluate the ADC values in the lateral ventricles in patients with glioblastoma (GBM) and compare to controls.

Materials and Methods
The ADC values were measured in 12 patients with GBM and 20 patients as a control group who had a history of cancer, but no clinical or radiological evidence of active disease. Measurements were taken in the anterior body and atrium of the lateral ventricles, and the 4th ventricle. Apparent diffusion coefficient values were excluded from analysis if there was marked compression upon the ventricle.

Results
The mean ventricular ADC value in the patients with GBM were 3.36E-09 and 3.34E-09 (right and left anterior body), 3.2 E-09 and 3.07E-09 (right and left atrium), and 3.19E-09 (4th ventricle). In the control group, the values were 2.93-09 and 2.97E-09 (right and left lateral ventricle), 2.65E-09 and 2.7E-09 (right and left atrium), and 3.09E-09 (4th ventricle). Simple T-test comparisons showed that the difference in ADC values was statistically significant in the lateral ventricles \([p=.0082 \text{ and } p=.0095 (\text{right and left anterior body}); p=.0015 \text{ and } p=.0326 (\text{right and left atrium})]\), but not in the 4th ventricle \((p=.4861)\).
Conclusions
The ADC values in patients with GBM are significantly greater than control patients in both the anterior body and atria of the lateral ventricles, but not the 4th ventricle. Future applications may include ADC measurement in the lateral ventricles to assess tumor aggressiveness and treatment response.

KEYWORDS: ADC, Leptomeningeal Disease, Ventricles

P-36
Voxelwise Correspondence of Resting-State and Task-Based FMRI Brain Maps

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Purpose
Resting-state functional MR imaging (fMRI) can provide brain maps of cortical vision, motor, language, and attention networks without the use of an overt behavioral task, thereby making this technique potentially valuable for planning and guidance of brain surgery in behaviorally/cognitively impaired patients and young children (1). Presurgical resting-state mapping could be appropriate for patients with brain tumors, arteriovenous malformations, epilepsy and other pathologies. However, it is not clear that resting-state fMRI signals necessarily reflect the same functional limits and specificity as task fMRI, especially at the level of individual voxels. To test the correspondence of task fMRI and resting-state fMRI, we obtained both types of data in the same imaging session from volunteers and compared the patterns of activation on a voxel-by-voxel basis.

Materials and Methods
One healthy subject and three brain tumor patients underwent conventional task fMRI vision mapping using an expanding checkered annulus extending to 20 degrees eccentricity plus a 5-10 minute resting-state fMRI scan with eyes closed. Task fMRI data were subjected to a temporal correlation analysis using a model of the task timing convolved with a standardized hemodynamic response function (2). Resting-state data were processed using FSL Melodic Independent Component Analysis (ICA) (3). A region of interest (ROI) including the occipital lobe plus adjacent portions of the parietal and temporal lobes was manually outlined on each subject’s anatomical data. Within this ROI, the task fMRI and resting-state fMRI signals were compared for each of 441 combinations of statistical threshold settings for each signal type. For each voxel, the presence (+) or absence (-) of resting-state fMRI and task fMRI signals were scored as one of four logical combinations (+/+,+/-,/-+,/-) and the number and probability of occurrence of each combination was recorded for all voxels in the analysis ROI. Volumetric brain maps of the voxel classifications were constructed and pseudocolored to show regions of high predictive validity (+/+ and -/-) versus zones in which the two activity patterns were mismatched (+/- and -/+).

Results
Optimal threshold combinations, yielded brain maps in which the resting-state fMRI and task fMRI patterns matched to a high degree (approximate probabilities of occurrence: 0.75, 0.75, 0.25, 0.25 for +/+,+/-,-/+,-/ respectively), though some regions of mismatch were evident.
Examination of the classification maps showed that the mismatch regions often consisted of clusters of voxels at the edges of the resting-state fMRI and task fMRI patterns suggesting that zones of mismatch reflect organized spatial differences in the location/extent of the two types of activation patterns. One potential cause of mismatch is the limited retinotopic extent (max 20 degrees visual field eccentricity) of the visual stimulus. Normal visual fields typically extend 80 degrees into the temporal field. So, a portion of the cortical retinotopic map will not be activated by our stimulus yet may share a common resting-state fMRI signal that allows it to be mapped with resting-state fMRI.

Conclusions
Task fMRI and resting-state fMRI maps can be highly consistent on a voxel-by-voxel basis at least within those portions of the cortical maps that can be activated by a task fMRI stimulus. However, resting-state fMRI may provide a more complete map including those regions not activated by task fMRI.

KEYWORDS: Brain Connectivity, Brain Mapping

P-44

White Matter Microstructure Abnormalities in the Fornix and Cingulum of Cigarette Smokers: a Diffusion Weighted Tractography Based Analysis

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Purpose
With cigarette addiction's one year quit success rate of only 5%, more effective therapies are greatly needed. A better understanding of the neurobiology of cigarette addiction may help to advance this effort. People with addictive disorders characteristically select smaller, sooner over larger, delayed rewards, and the neurobiology of such decision-making is beginning to come to light. For instance, recent studies in healthy people show that the use of episodic prospection during decision-making can reduce impulsive choices, an effect mediated by enhanced synchrony between medial temporal lobe regions implicated in episodic prospection and medial prefrontal areas implicated in decision-making. As such, we hypothesized that regular smokers would show structural abnormalities in the white-matter tracts through which these brain areas communicate: the cingulum, fornix, and uncinate. Previous studies of white-matter in smokers using diffusion tensor imaging (DTI) have yielded inconsistent results, and no prior studies report data from the fornix. Here, we used a novel DTI tractography analytical approach assessing diffusion properties along our tracts of interest to quantify differences in white matter microstructure integrity associated with smoking. In addition, we measured correlations between white matter integrity and measures of addiction severity, and cigarette consumption.

Materials and Methods
We obtained diffusion-weighted images from nonsmokers (n=15) and smokers (n=10), ages 19-40. Images were processed and analyzed using the UNC-Utah NA-MIC Framework for DTI Fiber Tract Analysis, including rigorous quality control, a study specific atlas, tractography, and analysis along the tract of diffusion parameters (fractional anisotropy, radial diffusivity, axial diffusivity, mean diffusivity).
Results
We found decreased white matter integrity in bilateral fornix crus of smokers relative to nonsmokers. Among smokers, white matter integrity in these tracts, as well as the anterior and body of bilateral superior cingulum positively correlated with measures of both cigarette consumption (including CO levels) and cigarette dependence.

Conclusions
White matter microstructural integrity is decreased in smokers compared to nonsmokers in the fornix crus. However, within smokers, those with increased addiction severity have increased integrity in this same area of the fornix, as well as in the body and anterior of the cingulum. This alteration in white matter integrity could reflect consequences of cigarette consumption and/or addiction, but also could reflect pre-existing structural difference in the brains of smokers, which would represent possible risk factors. The fornix and cingulum are both implicated in episodic prospection and decision-making, processes that may facilitate successful addiction treatment.

KEYWORDS: Diffusion Tensor Image, Diffusion-Weighted Imaging

P-06

Whole-brain Grey Matter Alteration Pattern Differs between Pure and Complicated Hereditary Spastic Paraparesis

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Purpose
The hereditary spastic paraplegia (HSP) is a rare neurodegenerative disorder, where the main clinical feature is progressive spasticity due to ‘dying back’ axonal degeneration. The HSP is classified into pure (pHSP), where the spastic paraplegia is the major clinical manifestation, and complicated forms (cHSP), presented with additional neurological signs (1). Due to borderline conditions, clinical distinction between pHSP and cHSP often is confounded. The same mutation may associate with intra- and inter-familiar phenotype variability, thus highlighting the forceful role of the environmental factors. Conventional brain MRI is usually normal in pHSP, while nonspecific findings, such as cortical atrophy, subcortical and periventricular white matter alterations may be presented in cHSP. The goal of this study was to identify gray matter (GM) alteration pattern across the whole brain in the two forms of HSPs.

Materials and Methods
The study involved genetically defined HSP patients from two research institutions, classified as pure or complicated according to Fink's criteria (3)]. Twenty pHSP patients (45 ± 13 years) and 20 age-matched controls were studied with 1.5 T MRI system, whereas ten cHSP (44 ± 18 years) and ten age-matched controls were studied with 3.0 T system. Voxel-based morphometry (VBM) optimized protocol was performed using high resolution T1-weighted MR images, separately for
both group. Voxelwise statistics were applied using TFCE option with 5000 permutations. Data were analyzed accounting age as a nuisance covariate. The level of significance was set to 0.05 corrected for multiple comparisons.

Results

Compare to normal controls cHSP group exhibits lower GM volume in multiple brain regions including bilateral motor and extramotor areas, subcortical and limbic structures, such as pre- and postcentral regions; inferior, middle, superior frontal gyri; supramarginal and angular gyri, dorsal and ventral striatum, hippocampus, parahippocampal gyrus, uncus and amygdala. No regions of increase or decreased GM volume were found in pHSP patients in comparisons to healthy controls. Figure 1: VBM analysis shows clusters of gray matter volumetric reduction (red-yellow) in cHSP group compared to controls. Results are represented on MNI152 2mm standard space.

Conclusions

The present study revealed widespread reduction of the GM volume in cHSP patients. It highlights the notion that distinct neuro-anatomical pattern of GM alterations can be presented in the two extreme clinical subtypes of HSPs.

KEYWORDS: Degenerative, Gray Matter, Voxel-Based Morphometry

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Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Printed Posters - Anatomy
Purpose
The purpose of our study was to review brain imaging findings in small bowel and combined liver/small bowel transplant recipients at our Center for patterns of findings. We compare our results with published data in other patients who underwent small bowel and other organ transplantations.

Materials and Methods
We retrospectively reviewed the brain imaging, clinical and electronic medical records of pediatric patients (< 18 years of age) who underwent isolated small bowel transplant (SBT) or liver-small bowel–pancreas (LSBT) transplantation at our institution, from January 2003 to December 2007. The study was approved by our Institutional Review Board. We included only patients who underwent transplantation during the study period. Data collected included: patient demographics, type of organs transplanted, date of transplantation, brain imaging modalities and findings and time of death. The patients were divided into two groups: patient who underwent imaging (“imaging group”) and patients without imaging (“nonimaging group”). The brain images including CT and MR imaging post-transplant then were reviewed individually for confirmation of the abnormalities. Ninety-seven patients (47.4% female and 52.6% male) were included in our study. The mean age at transplantation was three years with standard deviation of +/- 3.6. The youngest patient was 0.6 years while the oldest patient was 17.6 years. The majority of patients received small bowel/liver/pancreas (SB/L/P) transplant (74.2%), followed by isolated small bowel transplant (ISB) (22.7%), and small bowel/liver/kidney/pancreas (SB/L/K/P) transplant (3.1%). Thirty-eight patients (39.2%) had brain imaging post-transplant while 59 (60.8%) did not get brain imaging. Two of our patients had two transplantations each during the study period.

Results
Of the 38 (39.2%) patients who had brain imaging, 44.7% were males and 56.3% were females. Indications for imaging included seizures 13.4%, mental status changes 11.7%, PTLD 11.7%, fever 7.8%, hemorrhage 4.4%, headache 3.9% and stroke 3.9%. Patients were more likely to be investigated with CT without contrast 47.6% compared to CT without and with contrast 17%. On the other hand when MR imaging (MRI) was the method of investigation, MRI was more likely to be contrast enhanced, 23.6% compared to MRI without contrast 11.8%. In the imaging group, 26.3% had one brain imaging and 73.7% had more than one brain imaging and 47.4% had CT scan of the head alone. Also, 10.5% had MRI of the head alone and 42.1% had both CT and MRI. The highest number of images in any one patient was 33 consisting of 14 CT without contrast, 3 CT with contrast, 6 MRI without contrast and 10 MRI with contrast and 31.6% of the imaging group had no abnormal findings. Findings include volume loss in 37.8%, with improved volume loss in 20% of those, brain infarcts 27.8%, white matter changes 15.25%. PRES 10.5% with two episodes of recurrent PRES. Complications of PRES recorded included hydrocephalus, intraventricular hemorrhage, infarcts and cortical laminar necrosis. There were two subarachnoid hemorrhages and one each of PTLD and angitis. The overall mortality was 40 out of 98 patients.
(41.2%) at last follow up. The median follow-up time for the 57 living patients was 74.7 months (range 48.1 – 106.6 months). The log-rank test revealed that the nonimaging group was more likely to have a better survival compared with the imaging group (median survival, non estimable versus 38.9 months, p=0.03 (Figure 15). One year survival rate for patients in the nonimaging group was 81.4% (95%CI: 68.9-89.2%) and for patient in the imaging group, 68.4% (95%CI: 51.1-80.7%)

Conclusions
Thirty-nine percent of our small bowel transplant population was investigated for neurological disorders. Pediatric small bowel transplant patients were more likely to be investigated by noncontrast CT rather than MRI probably for reasons of expediency. On the other hand, when MRI was used, it was more likely to be contrast-enhanced. Reasons for imaging included seizures, mental status changes, stroke, PTLD and fever. The commonest abnormalities were brains volume loss, ischemic infarcts, PRES and hemorrhages. Some of the more interesting findings not previously reported include reversible volume loss, recurrent PRES which often was complicated by ischemia and hydrocephalus, and absence of brain infections and significant neoplasms. Brain imaging in SBT may indicate a worse outcome.

KEYWORDS: Brain Abnormalities, Pediatric Brain, Treatment Assessment

P-57

Discrepancy Between the Natural Angulation of Foramen of Monro and the Trajectory of an Endoscope Reaching the Floor of the Third Ventricle: An MRI Morphometric Study Explains Potential Damage to the Forniceal Columns During Neuroendoscopy

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Purpose
Crossing foramen of Monro (FoM) is essential during approach to the third ventricular (3rdV) floor for endoscopic third ventriculostomy (ETV) and treatment of hydrocephalus. Traversing FoM (known mean width of 2.4 mm) in a nondilated ventricular system with current semirigid endoscopes (smallest size of 2.5 mm) may put the fornical columns and thalamus at risk of injury. There is currently insufficient description of endoscopic trajectories across FoM relative to the actual 3D configuration of the normal FoM, which would help explain potential discrepancies accounting for such injuries during ETV. Therefore, in this MRI morphometric study we measure and compare the trajectory of endoscopic approach to the floor of 3rdV and the natural spatial angulation of FoM.

Materials and Methods
We retrospectively reviewed 3D FSPGR datasets from 50 patients (mean 48 years), all with normal, nondilated ventricles (mean Evans' index 0.23) and no intracranial pathology. Using multiplanar reconstruction, we established the skull entry point that theoretically would provide a straight trajectory to the usual site of ETV at the "safe zone" in the 3rdV floor by drawing a line from the "safe zone" through the center of FoM. We measured the distance of the point of intersection of this line with the skull from the midline and from the coronal suture. We
established the relation of this trajectory to FoM by measuring its angulation relative to the midsagittal and intercommissural (AC-PC) lines. We also measured the natural orthogonal angulation for each FoM and compared this with angles of endoscopic trajectories.

**Results**
The trajectory line towards the 3rdV floor was 86±5° to the AC-PC line, and 12±3° to the midsagittal line. In comparison, the true anatomical angulation of FoM was 31±8° relative to the AC-PC line, and 37±4° from the midsagittal line. Therefore, the ETV trajectory is discrepant from the anatomical configuration of FoM by as much as 55° and 25° relative to these respective planes. The mean coordinates of the theoretical skull entry points for an endoscope were 20±4 mm lateral to the midsagittal plane, and 16±8 mm posterior to the coronal suture; these were more medial and posterior to the standard burr hole location performed for ETV, which is at or anterior to the coronal suture along the midpupillary line (i.e., at 31±3 mm from the midsagittal line in our dataset).

**Conclusions**
We provide the first MR imaging (MRI) morphometric data for endoscopic trajectories during ETV. When currently used semi-rigid endoscopes span FoM the relative approach to the 3rdV floor is markedly at variance with the natural orthogonal angulation of FoM. This discrepancy between the configuration of FoM and the angle necessary for an endoscope to reach its target may theoretically result in stretching and injury to brain structures forming the boundaries of FoM. Even greater strain may be placed on these structures by the placement of skull entry points that are not on straight projections to the 3rdV through FoM. These results will be useful to better plan neuroendoscopic procedures and assess the risk of injury to structures adjacent to FoM.

**KEYWORDS:** Anatomy, Monro Foramen

**P-58**

**Enhancement Pattern of the Normal Facial Nerves on Three-Dimensional T1-Weighted Images Using 3T and 1.5T MRI Scanners**

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**Purpose**
Magnetic resonance imaging (MRI) is useful for evaluating diseases affecting facial nerves. Recently, 3 T MRI scanners have become common in our daily clinical practice along with 1.5 T scanners, and gradient echo-based three-dimensional T1-weighted images (3D-T1WIs) are commonly used. In contrast, gradient echo-based 3D-T1WIs are expected to show susceptibility artifacts due to mastoid pneumatization, which are greater at using 3 T than 1.5 T scanners. We compared the enhancement patterns of normal facial nerves using 3 T and 1.5 T scanners.

**Materials and Methods**
We retrospectively reviewed 76 normal facial nerves of 38 patients who underwent pre and postenhanced 3D-T1WIs at our hospital from December 2012 to November 2013. Nine patients (6 men, 3 women: mean age, 63.11 years) underwent T1-weighted fast field echo (T1-FFE) at 3 T MRI (Achieva, Philips) with 8 ch head coil, slice thickness of 0.8-1.0 mm, and slice gap of 0
Twenty-nine patients (18 men, 11 women: mean age, 62.24 years) underwent radio frequency spoiled field echo (RF-spoiled FE) at 1.5 T MRI (Vantage, Toshiba) with 8 ch head coil, slice thickness of 1.0-1.2 mm, and slice gap of 0 mm. Cases with clinical facial palsy, cerebello-pontine angle tumor, past history of intracranial surgery, and radiation therapy were excluded from this study. We divided the normal facial nerves into five anatomical segments as follows: the intrameatal segment (Im), labyrinthine segment (Lb), geniculate ganglion (GG), horizontal segment (Hz) and vertical segment (Vt). Two radiologists evaluated the enhancement of each segment using a 3-scale visual score as follows: 1, not enhanced; 2, mildly enhanced and hypointense to vessels; 3, strongly enhanced like vessels. We compared the visual scores in each segment on a 3 T scanner with those on a 1.5 T scanner via relative to an identified distribution (RIDIT) analysis.

**Results**

Visual assessment score and percentage of visual enhancement (Enhance %) in each segment are shown in the Table. No strong enhancement was observed in the Hz (3 T) and Im (3 T and 1.5 T). The scores in Hz and Vt at 1.5 T were significantly higher than those at 3 T (P<0.01). There were no significant differences between the scores in Im, Lb, and GG. Image quality was adequate for diagnosis.

**Conclusions**

Enhancement of the Hz and Vt segment of normal facial nerves were better visualized at 1.5 T than at 3 T MRI, whereas there were no significant differences in the Im, Lb, and GG between 1.5 T and 3 T.

**KEYWORDS:** Facial Nerve

**Table** Visual scores and percentage of visually-enhanced segments at 3T and 1.5T 3D-T1WIs

<table>
<thead>
<tr>
<th>score</th>
<th>Im 3T</th>
<th>Im 1.5T</th>
<th>Lb 3T</th>
<th>Lb 1.5T</th>
<th>GG 3T</th>
<th>GG 1.5T</th>
<th>Hz 3T</th>
<th>Hz 1.5T</th>
<th>Vt 3T</th>
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<td>4</td>
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<td>20</td>
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<td>3</td>
</tr>
<tr>
<td>Enhance %</td>
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<td>10.3</td>
<td>55.6</td>
<td>62.1</td>
<td>88.9</td>
<td>93.1</td>
<td>11.1</td>
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<td>94.8</td>
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</table>

**P-56**

Ossification of the Pterygoalar and Pterygosinous Ligaments: A Study of CT Variants Clinically Relevant to Mandibular Nerve Entrapment and Percutaneous Approaches to the Infratemporal Fossa

T Matys¹, T Ali¹, R Kirollos¹, T Massoud²
Purpose
The superior aspect of the infratemporal fossa is a region of considerable neurosurgical importance, containing branches of the mandibular nerve exiting foramen ovale (FO). In this area two ligaments course from the pterygospinous process of the lateral pterygoid plate to the inferior aspect of the sphenoid bone, namely the pterygospinous ligament (ligament of Civinini) attached caudally to the spine of the sphenoid bone, and the pterygoalar ligament (ligament of Hyrtl-Calori, innominate ligament) attached more anteriorly to the infratemporal surface of the sphenoid. Their ossification leads to formation of bony bars or complete foramina named after the respective ligaments, which may produce neurological symptoms by entrapment of mandibular nerve branches. Ossification of the pterygoalar and pterygospinous ligaments can also interfere with passage of needles during percutaneous approaches to the mandibular nerve, or the submandibular approach to the trigeminal ganglion for treatment of trigeminal neuralgia. While presence of these two ligaments has been studied on dried skulls, and plain radiographs have been used to check for their presence prior to percutaneous procedures, there are no reports of their in vivo demonstration using modern cross-sectional imaging. In this study we assessed the feasibility of visualization of pterygoalar and pterygospinous ligaments on high resolution computed tomography (CT), and determined the frequency of their occurrence.

Materials and Methods
We retrospectively analyzed 150 CT scans of patients undergoing sinonasal imaging (80 men, 70 women, mean age 52 years, range 18-84 years). Axial 0.75-1.0 mm images with bone algorithm reconstruction were imported into Osirix v.5.7. On each side, the presence of bony bars traversing FO was checked by obtaining 20 mm horizontal maximum intensity projection (MIP) reconstructions at the level of FO. Next, oblique 10 mm MIPs were obtained parallel to the lateral pterygoid plate and through the region of FO, and the presence or absence of ossified pterygoalar and pterygospinous ligaments was assessed.

Results
Ossified pterygoalar and pterygospinous ligaments were identified easily using the above method. An ossified pterygoalar ligament was demonstrated in five patients (3.3%); in two of these (1.3%) ossification was bilateral; ossification of these ligaments was always complete. The average diameter of the resulting pterygoalar foramen was 4.4 mm. A completely ossified pterygospinous ligament was seen in four patients (2.7%); all of these were unilateral. The average diameter of the resulting pterygospinous foramen was 7.5 mm. Partial ossification of pterygospinous ligament was present in 23 patients (15.3%), and in 11 (7.3%) of these patients the ossification was bilateral.

Conclusions
We describe for the first time the visualization of ossified pterygoalar and pterygospinous ligaments on routine helical high resolution CT. The frequency of seeing these foramina on CT is in the range of previously reported results on dry skulls, suggesting that our method is accurate. Our data are clinically useful during skull base imaging when special attention is directed to FO for the possible presence of ossified ligaments as a cause of a patient's facial pain, or to explain potential obstacles in percutaneous needle access to the infratemporal fossa.

KEYWORDS: Anatomical Variation, Foramen, Skull
The Large Unilocular Anterior Temporal Virchow-Robin Space with Perilesional FLAIR Signal: a Tumour Mimic

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Purpose
To report a cohort of large unilocular anterior temporal Virchow-Robin (VR) spaces with an aim to assess the incidence of perilesional FLAIR MR signal, change in size or perilesional FLAIR signal over time, and to identify potentially unique MR imaging features.

Materials and Methods
A series of 10 cases were identified by review of teaching file database of SS between August 2010 and November 2013. Inclusion criterion was location in the anterior temporal lobe, size greater than 5 mm and internal MR signal characteristics identical to cerebrospinal fluid. Demographic, clinical and temporal data were reviewed retrospectively. Two neuroradiologists measured the lesion size and categorized the perilesional MR signal as mild, moderate and extensive at initial imaging, and at longitudinal follow up.

Results
Median age was 60 years (range 37–83). Mean maximal size was 9.5 mm (range 6–15). A total of eight patients had perilesional FLAIR signal abnormality; this was mild in one patient, moderate in two patients, extensive in five patients. Imaging follow up was available in seven patients (mean 43 months; range 15–100). There was no change in lesion size or perilesional FLAIR signal in six patients. One patient developed increased perilesional FLAIR signal; the perilesional signal later regressed with replacement by smaller VR spaces and an overall increase in size of the large unilocular VR space. Notably, contact with a branch of the middle cerebral artery with associated focal cortical distortion or thinning overlying the VR space was seen in all but one patient; two patients had a thin tract leading to the subarachnoid space.

Conclusions
Perilesional FLAIR signal change is common with large (>5 mm) unilocular anterior temporal VR spaces. While the majority of large anterior temporal VR spaces remain stable in size and appearance, rare change in perilesional FLAIR signal or size may occur. Focal cortical distortion or thinning at the point of adjacent vascular contact is frequent, and rarely a tract can be identified leading to the subarachnoid space. These may be unique diagnostic features that could allow more definitive distinction from cystic tumor. Accurate recognition of these benign "do-not-touch" abnormalities will avoid unnecessary invasive treatment.

KEYWORDS: Anatomy, MR Imaging Brain, Virchow-Robin Space
The Moving Carotid Artery: A Retrospective Review of the Retropharyngeal Carotid Artery and the Incidence of Positional Changes on Serial Studies

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Purpose
Retropharyngeal carotid arteries are a well known anatomical variant in the neck, and can have clinical significance related to potential surgical complications. Congenital alterations of the normal anatomy as well as increasing tortuosity of the arteries with age have both been suggested as possible causes. Multiple studies have documented the incidence of retropharyngeal carotid arteries, but to date, only a single case report (from the otolaryngology literature) has discussed the change in position of the carotid artery to and from a retropharyngeal location at two time points. The purpose of this study was to evaluate for the incidence of retropharyngeal internal carotid arteries and to evaluate their change in position over serial computed tomography examinations of the neck.

Materials and Methods
A retrospective review of 307 computed tomography examinations of the neck in 145 patients was performed. Patients with previous neck surgery or large neck masses were excluded because of altered anatomy. The position of each carotid artery was given a numerical rating on each examination, indicating that the artery was retropharyngeal, marginal, or lateral in position. In patients with prior examinations, the position of each artery and change or lack of change in position was recorded. The data was reviewed to assess the incidence of retropharyngeal carotid arteries in the study population and to assess for the incidence of change in the position of the carotid arteries. Potential confounding factors, such as head rotation, head tilt or degree of atherosclerosis were also recorded for each patient, to determine whether these elements had an influence on the carotid artery position.

Results
Of the 145 patients evaluated, 34 were excluded. The final number of examinations included in the study was 250. Sixty-three of 111 patients had at least 1 comparison study. In this group of patients, there was a range of 1 to 4 comparison studies. A total of 26 retropharyngeal carotid arteries were present on the baseline exam in 19 (17.1%) of 111 patients. There was documented motion from retropharyngeal to lateral or vice versa in a total of 4 (6.3%) of 63 patients with comparison studies. The average patient age in the study population was 51.7 years with a range of 2-84 years. The average age of patients with retropharyngeal carotid arteries was 60.8 years with a range of 37-78 years.

Conclusions
A carotid artery that assumes a retropharyngeal position at some point during its cervical course is not uncommon, occurring in 17.1% of our patients. The only recently reported phenomenon of migration of the carotid arteries to and from a retropharyngeal position in the neck over time is confirmed by our study, occurring in 4 of 63 patients. It is important for radiologists and clinicians to be aware of this phenomenon to avoid potential procedural complications.
Time course study of neurochemical alteration in MCAO rats: An in vivo 1H-MRS study at 7.0 T

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Purpose
We aimed to assess and quantify the onset time for hyperacute middle cerebral artery occlusion (MCAO) ischemic stroke by measuring the apparent diffusion coefficient (ADC) of diffusion-weighted imaging (DWI) and one hour magnetic resonance spectroscopy (MRS) at 7.0 T.

Materials and Methods
Diffusion-weighted imaging (DWI), conventional T2-weighted imaging (T2WI), and subsequent focal ADCs were employed to evaluate ischemic brain lesions in a rat model of MCAO (n = 12) at different time points following stroke. A quantitation of local changes in metabolite concentrations within the lesions was performed using MR spectroscopy (MRS). Proton metabolites were quantified automatically using LCModel software.

Results
Half an hour after MCAO, a high signal area was observed on DWI in all animals. No abnormal signal was observed within six hours on T2WI. Apparent diffusion coefficient (ADC) images of the central area, peripheral striping, and on the fringes of the infarction showed a lower signal than the normal side. The ADC decreased significantly within half an hour after infarction, followed by a gradual elevation in volatility levels, and then becoming relatively stable at a lower level three hours later. MR spectroscopy displayed a consistent elevation of lactate and reduced n-acetyl aspartic acid. Glutamate and taurine reached a maximum two hours after MCAO, and began to decrease one hour later.

Conclusions
Hyperacute ischemic stroke can be quantitatively detected with the application of ADC, DWI, and MRS. These methods also may be used to quantitatively assess the ischemic onset time of a hyperacute stroke.

KEYWORDS: MR Diffusion, MR Spectroscopy

Variations in Euclidean space angles of confluence for superior cerebral bridging veins and the superior sagittal sinus in normal and AVM patients: An MRV-morphometric study

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¹Stanford University Medical Center, Stanford, CA, ²Stanford University School of Medicine, Stanford, CA
Purpose
Neuroimaging anatomy of the intracranial venous system has been studied extensively, and many variations in drainage, size, and collaterals are well documented. Superficial veins lie on the surface of the cerebral cortex and drain mainly into several groups of bridging veins (BVs). The superior sagittal sinus (SSS) receives 8-12 BVs mainly from the superior surfaces of the frontal, parietal and occipital lobes. Although we know that most BVs enter the SSS at an angle opposite to the direction of blood flow, to date, few studies have attempted to investigate in detail the point of entry of BVs into the SSS. In particular, the 3D spatial configuration of these venous confluences has not been studied previously. This anatomical information would be pertinent to several clinically applicable scenarios: to plan intracranial surgical approaches with the goal of preserving bridging veins; to study anatomical factors in the pathophysiology of cerebral venous thrombosis occurring in the SSS; and to plan endovascular retrograde microcatheterization of pial veins when attempting transvenous embolization strategies for vascular malformations (AVMs). We wished to determine if AVM pial veins were theoretically more acutely angled and difficult to engage at the SSS than normal. Therefore, we measured the nonreflex angles between two vectors on an oriented Euclidean plane at the confluence of normal cortical BVs with the SSS, and compared these with similar angles of BVs that drain ipsilateral cortical AVMs.

Materials and Methods
We retrospectively analyzed diagnostic brain MRI coronal 2D TOF MRV images of normal and AVM patients. We manually segmented 2-4 major superior cerebral BVs in each hemisphere and the adjacent segments of confluence with SSS. The concept of a Euclidean space encompasses Euclidean planes in 3D space, and in a Euclidean plane the angle between two vectors is related to their dot product and their magnitude. We therefore measured the confluence angles between BVs and SSS by calculating the arcsine or the dot product of two vectors divided by the product of their magnitudes, where one vector was created parallel to the SSS and the other on the path of the intersecting cortical vein of interest. We compared cortical BV angles of confluence with the SSS for veins draining pial AVMs and those in normal patients using the two-tailed Students t-test.

Results
We measured 70 venous confluence angles in normal (n=44) and AVM patients (n=26). The rostrally located BV/SSS angles were less acute than those observed more caudally. However, there was no statistical difference (p>0.05) between mean BV/SSS confluence angles in normal patients (56.2°, SD=22.4°), compared with AVM patients (46.2°, SD=22.3°).

Conclusions
There is no difference between normal and AVM patients in the angles projected in 3D space between the superior cerebral BVs and the SSS. In principle, participation of cortical veins in the drainage of pial AVMs should not confer added difficulty to their microcatheterization across the SSS, when compared to the acute angles present in normal individuals. This has useful implications for potential choices and strategies requiring transvenous retrograde approaches for AVM treatments.

KEYWORDS: Anatomical Variation, Anatomy, Arteriovenous Malformation

Monday
6:30AM - 3:00PM
Magnetic Resonance Image Evaluation of Temporomandibular Joint Cartilage Using Microscopic Coil.

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Purpose
To evaluate the cartilage morphology of the temporomandibular joint (TMJ) in symptomatic and asymptomatic volunteers using microscopic coil in MR imaging (MRI).

Materials and Methods
A regional committee for medical research ethics approved the study and informed volunteer consent was obtained. In this prospective study, 40 TMJs were examined: 20 from symptomatic patients with temporomandibular disfunction (TMD) and 20 asymptomatic volunteers. Bilateral MR imaging of the TMJs were performed by using microscopic coil and the images were assessed for disk position and cartilage morphology and thickness.

Results
There is no statistically significant difference in control and DTM groups regarding the cartilage regularity in the right condyle (p>0.999), left condyle (p=0.617), right articular eminence (p=0.117) and left articular eminence (p>0.303). Both groups presented no statistically differences regarding to thickness (Table 1). The cartilage morphology was similar to the cortical bone morphology (Figure 1).

Conclusions
MR images of the TMJ using microscopic coil provide good observation of the articular cartilage, with no significant differences between symptomatic and asymptomatic group. The fibrocartilage regularity was similar to the cortical bone morphology.

KEYWORDS: Coils, MR Imaging, Temporomandibular

Table 1. Cartilage thickness (mm) in control and TMD groups

<table>
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<tr>
<th></th>
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<th>CONTROL sd</th>
<th>TMD average</th>
<th>TMD sd</th>
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OLC-oclusion - left condyle
ORC-oclusion - right condyle
OLE-oclusion - left eminence
ORE-oclusion - right eminence

Cartilage in mandibular condyle and temporal eminence
(Filename: TCT_P-62_Ansr2.jpg)

P-66

Metastasis to the Thyroid Gland: Spectrum of PET/CT Imaging Findings

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¹Wilford Hall Ambulatory Surgical Center, San Antonio, TX, ²The University of Texas MD Anderson Cancer Center, Houston, TX

Purpose
Intrathyroid metastases from extrathyroid primary malignancies are rare but do occur. While clinical findings may be subtle, detection of intrathyroid metastases has improved with current imaging techniques. The purpose of this study is to evaluate the positron emission tomography (PET)/computed tomography (CT) appearances of intrathyroid metastases.
Materials and Methods
The PET/CT appearances of metastases to the thyroid were reviewed retrospectively. Inclusion criteria were PET/CT imaging and cytologic documentation of metastasis matching an extrathyroidal primary tumor. The following PET/CT features of intrathyroid metastases were recorded: disease extent, standardized uptake value (SUV) and presence of associated cervical adenopathy.

Results
Intrathyroidal metastases were diagnosed in 23 patients, 10 men and 13 women. Ages ranged from 44 to 79 years (median, 58 years). Sites of primary tumor were lung (n=9), breast (n=5), head and neck (n=4), melanoma (n=2), colon (n=1), neuroendocrine tumor (n=1), and synovial sarcoma (n=1). The time elapsed from the diagnosis of the primary tumor to the PET/CT scans ranged from 2 to 141 months (median, 21 months). Fifteen patients were asymptomatic, seven presented with a palpable neck mass, and one patient complained of neck pain. Indications for PET/CT included the following: staging (n=16), prior ultrasound-guided fine-needle aspiration of a suspicious thyroid nodule documenting metastatic disease (n=6), and a thyroid mass seen on prior CT examination. The intrathyroidal metastases presented on PET/CT as a solitary nodule (n=20), multiple discrete thyroid nodules (n=2), or diffuse infiltration of the thyroid gland (n=1). The SUV ranged between 3.9 and 42 (median, 12.5). On PET/CT, other distant metastases were present in 17 patients; six patients had metastatic disease limited to the neck and in four of these six patients, the thyroid was the only site of metastatic disease.

Conclusions
In any patient with a previous or current history of an extrathyroid malignancy, an FDG-avid thyroid mass or diffuse infiltration of the thyroid on PET/CT should be considered a potential metastasis until proven otherwise.

KEYWORDS: Metastases, PET/CT, Thyroid

Role of PET/CT parameters in oral cavity squamous cell cancers

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Purpose
American Joint Committee on Cancer (AJCC) staging for oral cavity squamous cell cancers (OSCC) currently is based on anatomy and size, but metabolic tumor characteristics also should be considered. The goals of this study were to seek associations between Positron Emission Tomography/Computed Tomography (PET/CT) parameters and pathological findings, and determine the potential prognostic value of PET/CT parameters in oral squamous cell cancers (OSCC).

Materials and Methods
In this retrospective study with IRB approval, 36 OSCC patients underwent staging PET/CT and contrast enhanced neck CT before surgery. PET/CT parameters were measured for the primary
tumor and the largest involved node, including maximum, mean, and peak standardized uptake values (SUVmax, SUVmean, and SUVpeak), metabolic tumor volume (MTV), total lesion glycolysis (TLG), standardized added metabolic activity (SAM), and normalized standardized added metabolic activity (NSAM). Patients' age, sex, alcohol use, and smoking status were collected. Pathological outcomes included: Perineural invasion (PNI), lymphovascular invasion (LVI), extracapsular spread (ECS) of nodal disease, and pathological T and N stages. Separate multivariable logistic regression models were fit for each PET/CT parameter and outcome adjusting for potentially confounding variables. Multivariable Cox proportional hazards models were used for the analysis of progression free survival (PFS).

Results
In multivariable analysis, high (>=median) tumor SUVmax (OR 7.5), SUVmean (OR 7.5), MTV (OR 62.8), TLG (OR 20.6), SAM (OR 16.6) and NSAM (OR 62.8) compared to low had significantly higher odds of having a high pathological T-stage (T3/T4) (p<0.05). No other significant associations between the PET parameters and other pathological outcomes were found in multivariable analysis. No significant associations were found with PFS.

Conclusions
PET/CT parameters can be useful to identify advanced T stage. As T stage increased in OSCC, PET parameters increased, especially tumor MTV, TLG, SAM and NSAM. PET/CT parameters did not predict other pathological outcomes or clinical behavior in OSCC.

KEYWORDS: PET/CT

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Printed Posters - Interventional
P-71

Acute Respiratory Distress Syndrome Following Transarterial Embolization of a Dural Arteriovenous Fistula by Using Onyx Liquid Embolic System

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Purpose
To demonstrate a rare, remote but possible complication during transarterial embolization of a cerebral dural arteriovenous fistula with Onyx liquid embolic system.

Materials and Methods
A 56-year-old woman with a dural arteriovenous fistula (dAVf) associated with a silent arteriovenous malformation underwent endoarterial surgical treatment to eliminate the dAVf.

Results
The dAVf was eliminated successfully endovascularly followed by surgical removal of the AVM two weeks later. Subsequently, she developed respiratory problems. Chest x-ray showed Onyx cast within the right lung.
Conclusions
Remote cardiac and pulmonary complications associated with transarterial Onyx embolization procedures are rare however possible. To avoid this issue, users must get enhanced training in particular with angio-architectural hemodynamic behavior of the fistulae so that they can choose suitable and heavier properties for embolization in fast running pathologies. Also physicians who take over postoperative care need to be trained and informed of possible postoperative symptoms for an accurate and early diagnosis of the source of the respiratory issue.

KEYWORDS: Arteriovenous Fistulas, Arteriovenous Malformation, DAVF

P-73 6:30AM - 9:00PM

Anatomical features of the vertebral artery for transbrachial direct cannulation of guiding catheter to perform coil embolization of posterior circulation aneurysms

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Purpose
Transfemoral approach is a common technique for coil embolization of cerebral aneurysms in the posterior cerebral circulation. However, it is difficult to advance a guiding catheter into the vertebral artery (VA) through the femoral route in patients with a tortuous aortic arch, an unfavorable supra-aortic takeoff, aortic diseases or occlusion of the femoral artery. The purpose of our study was to investigate the anatomical features of the VA for transbrachial direct VA cannulation of a 6Fr guiding catheter to perform coil embolization of cerebral aneurysms in the posterior cerebral circulation.

Materials and Methods
Included in our retrospective analysis were patients who underwent transbrachial coil embolization of cerebral aneurysms in the posterior cerebral circulation by direct VA cannulation of a 6Fr guiding catheter from January 2007 to December 2013. Investigated were patient characteristics, preoperative sizes of aneurysms, aneurysms location, the angle formed by the proximal VA and the subclavian artery (AVS) and the VA diameter at the level of the fourth cervical vertebrae (VAD) in the side of the transbrachial access route.

Results
Thirty-two patients with 33 aneurysms met our criteria. Their age ranged from 26 to 83 years (average; 59.0 years). The locations of aneurysms were the VA (n=17), basilar artery (BA) tip (n=10), BA trunk (n=3), BA superior cerebellar artery (n=1), BA anterior inferior cerebellar artery (n=1) and VA posterior inferior cerebellar artery (n=1). The right brachial artery was punctured in 28 cases with 29 aneurysms as transbrachial direct cannulation of a 6Fr guiding catheter, and left was in four cases with four aneurysms. The average AVS ranging from 45 to 130 degree was 80 degree, and the average VAD ranging from 3.18 to 4.45 mm was 3.91 mm.

Conclusions
For transbrachial direct cannulation of a 6Fr guiding catheter, it seems required that the AVS is about 45 degree or more and the VAD is about 3.18 mm or more.

KEYWORDS: Interventional
Classification of Brain Arteriovenous Malformations: a Model Based on Angioarchitecture

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Purpose
The aim of our study is to propose a new grading system for brain arteriovenous malformations (BAVMs) that relies on angioarchitecture and embryogenesis. Our work could be useful to illustrate the nature of these lesions and to help physicians, specifically interventional neuroradiologists, to determine the best management of their patients.

Materials and Methods
We reviewed the neuroradiological images of a series of patients with BAVM referred to our Department since 2000. All subjects underwent at least one session of angiography and MR imaging (MRI). Patients with imaging acquired only post-treatment were excluded. The magnetic resonance imaging and digital subtraction angiography data were analyzed according to 1) the anatomical location, size and morphology, 2) the angioarchitecture, and 3) the presumptive embryological stage of origin of the AVM according to size, location and type of tissue involved. This hypothesized developmental stage was subdivided into three categories, respectively early gestational age (week 1 to 12), midgestational age (week 13 to 27), and late gestational age (week 28 to 40). Data were processed for statistical relevance. Please refer to Table 1 for our proposed scoring system.

Results
We reviewed the imaging data of a total of 97 patients with BAVMs. The size of the lesion was < 3 cm in 63.9% of the subjects, ≥ 3 cm and ≤ 6 cm in 32.0%, and > 6 cm in 4.1%. The lesion was superficial in 70.1% of cases, deep in 22.7%, and infratentorial in 7.2%. The AVM disrupted the white matter only in 8.2%, the cortex only in 57.7%, the basal ganglia only in 2.0% and both the white matter and gray matter structures in 32%. The hypothesized embryological stage of the BAVM formation was set at the early, mid and late gestational age respectively in 33%, 19.6% and 47.4% of cases. Regarding the angioarchitecture, 55.7% of the BAVMs were drained by superficial veins only, 18.6% by deep veins only, and 25.8% by both types of venous drainage. The grade distribution of the lesions according to our proposed classification is as follow: 39.2% grade I, 15.5% grade II, 14.4% grade III, 16.5% grade IV, and 14.4% grade V. A comparison with the Spetzler-Martin grade allocation also has been performed.

Conclusions
Our work has produced a new BAVM grading system based on embryological stage of development and type of venous drainage. The analysis of the venous drainage is crucial in the setting of endovascular treatment. In addition, the presumptive time of development of the lesion helps to understand the extent to which the malformation is embedded and affects the brain tissue. Both these features, and therefore the proposed classification, can provide the clinicians important information to guide their management choices.

KEYWORDS: Arteriovenous Malformation, Classification

| Table 1: Proposed Scoring System |
### Table

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<th>Characteristic</th>
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Grade allocation: Total grade = *embryological stage* + *venous drainage*

### P-70

Establishment of experimental animal models suitable for feasibility testing in the development of covered stent for intracranial aneurysms

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**Purpose**

For the treatment of large or giant intracranial aneurysms, we have developed a stent graft covered with a thin, microporous segmented polyurethane membrane. The aim of this study is to establish animal models to assess the feasibility of this stent in tortuous intracranial vessels.

**Materials and Methods**

The covered stents were prepared using the specially designed balloon expandable stents (CoCr; 3~5 mm x 18~22 mm) by 1) dip-coating of polyurethane for covering using stainless steel rod, 2) laser-induced microporing (pre-pore size:100 μm, pre-opening ratio: 25%). Three types of animal experimental models were developed: (1) Canine carotid siphon model, which was made by inlaying anastomosed CCAs into a skeletonized acrylic tube designed according to the geometry of the human ICA on the basis of 3D rotational angiography (3D-RA) and 3D-printing-aided rapid prototyping manufacturing technology (Figure 1A). (2) Canine sidewall aneurysm model with modification by creating curves using a part of acrylic casing noted above while capable of making wide necked aneurysms on its outer curvature (Figure 1B). (3) Stent placement in rabbit aorta at the branching of lumbar arteries. Navigability, aneurysm occlusion, and patency of branching vessel were assessed using these models, respectively.

**Results**

(1) Our stents smoothly went through the canine carotid siphon model in all cases (n=6). (2) Our stents fitted well in the curved vessels in all case but one (endoleak) and spontaneous occlusion was confirmed in all cases after stent placement (n=6). Follow-up angiography at 12 weeks revealed patency of the parent vessels with minimal intimal hyperplasia as well as the occlusion of aneurysms (n=4). (3) The flow of lumbar arteries whose ostia were covered by the stents were maintained both in immediate and chronic (12 weeks) phase (n=6). This finding also is observed in overlapping stent placement (n=4).
Conclusions
These experimental models in combination seem feasible and sufficient to assess the devices designed for endovascular treatment of intracranial aneurysms on tortuous vessels with small branches. Also, our stent showed the potential of intracranial use in human.

KEYWORDS: Aneurysm Treatment, Animal Model, Stents

 Felipe P-Sanchez
Pediatric Neurointervention: Radiation Exposure Associated Lifetime Excess Brain Tumor Risk

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1St Luke's Roosevelt Hospital Center, New York City, NY

Purpose
Neurointerventional procedures have evolved to become the treatment of choice for intracranial vascular malformations in the pediatric population. Our aim is to assess the lifetime excess relative risk of brain tumors in pediatric patients receiving fluoroscopic radiation during endovascular treatment of intracranial vascular malformations.

Materials and Methods
A retrospective chart review was performed to tabulate the fluoroscopic dose in children from neonatal to 18 years of age treated at the Hyman Newman Institute for Neurology and Neurosurgery from 2004 to 2013 for intracranial vascular malformations. These values were corrected for scatter and attenuation to approximate maximal skin dosing. Using data modeled in a previous study, maximal skin dosing is converted to brain absorbed dose which then was applied to epidemiological data from the UK CT study to quantify the excess relative risk of
developing brain tumors for each procedure. These projections will be calculated in both the collimated and uncollimated setting.

Results
In the pediatric population, the excess relative risk for the development of brain tumors following neurointerventional procedures for intracranial vascular malformations ranges from 9 to 20 times that of the unexposed population per procedure in the uncollimated setting. When categorized for specific disease, the excess relative risk is highest following treatment of more complex vascular disorders such as vein of Galen malformations and arteriovenous malformations. When accounting for cumulative exposure of an individual following multiple procedures required for cure, the excess relative risk per patient can reach up to 100 times that of the unexposed individual in the uncollimated setting.

Conclusions
The advancement in neurointerventional procedures to treat intracranial vascular malformations in the pediatric population is associated with increased lifetime excess relative risk for the development of brain tumors. While this likely represents the sequela of our capability to treat more difficult and complex lesions, interventionalists should consider discussing such risks in their consultations with patients' families and take appropriate measures to reduce radiation exposure.

KEYWORDS: Arteriovenous Malformation, Radiation Dosage, Vein Of Galen

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P-67
6:30AM - 9:00PM

Radiation: A Secondary, Hazardous and Mostly Unrecognised Complication in Sole or Combined Neuro Endovascular Procedures

O Sanders1, S Derakhshani1, D Taylor1, S Derakhshani1

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Purpose
At present, there is no radiation dose limitation in neuro-endovascular surgery. High radiation doses in radiologically guided procedures can carry a substantial risk for radiation-induced injuries. This study questions if the radiation dose received by patients who have had failed or complicated treatment(s).
Materials and Methods
A retrospective study of 211 patients was carried out between January 2012 and November 2013. The inclusion criteria were the patients who have had incomplete, failed or complicated neuro-endovascular procedure(s)/treatments.

Results
In total, eight patients had their total radiation exposure doses calculated. The total radiation exposure dose included intra-operative imaging and postoperative follow-up imaging doses. Due to their incomplete or failed treatments, each patient underwent multiple computed tomography scans, angiograms and/or endovascular treatments. An analysis of the dose report for each surgery and/or follow-up scans showed that all patients had combined doses exceeding the recommended annual dose of 1 Millisievert. Each patient had received enough radiation for potential radiation-induced complications such as cataracts, skin burns, bone marrow death and hair loss (which was apparent in one patient).

Conclusions
Radiation dose is an important complication, especially in the patient who has had failed neuro-endovascular treatment(s). It is important to consider discussing radiation-induced complications when seeking patient's consent for neuro-endovascular procedures. Further radiation related follow ups may need to be debated, discussed and considered in patients receiving over two Gray of radiation in particular conditions such as for marrow failure, burns and other radiation-induced complications.

KEYWORDS: Radiation, Radiation Injury

Variations in cortical vein tortuosity metrics in normal and AVM patients: An MRI-morphometric study relevant to retrograde endovenous microcatheterization and treatment

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Purpose
Brain arteriovenous malformations (AVMs) produce localized clusters of abnormally tortuous vessels. Tortuosity metrics have been developed and applied to AVM feeders, but tortuosity of AVM draining veins (DVs) has not been studied previously. These veins increase in diameter in response to increased wall shear stress, and increase in length in response to increased mean venous pressure; both parameters result in increased vein tortuosity. Vessel tortuosity impacts on safety and efficacy of endovascular catheter navigation. There has been recent heightened interest in the concept of transvenous endovascular treatment of pial AVMs. Although there is perceived difficulty in catheterizing tortuous cortical superior cerebral veins (CVs), this is mitigated in part by the low profile and design of currently available microcatheters, allowing superior navigation in tortuous vessels. Nonetheless, objective methods of quantifying DV tortuosity would be useful in diagnosis and monitoring of AVM treatment. Here we quantify CV tortuosity in normal and AVM subjects using two complementary image segmentation methods.
Materials and Methods
We retrospectively analyzed diagnostic brain MR images (MRIs) of normal and AVM patients using axial contrast-enhanced BRAVO sequence images. Vessel segmentation required definition of each vessel's axis through a regularly spaced set of 3D points describing its skeleton curve. We manually segmented three major superior CVs in each hemisphere and analyzed these using metrics for evaluating 3D image data. We first used the 'distance metric' (DM), a tortuosity measure providing a ratio (dimensionless number) of the actual path length to the linear distance between curve endpoints. We also used the 'sum of angles metric' (SOAM) which integrates total curvature along a curve and normalizes by path length. We calculated DM and SOAM for each vessel, and report a normal range for CVs. We compared three datasets: (1) AVM DVs with CVs of separate normal subjects; (2) normal CVs in AVM patients not directly draining the AVM with CVs of separate normal subjects; and (3) in AVM patients, AVM DVs with matched contralateral CVs not directly draining the AVM; all comparisons made using two-tailed Student's t-test.

Results
We calculated 168 tortuosity metrics in 84 superior cerebral veins; 43 veins were in eight normal subjects and 41 were in seven AVM patients. In normal subjects the mean DM for CVs was 1.42±0.25, and the mean SOAM was 21.34±7.49 degrees/mm. In AVM patients, AVM DVs (n=14) showed greater tortuosity than in normal subjects, with a mean DM of 2.94±1.88 (p=0.01) and mean SOAM of 30.67±12.06 degrees/mm (p=0.02). CVs not draining the AVM (n=27) showed similar tortuosity as in normal subjects, with a mean DM of 1.41±0.20 (p=0.35), and mean SOAM of 15.61±5.78 degrees/mm. In AVM patients, AVM DVs were significantly more tortuous than matched contralateral uninvolved CVs (p=0.0002).

Conclusions
We report the normal ranges of two complementary CV tortuosity metrics. Objectively, AVM cortical DVs are significantly more tortuous than CVs not participating in AVM drainage, as well as more tortuous than CVs in normal subjects. Availability of these tortuosity metrics is valuable in prospective procedural planning of transvenous microcatheter-based AVM therapies.

KEYWORDS: Anatomical Variation, Anatomy, Arteriovenous Malformation

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Printed Posters - Pediatrics
P-77

ADC Histogram Analysis of Neonatal Hypoxic-Ischemic Encephalopathy

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Purpose
Diffusion-weighted imaging is a valuable tool in the assessment of neonatal brain, and changes in diffusion are seen as a consequence of normal development, and of pathologic states such as
hypoxic ischemic encephalopathy (HIE). Various methods of quantitative assessment of diffusion values have been reported. Global ischemic injury occurring during the time of rapid developmental changes in brain myelination can complicate the imaging diagnosis of neonatal hypoxic-ischemic encephalopathy (HIE). We compare a quantitative method of histographic analysis of brain apparent diffusion coefficient (ADC) maps to the qualitative interpretation of routine brain MR imaging studies by two experienced neuroradiologists. We correlate changes in diffusion values with gestational age in radiographically normal neonates, and we investigate the sensitivity of the method as a quantitative measure of hypoxic-ischemic encephalopathy (HIE).

Materials and Methods
All brain MR imaging (MRI) studies from the neonatal intensive care unit at our university medical center over a four-year period were reviewed to identify cases which were radiographically normal (23 cases), and those with diffuse, global HIE (12 cases). Apparent diffusion coefficient values of a single brain slice at the level of the basal ganglia were displayed histographically and peak (s-SDav) and lowest histogram values (s-SDlowest) were correlated with gestational age.

Results
Normative s-SDav values were significantly correlated with gestational age and declined linearly through the neonatal period (r²= .477, p< .01). Six of 12 cases of known HIE demonstrated significantly lower s-SDav and s-SDlowest ADC values than reflected in the normative distribution, several cases of HIE fell within the bounds of 95% confidence interval for normative studies, and one case demonstrated higher than normal s-SDav.

Conclusions
Single slice histographic display of ADC values is a rapid and clinically feasible method of quantitative analysis of diffusion. In this study normative values derived from consecutive neonates without radiographic evidence of ischemic injury is correlated with gestational age, declining linearly throughout the perinatal period. This method identifies cases of HIE, though the overall sensitivity of the method is low.

KEYWORDS: Neonatal HIE, Neonatal MR Imaging
Altered Structural and Functional Parietal Resting State Network Connectivity in Late Preterm Pre-adolescent Children.

A Degnan¹, V Schmithorst², J Wisnowski³, V Lee², R Ceschin², A Panigrahy²
¹University of Pittsburgh Medical Center, Pittsburgh, PA, ²Children’s Hospital of Pittsburgh of UPMC, Pittsburgh, PA, ³Brain and Creativity Institute, University of Southern California, Los Angeles, CA

Purpose

The significance of severe prematurity on white matter development is well established (1). Early prematurity greatly affects normal development and impacts elaboration of integrated brain networks. Resting state MR imaging (MRI) and diffusion tensor imaging (DTI) studies of premature infants demonstrate differences in connectivity in these networks (2, 3). The basic architecture of the default mode network (DMN) essential to normal cognition is likely formed during late gestation and may be affected even in near-term birth, although the effects of late preterm birth on functional and structural connectivity are presently undefined. To ascertain the
effect of late preterm birth on neuronal connections, this study examined differences in both structural and functional connectivity between late preterm and full term twins during pre-adolescent childhood from a cohort of children in Brazil without access to advanced neonatal care.

Materials and Methods
Forty preadolescents (ages 9-13) from a low socioeconomic status community in Brazil, 20 born in the late preterm period (≥ 32 weeks gestational age) and 20 at term, underwent neurocognitive testing, DTI and resting state functional MRI (RS-fMRI) using a 1.5 T Philips Achieva. Functional network topology was assessed using correlational coefficient analysis as a measure of connectivity strength for all possible connections between network nodes with correlation coefficients as the dependent variable (Fisher-transformed to Z-scores) using clustered wild bootstrap. Regions were classified for each major neuroanatomical region [subcortical (SC), frontal (FR), temporal (TP), occipital (OC) and parietal (PA)]. Seed-based probabilistic tractography DTI and RS-fMRI analyses were performed using right and left-sided seeds within the lateral parietal DMN (superior marginal, angular gyri), posterior DMN (posterior cingulate cortex, precuneus) derived from BrainSuite comparing groups in a voxelwise manner.

Results
Correlation coefficient matrix analysis (Figure) demonstrated increased functional connection strength within mostly posterior network nodes in preterm children. Parietal-parietal occipital-parietal, occipital-subcortical and parietal-subcortical connections occurred with greater frequency (p < 0.001) in preterms. RS-fMRI analysis showed overall diffusely increased functional connectivity in late preterms within the salience network, central-executive network, and posterior DMN when seeded from lateral-parietal DMN. There were small lateralized differences observed. Lateral-parietal DMN connectivity was more altered than posterior DMN with subcortical and temporal connectivity increases not observed with posterior DMN seeds. Subdividing the PMC showed most connectivity alterations in the posterior DMN with precuneus seeding, but posterior cingulate seeds also had anterior cingulate connectivity not seen with precuneus. Probabilistic tractography analyses showed intrahemispheric connectivity differences posteriorly and interhemispheric connectivity alterations in the posterior corpus callosum in preterms. In general, for both functional and structural analyses, there were greater right-sided connectivity differences.

Conclusions
Combined functional and structural connectivity analysis suggests that the late gestational period is critical for normal development of resting state networks with differences observed between late preterm and term twins during pre-adolescence. Correlation coefficient analysis showed increased global posterior connectivity. The posterior DMN, in particular, shows lasting differences between groups with increased local connectivity on functional imaging. Similar findings of inefficient network connectivity have been observed in autism and may reflect aberrant development and possibly, inefficient compensatory connectivity (4). Thus, increased functional parietal connectivity observed in late preterm, pre-adolescent children may reflect an alteration of posterior DMN development normally occurring in late gestation.

KEYWORDS: Diffusion MR Imaging, Functional Connectivity MR, Functional Networks
Apparent Diffusion Coefficient Changes during Cardiac Cycle in Craniosynostosis: Comparison of Pre- and Post-operation

Y Takahashi\textsuperscript{1}, M Hori\textsuperscript{1}, F Kumagai\textsuperscript{1}, M Suzuki\textsuperscript{1}, M Yoshida\textsuperscript{1}, K Asahi\textsuperscript{1}, K Kamagata\textsuperscript{1}, K Kamiya\textsuperscript{1}, M Miyajima\textsuperscript{1}, H Arai\textsuperscript{1}, S Aoki\textsuperscript{1}

\textsuperscript{1}Juntendo University School of Medicine, Bunkyo-ku, Tokyo, Japan

Purpose
Apparent diffusion coefficient (ADC) of the white matter changes significantly over the cardiac cycle due to the arterial inflow. The difference between maximum and minimum ADC on a pixel-by-pixel basis through the cardiac cycle was defined $\Delta$ADC. We hypothesize that $\Delta$ADC would reflect the change of the local intracranial pressure. The purpose of this study is to determine whether changes of $\Delta$ADCs comparing before and after neurosurgical operations in craniosynostosis patients.

Materials and Methods
$\Delta$ADCs were calculated and compared between pre- and postoperative states in four patients with craniosynostosis. Ages at the pre-operative MR study and genders of each patient as
follows; Patient 1: pre-operative study was performed at two years and 10 months old, gender was male, Patient 2: 10 months old, male, Patient 3: five months old, male, Patient 4: two years and two months old, male. Images acquired with a 3 T MR imaging unit (Philips Medical Systems, Best, The Netherlands) ECG-triggered single-shot diffusion EPI was performed with b-0 and 1000 sec/mm2. The regions of interests (ROIs) were drawn manually in the frontal white matter. The ROIs were placed at three points and averaged in each patient.

Results
The changes of ΔADC between pre- and postoperative MR studies in each patient were as follow; Patient 1: ΔADC was 0.11±0.021×10⁻³mm²/sec at pre-operative study, and increased to 0.16±0.017×10⁻³mm²/sec at postoperative study (Figure 1, ΔADC color map). Patient 2: 0.11±0.020×10⁻³mm²/sec at pre-operative study, increased to 0.15±0.040×10⁻³mm²/sec at postoperative study. Patient 3: 0.04±0.007×10⁻³mm²/sec at pre-operative study, increased to 0.32±0.051×10⁻³mm²/sec at postoperative study. Patient 4: 0.04±0.002×10⁻³mm²/sec at pre-operative study, increased to 0.07±0.006×10⁻³mm²/sec at postoperative study. Postoperative ΔADC tended to be higher than pre-operative state in all patients.

Conclusions
Changes of ΔADC in the frontal white matter between pre- and postoperation in patients with craniosynostosis indicated that ΔADC might reflect of intracranial pressure. Measurements of ΔADC may be a promising tool for noninvasive intracranial pressure monitoring.

KEYWORDS: Apparent Diffusion Coefficient, Craniosynostosis

Comparison of DTI parameter values in whole spinal cord ROIs versus white matter ROIs in the normal pediatric spinal cord

E Carabelli¹, P Shah², S Faro³, n barakat⁴, D Middleton², M Mulcahey⁵, F Mohamed²
Purpose
Currently diffusion tensor imaging (DTI) measures are obtained in the spinal cord by drawing whole cord regions of interest (ROIs) which introduces contamination from the gray matter structures. This may restrict measurements from subsections of the cord which may be clinically important in patients with spinal cord injury (SCI). Reduced field of view (FOV) DTI allows us to obtain DTI images at higher resolution enabling better characterization of gray and white matter structures. Hence the purpose of this study was to compare fractional anisotropy (FA), radial diffusivity (RD), and axial diffusivity (AD) values in whole cord ROIs and ROIs strictly limited to white matter.

Materials and Methods
Diffusion tensor imaging data of the cervical spinal cord (C1-C7) from three typically developing pediatric subjects were acquired using an inner-field-of-view (iFOV) echo-planar DTI pulse sequence implemented on a 3 T Siemens Verio scanner. The imaging parameters are: 20 diffusion directions, b=1000s/mm², voxel size = 1.2x1.2x3mm³, axial slices = (34-39), TR = 6100-8000 ms, TE = 115 ms, and number of averages = 3. Prior to tensor estimation image registration was performed for all of the diffusion-weighted directions using a 3D rigid body transformation. Diffusion tensors metrics (FA, RD and AD) then were calculated using MedINRIA software in all the slices using two different ROIs described below. Region of interest drawings criterion: ROIs were drawn in the transverse plane on B0 images on 49 slices in total across three subjects. Regions of interest were conservatively drawn leaving a one voxel space between spinal cord and CSF to reduce CSF contamination (Figure 1A). Next, utilizing an anatomical atlas and T2-weighted images we determined restricted ROIs to exclude gray matter and include only the white matter at each cord level (Figure 1B).

Results
Across all three subjects there was no statistically significant difference in FA, RD, or AD values after limiting ROIs to white matter (Table 1).

Conclusions
Traditional whole cord as well as selective gray and white matter analysis of the spinal cord can be performed using small FOV DTI and T2-weighted imaging. In doing so, there does not appear to be a significant difference in DTI (FA, RD, AD) values between whole cord and selective white matter tissue. This would imply that there is no significant contribution to spinal cord DTI values from gray matter tissue in normal pediatric subjects.

KEYWORDS: Diffusion Tensor Image

<table>
<thead>
<tr>
<th>Subject</th>
<th>Whole cord FA (std)</th>
<th>Restricted cord FA (std)</th>
<th>Whole cord AD</th>
<th>Restricted cord AD</th>
<th>Whole cord RD</th>
<th>Restricted cord RD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.494 (0.153)</td>
<td>0.505 (0.153)</td>
<td>0.691 (0.197)</td>
<td>0.711 (0.190)</td>
<td>0.316 (0.088)</td>
<td>0.317 (0.087)</td>
</tr>
</tbody>
</table>
Table 1. Measurement Parameters

Subject 2 | 0.446 (0.157) | 0.472 (0.157) | 0.959 (0.264) | 1.015 (0.279) | 0.508 (0.143) | 0.506 (0.157)
Subject 3 | 0.546 (0.142) | 0.527 (0.135) | 1.270 (0.339) | 0.1265 (0.317) | 0.502 (0.059) | 0.514 (0.073)

Figure 1. ROIs at C1 level

a. Whole cord ROI  b. Restricted ROI

(P-76) Computed Tomography (CT) Imaging Evaluation of the Cranio-cervical Junction in Pediatric Achondroplasia

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Purpose
Achondroplasia is a genetic disorder characterized by abnormal bone growth, leading to short stature and multiple osseous deformities (1). Pediatric mortality is secondary to brainstem compression (2). Life-saving spine decompression may be performed if early neurological deficits occur; however, often these patients die suddenly without preceding symptoms (3). Computed tomography (CT) imaging is the first-line modality to evaluate the osseous cranio-cervical junction when symptoms initially develop. We define CT imaging parameters that may be used to characterize the cranio-cervical junction in pediatric achondroplasia, in order to prognosticate which patients would benefit from early surgical intervention and thereby reduce morbidity and mortality.

Materials and Methods
In this retrospective study, included were pediatric patients (less than 18-years-old) with achondroplasia, who had CT imaging involving the cranio-cervical junction, from January 1, 2006 to June 30, 2013, at our institution. Two pediatric fellowship-trained radiologists evaluated each patient for quantitative and qualitative parameters, that have been defined previously in the literature for unrelated disorders (4,5) and were blinded to each other's results. These parameters included: Clivus orientation, clival-supraoccipital angle, opisthion hypertrophy, sagittal cervical canal diameter, powers ratio, and basion-axial interval. Age-gender-matched patients, in whom
the CT imaging results were unremarkable for intracranial findings, were used as the control
Results
Eleven achondroplasia and 11 control patients were included in the analysis. Achondroplasia
patients displayed a consistently abnormal clivus orientation and greater clivus-supraoccipital
angle mean (110.1 +/- 9.3 degrees) compared to controls (88.5 +/- 9.6 degrees). The opisthion
typically was hypertrophied and extended anteriorly to the posterior arch of C1 in achondroplasia
patients, resulting in a smaller sagittal diameter, and a larger mean powers ratio (ratio 1.67 +/-
0.57) compared to controls (ratio 0.80 +/- 0.12). Patients with significantly thickened opisthion,
developed clinically relevant neurological symptoms and required surgical decompression.
Sudden death occurred in one patient due to significant extension of the opisthion into the central
cervical canal.
Conclusions
This is the first study to define specific parameters for the CT imaging characterization of the
cranio-cervical junction in pediatric achondroplasia patients. Identifying these quantitative and
qualitative features on initial CT imaging will assist in determining which patients are at greater
risk of morbidity and mortality, and thus may benefit from close follow up, further imaging, and
prophylactic decompression surgery.

KEYWORDS: Compression, Cranio-Cervical Junction, Pediatric Spine

P-81


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¹The Hospital for Sick Children, Toronto, Ontario, Canada

Purpose
1) To review and demonstrate brain MR imaging (MRI) features of neonatal encephalopathy
(NE) which suggest etiologies other than hypoxia-ischemic injury (HII). 2) To provide an easy to
use road map for important alternative (other than HII) diagnostic considerations to the
radiologist performing neonatal MRI.

Materials and Methods
A retrospective analysis of 750 consecutive neonatal MRI brain studies obtained between
November 2010 and October 2013 at presentation of encephalopathy was performed to assess
the imaging findings that suggest etiologies other than HIE. Inclusion criteria were term neonates
(≥ 36 weeks gestational age) with seizures, hypotonia, altered sensorium, feeding difficulty or
difficulty in maintaining respiration. Preterm babies, those with therapeutic hypothermia and
studies performed for reasons other than the aforementioned were excluded from our study.
Where feasible and necessary, additional information was obtained from patient's electronic
charts. Entities with rare incidence such as some of the metabolic causes of NE, have been
selectively included in this study from former hospital database for the sake of complete
depiction of the spectrum.

Results
The causes of NE are heterogeneous. The outcomes of NE range from potentially reversible to
severe long term morbidity such as cerebral palsy, intellectual disability, learning/behavioral problems and/or mortality. MR imaging evaluation has been extremely valuable to assess neonatal brain in NE for the purpose of diagnosis and prognostication. HII is the most common cause of NE for which characteristic MR appearances have been described. Neonatal brain imaging is becoming more common place and neonatal brain injury often leads to medico-legal cases involving physicians, hospitals and parents. Given the facts that there is a considerable overlap of clinical and MRI appearances of different etiologies and that more than one etiology may co-exist, it is exceedingly important to recognize the patterns of brain injury that constitute the complex imaging spectrum of NE. Diffusion-weighted imaging (DWI) and MR spectroscopic imaging are particularly useful and often problem solving tools in the setting of metabolic encephalopathy. MR angiography, MR venography and susceptibility-weighted imaging compliment neonatal vascular imaging and neonatal head trauma at time of injury. MR evaluation may, thus, point to an alternate and/or co-existent etiology, aiding in accurate diagnosis and timely institution of specific therapy. Table 1 is a list of various etiologies (other than HII) which will be reviewed and demonstrated as an easy to review roadmap for important alternative diagnostic considerations.

Conclusions
Neonatal encephalopathy is etiologically diverse with a wide range of outcomes and broad MR imaging spectrum. MR imaging appearances can help to identify additional and/or alternative diagnosis in apparent HIE and point to a specific etiology. This is invaluable for appropriate management decisions, prognosis and medicolegally.

KEYWORDS: Encephalopathy, Metabolic, MR Imaging Brain

**Etiologies of Neonatal Encephalopathy:**

**I. Metabolic encephalopathy**

1. Hyperbilirubinemia
2. Hypoglycaemia
3. Hypernatremia
4. Inborn errors of Metabolism:
   a. Congenital lactic acidosis :
      i. Mitochondrial electron transport defect
      ii. Disorders of gluconeogenesis
         1. Pyruvate dehydrogenase deficiency
         2. Pyruvate carboxylase deficiency
   b. Fatty acid oxidation disorder
   c. Amino and organic aciduria
      i. MSUD
      ii. Propionic aciduria
   d. Urea cycle defect
   e. Co-factor, vitamin and metal deficiency
      i. Molybdenum co-factor deficiency
      ii. Menke’s syndrome
f. Defect in glycine cleavage
   i. Nonketotic hyperglycinemia
g. Peroxisomal disorder
   i. Zellweger disease

II. Malformations

1. Agenesis of the corpus callosum with / without colpocephaly
2. Polymicrogyria-agryria
3. Heterotopia
4. Hemimegalencephaly
5. Hydranencephaly
6. Brainstem malformation
7. Cerebellar dysplasia
8. Sturge Weber Syndrome

III. Perinatal stroke

1. Arterial ischemic stroke
2. Sino-venous thrombosis
3. Hemorrhage due to coagulopathies

IV. Congenital and neonatal CNS infections

1. Neonatal meningitis
2. Encephalitis
3. Congenital infection (TORCH)

V. Tumour

1. Teratoma
2. Choroid plexus papilloma
3. Astrocytoma
4. Glioblastoma

VI. Trauma

1. Severe birth trauma
   a. Iatrogenic
   b. Non-iatrogenic
Postoperative Surveillance of Cerebellar Pilocytic Astrocytomas

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Purpose
To identify the optimal frequency and duration of magnetic resonance (MR) imaging follow up in children who had gross totally resected cerebellar pilocytic astrocytomas. Our hypothesis is that following two consecutive MR examinations showing no evidence of tumor, separated by at least three months, gross totally resected cerebellar pilocytic astrocytomas do not recur and no further imaging follow up is necessary.

Materials and Methods
Retrospective review of our Neuro-Oncology database from January 2000 to July 2013 yielded 72 patients with cerebellar pilocytic astrocytomas who had their preoperative imaging available on PACS. Exclusion criteria were neurofibromatosis type I (n=1), patients who had imaging follow up < 2 years (n= 20), patients with subtotal resection (n = 16) and patients with metastatic tumors (n=1). There were 34 patients, (19 females, 15 males). The tumor volumes were recorded on the latest preoperative examinations. The postoperative MR examination dates and number of examinations (n=268) were recorded.

Results
The mean age at presentation was 6.4 years. The mean preoperative tumor volume was 46.9 ± 33.3 cm³. The mean number of follow-up examinations was 8.91 (± 2.84). The mean follow-up duration was 5.9 ± 2.8 years. The frequency of follow up was 2.1 ± 1.7 studies per year prior to the mention of 'no tumor' was recorded in the impression of the radiology report, versus 1.6 ± 0.9 year thereafter. In patients who had gross total resection of their tumors and at least two consecutive MR examinations demonstrating no residual disease we identified one recurrence, occurring 6.4 years after initial resection.

Conclusions
Local recurrence is exceedingly rare (2.8%) in children who underwent gross total resection of cerebellar pilocytic astrocytomas. The current follow-up MR frequency (approximately 2/year) appears excessive given the rarity and late occurrence of recurrences.

KEYWORDS: Pediatric Neoplasms, Pilocytic Astrocytoma, Primary Brain Tumors

Quantitative Susceptibility Mapping of hippocampus in children treated by cranial irradiation

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Purpose
Children treated for brain tumors often suffer debilitating effects of cranial irradiation, including memory dysfunction. Given sensitivity of quantitative susceptibility mapping (QSM) to tissue paramagnetic properties, we hypothesized that QSM can identify altered hippocampal tissue contrast that might reflect injury in children treated by cranial irradiation.

Materials and Methods
We retrospectively identified all children who underwent whole brain radiation for treatment of posterior fossa medulloblastoma and obtained 3D multi echo EPI MRI at 3 T. Controls who did not receive cranial irradiation also were selected randomly from our normal database. The parameters of 3D multi echo EPI were TE of 16.8, 40.3, and 63.8 (TR=95 ms, 1 mm3 isotropic voxel size, whole brain). The volumetric phase images were fitted linearly to generate a field map, followed by a background field removal and a phase unwrapping to calculate local field perturbation. The background-removed field map then underwent a dipole inversion algorithm regularized by L1-norm of wavelet transformation of magnitude images. Region of interest (ROI) analysis was performed to generate QSM metrics of the bilateral hippocampi and compared against controls.

Results
Fifteen irradiated children (mean age 12 years; 5 girls and 10 boys) and 11 controls were included. The mean time since completion of radiation therapy was 62 months (range 4-145 months). The mean QSM values (ppm) of the right hippocampi were: -0.0132 ± 0.0072 for the irradiated and 0.0089 ± 0.0039 for the control groups. The mean QSM values of the left hippocampi were: -0.0122 ± 0.0067 for the irradiated and 0.0067 ± 0.0023 for the control groups. Significantly lower QSM values were seen in the irradiated group compared to the controls for both right (p<0.001) and left (p<0.001) hippocampal regions.

Conclusions
Quantitative susceptibility mapping values were reduced that suggest altered paramagnetic properties of the hippocampal tissue after radiation exposure. The difference in susceptibility values may reflect changes in vascular condition or tissue oxygen extraction in the setting of reduced cell population and inhibition of hippocampal neurogenesis known to occur after radiation exposure. Quantitative susceptibility mapping may serve a future role in evaluating radiation-induced brain injury and associated changes in tissue microenvironment.

KEYWORDS: Hippocampus, Radiation Toxicity, Susceptibility-Weighted Imaging

P-74

Radiologic Progression of Facial Muscle Wasting Following Brainstem Tumor Resection.

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Purpose
Central nervous system (CNS) tumors are the leading cause of death in children with cancer. The most common brain tumor in the pediatric population is the WHO grade I pilocytic astrocytoma (PA). Focal tumors are the most common and are usually low-grade astrocytoma. Surgical intervention often is feasible although it carries significant risks due to important surrounding neuroanatomical structures. NF-1 patients are at increased risk of low grade gliomas which usually are located within the optic pathway or brainstem.

Materials and Methods
We describe a case of a 16-year-old male with NF-1 and atypical hamartomatous changes of the septum pellucidum and pons. Biopsy of the septum pellucidum revealed low grade PA. He completed chemotherapy resulting in significant tumor shrinkage and clinical improvement. However, subsequent imaging showed progressive cystic expansion of the left dorsal pons lesion involving the facial colliculus.

Results
A suboccipital craniotomy was performed with resection of the pontine lesion and histopathology confirmed the diagnosis of PA. Clinical and radiologic evidence of left masticatory, lateral rectus and facial expression muscle atrophy were observed six months after surgery, consistent with central injury of the left CN V, VI and VII.

Conclusions
The facial colliculus is a protuberance of the dorsal pons into the fourth ventricle. It consists of motor fibers from the seventh nerve and the sixth nerve nucleus. Lesion to this area is caused by primary CNS tumors, infection and stroke. Complete resection of brainstem tumors is not possible in light of important surrounding structures. A multidisciplinary approach is paramount for total rehabilitation.

KEYWORDS: Brainstem, Facial Muscle, Neoplasm
Reading comprehension in children with benign Rolandic epilepsy: an fMRI study.

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¹University of Montreal, Montréal, Quebec, Canada, ²Centre de Recherche du Centre Hospitalier Universitaire de Montréal, Montréal, Quebec, Canada, ³CHUM Notre Dame Research Center, Montréal, Quebec, Canada, ⁴CHU Sainte Justine, Montréal, Quebec, Canada, ⁵Montreal Children Hospital, Montréal, Quebec, Canada, ⁶Sainte-Justine Research Center/University of Montreal, Montréal, Quebec, Canada

Purpose
Children with benign epilepsy with centro-temporal spikes tend to show language impairments (Monjauze, 2005, Northcott, 2007). Abnormal epileptic activity is found in central and temporal regions of the brain, including regions involved in reading and syntactic comprehension (Overvliet, 2010). As far as we know, there is no study dedicated to sentence reading comprehension using functional magnetic resonance imaging (fMRI) suitable to young teenagers. Consequently, we adapted to French Canadian children a sentence reading task, earlier developed by Schafer (2011) to look at reading brain networks in RE children.

Materials and Methods
Ten children with Rolandic epilepsy (age=11.0 ± 1.3 y; 6 boys) and 14 healthy children (age=12.0 ± 1.5 y; 10 boys) performed a task in which they read a pair of syntactically complex sentences and decided whether the target sentence (the second sentence in the pair) is true or false given the meaning of the first one. Thereby the task requires both reading comprehension and decision making from verbal material. A MRI-compatible 2 buttons computer mouse was used to retrieve the accuracy and response time. To control for the motor, visual and executives aspects of the task, we added a control task in which children have to seek a target symbol, within two lines of nonverbal and nonfigurative symbols. They have to find one or two copies of the target symbols among distractors. We used a standard block design: seven task blocks of 27 s. (3 pair of sentences of 9s. each), seven control blocks of 27 s. (3 stimuli of symbols of 9 s. each) with a 9 s. fixation cross between blocks. A neuropsychological assessment (IQ, reading accuracy, reading comprehension, visual perception, processing speed) also was conducted with each child to ensure that they have a sufficient reading level to perform the language and control tasks.

Results
In healthy children, the « Sentence versus symbol » contrast revealed significant brain activations in six different clusters: 1) Left middle temporal gyrus – Wernicke (BA22/40), 2) Left superior temporal gyrus, 3) Left inferior frontal gyrus – Broca (BA45), 4) Right cerebellum. And for the same contrast, second level analysis showed differences between groups in these two regions: 1) Left superior temporal gyrus (BA22/40), 2) Left middle temporal gyrus (BA39). Children with RE showed less activations in these two regions.

Conclusions
In this study, we created a sentence reading comprehension task for children using fMRI with minimized task duration by limiting the number of stimuli to 21. This task significantly activates
language specific regions (p<0.05 FDR corrected), such as Broca and Wernicke areas, even for a small amount of subjects. Moreover, we have demonstrated differences in brain activations between epileptic children and age-and-IQ matched healthy controls. As such, epileptic children show less activation in the left superior and medial temporal lobe areas which are involved in reading networks and often in epileptogenic zones in benign centrotemporal epilepsy.

KEYWORDS: Epilepsy, FMRI, Language

P-80

6:30AM - 9:00PM

Tensor Estimation Methods for Spinal Cord DTI in Healthy Pediatric Subjects and Subjects with Spinal Cord Injury

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\textsuperscript{1}Temple University, Philadelphia, PA, \textsuperscript{2}Childrens Hospital of Philadelphia, Philadelphia, PA, \textsuperscript{3}Shriners Hospital for Childrens, Philadelphia, PA, \textsuperscript{4}Temple University School of Medicine, Philadelphia, PA, \textsuperscript{5}Thomas Jefferson University, Philadelphia, PA

Purpose

Examination of injury in the pediatric spinal cord (SC) using diffusion tensor imaging (DTI) has promise in providing important information on white matter integrity and quantitative biomarkers for injury location and severity. The lack of a gold standard for DTI values complicates the interpretation of results. Different tensor estimation techniques have been developed and employed to ensure reliable results. When examining DTI datasets, the tensor estimation method chosen has potential to impact results of the analysis. To our knowledge, no comparison of tensor estimation techniques has been performed for the pediatric SC using typically developing (TD) subjects and subjects with SC injury. The purpose of this study is to examine the effects of tensor estimation techniques on DTI values for the cervical SC in healthy pediatric subjects and subjects with SC injury.

Materials and Methods

Diffusion tensor imaging data for the cervical SC (C1-C7) from 14 pediatric subjects (7 TD and 7 with SC injury) were acquired using an inner-field-of-view (iFOV) echo-planar DTI pulse sequence implemented on a 3 T Siemens Verio scanner (1). The imaging parameters are: 20 diffusion directions, b=1000s/mm\textsuperscript{2}, voxel size = 1.2x1.2x3mm\textsuperscript{3}, axial slices = 35-45), TR = 6100-8000 ms, TE = 115 ms, and number of averages = 3. Image registration was performed for diffusion-weighted directions using a 3D rigid body transformation. Diffusion tensors then were calculated using three methods: linear least squares (LLS), linear least squares with nonpositive tensor removal (2), and a robust outlier rejection fitting technique (3). Sagittal regions of interest (ROIs) were defined on the midline of the SC with sparring of the outer margin of the cord to minimize volume averaging with cerebrospinal fluid. Fractional anisotropy (FA) and mean diffusivity (MD) for each estimation technique were calculated for each ROI.

Results

Group average FA and MD values were reasonably consistent for each subject group between various tensor estimation techniques. The greatest differences from LLS were in the SCI group for the robust estimation method (3.2% FA, 7.1% MD). However, greater variation was observed within subjects, particularly when using the robust estimation method (Table 1). Using robust
estimation, within subject difference from LLS ranged from -4.1% to 13.7% (FA) and -3.6% to 54.7% (MD) in SCI subjects and from -6.0% to 4.2% (FA) and -1.2% to 9.6% (MD) in TD subjects.

Conclusions
The greater change in diffusion indices likely is caused by correction of physiological/motion artifacts by the outlier rejection technique employed by the robust estimation method. In SCI subjects, the potential for change in diffusion indices appears greater; possibly due to aberrant physiological motion resulting from injury caused changes in cord size and rigidity. The results of this study suggest that potential for considerable variation in tensor estimation exists.

KEYWORDS: DTI, Pediatric Head And Neck, Pediatric Spine

Table 1 – Percent change vs linear least squares method in FA and MD for each subject with spinal cord injury (left) and each typically developing subject (right).

<table>
<thead>
<tr>
<th>Subject</th>
<th>% Change vs LLS</th>
<th>% Change vs LLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Robust LLS+NPTR</td>
<td>Robust LLS+NPTR</td>
</tr>
<tr>
<td>SCI1</td>
<td>0.0%</td>
<td>-1.0%</td>
</tr>
<tr>
<td>SCI2</td>
<td>0.0%</td>
<td>-3.4%</td>
</tr>
<tr>
<td>SCI3</td>
<td>2.4%</td>
<td>-1.7%</td>
</tr>
<tr>
<td>SCI4</td>
<td>-0.6%</td>
<td>-1.7%</td>
</tr>
<tr>
<td>SCI5</td>
<td>7.8%</td>
<td>-1.9%</td>
</tr>
<tr>
<td>SCI6</td>
<td>13.7%</td>
<td>-0.8%</td>
</tr>
<tr>
<td>SCI7</td>
<td>-4.1%</td>
<td>-6.9%</td>
</tr>
<tr>
<td>SCI8</td>
<td>2.4%</td>
<td>-1.7%</td>
</tr>
</tbody>
</table>

Monday
6:30AM - 3:00PM
Palais des congres de Montreal, 220d

Printed Posters - Socioeconomics
P-87

Evaluating the Clinical Impact of Discrepancies between Trainee and Attending Interpretations of Neurological Imaging Studies on Call

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Purpose
Assessing clinical outcomes related to discrepancies between preliminary and final interpretations for imaging exams is an important quality assurance activity that ensures high quality patient care. The purpose of this study is to evaluate the clinical impact of major discrepancies between trainee and attending interpretations in 11,783 neurological CT and MR studies independently interpreted by radiology trainees on call. Furthermore, we determined the rate of misinterpretation by residents and fellows of all subspecialties by year of training.

Materials and Methods
For this study, a major discrepancy is defined as a discrepancy between the trainee preliminary and attending final interpretation that has the potential to impact patient management or outcome. We used a prospectively compiled database containing major discrepancies in 11,783 neurological examinations over a 12-month period at the University of Pennsylvania Hospital. Studies with major discrepancies initially were reviewed to determine if there was the potential for an adverse outcome prior to attending radiologist review. Retrospective chart review then was performed for each major discrepancy with the potential for an immediate adverse outcome. Management initiated based upon the preliminary interpretation, documentation of a change in management following re-interpretation by an attending neuroradiologist and whether or not the interpretation led to an adverse event, change in management or delay in treatment were recorded during chart review. The rate of misinterpretation was determined for different years of training (PGY-3 through PGY-6).

Results
There were 249 (2.1%) major discrepancies among 11,783 neurological CT and MR studies. Of the 249 studies, 122 (1.0%) had the potential to result in an adverse outcome prior to faculty review. Of these 122 cases, no cases resulted in a major adverse outcome, 69 (0.6%) resulted in a change in management, 19 (0.2%) resulted in a delay in treatment and 23 (0.2%) were potentially "overcalled" (normal finding interpreted as abnormal) by attending neuroradiologists. Fifty-eight of 2525 (2.3%) of CT studies were misinterpreted by PGY-3 residents, 17 of 903 (1.9%) of CT studies by PGY-4 residents, 8 of 679 (1.0%) of CT studies by PGY-5 residents and 47 of 1619 (2.0%) of CT studies by fellows. Fifty-seven of 3896 (1.5%) of CT and 47 of 1619 (2.9%) of MR studies were misinterpreted by fellows in neuroradiology.

Conclusions
To ensure high quality patient care and patient safety, we evaluated the frequency of major discrepancies in neurological CT and MR imaging studies as well as the consequences of these discrepancies on clinical management and patient outcomes. No major discrepancies resulted in major adverse clinical outcomes. However, 0.6% of the cases resulted in a change in management, which mostly involved additional follow-up imaging; 0.2% of the cases resulted in a delay in treatment, which primarily included administering aspirin for cerebrovascular accident (CVA) and invoking stroke precautions. For acute CVA, all patients were either outside the treatment window for tPA or were not potential candidates for tPA due to co-morbidities. An additional 0.2% of cases potentially were overcalled by attending radiologists, which would decrease the overall major discrepancy rate to 1.9%. The rate of major discrepancies in preliminary interpretations provided by radiology residents and fellows at our institution is comparable to that of similar academic institutions, and none of the major discrepancies resulted in major adverse events, likely in part due to correction within less than 24 hours following attending review. These findings suggest that independent call experiences for residents and fellows can provide a valuable training experience without harm to patients.
Potential Effects of Patient Positioning on Radiation Dose to the Lens of the Eye During Routine Sinus CT: A Phantom Study

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Purpose
The lens of the eye is highly radiosensitive and prone to radiation-induced cataracts. Previous studies have shown differences in radiation dose based on patient position relative to isocenter, but have focused on body imaging applications. The purpose of this work was to characterize the effect of patient positioning within the gantry on radiation dose to the lens during CT of the paranasal sinuses.

Materials and Methods
An anthropomorphic head phantom was scanned on a Siemens Definition Flash CT scanner using a standard paranasal sinus CT protocol, implementing automatic tube current modulation and helical scanning. Radiation dose was measured by placing nanoDot optically stimulated luminescence dosimeters (Landauer) on thin plastic goggles above the eyes to create a set-up that could be replicated easily in future human subject studies. Preliminary studies showed no statistically significant difference in the readings of the dosimeters placed on the surface of the goggles versus placement on the eyes of the phantom. With the center of the phantom head placed at gantry isocenter in standard patient positioning, the two dosimeters were located 10 cm above isocenter, and 3 cm to the left and right of isocenter, respectively. The center of the phantom head then was positioned incrementally 2, 4, and 6 cm above, below, left, and right of this starting position. This corresponded to dosimeter positions of 4, 6, 8, 10, 12, 14, and 16 cm above isocenter, and 1, 3, 5, 7, and 9 cm to the left and right of isocenter. At each position, the phantom was scanned three times using a separate pair of dosimeters for each scan, and distance between gantry isocenter and the dosimeters was recorded. The dosimeters then were read three times each in accordance with manufacturer instructions. After adjusting for sensitivity, the mean and standard deviation of the raw counts were calculated. Normalized dose was plotted against both vertical and horizontal distance from isocenter.

Results
Dose decreased linearly as vertical distance of the dosimeters increased above isocenter, with a maximum reduction of 50%. Dose decreased with increasing horizontal distance from isocenter, with a maximum reduction of 37%.

Conclusions
Positioning the eyes off isocenter may result in significantly lower dose to the lens. Our results would support positioning the patient's head - as opposed to the face and eyes - at or above isocenter during CT examinations of the head and neck.

KEYWORDS: Radiation Dosage, Radiation Dose Reduction
Radiographic Screening of Orbits for Metallic Foreign Bodies: Effects of technique on Sensitivity with Computed Radiography (CR) and Digital Radiography (DR)

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¹University of Utah, Salt Lake City, UT

Purpose
Radiography is the standard methodology to screen for orbital metallic foreign bodies (OMFBs). Although in prior studies CT was shown to detect smaller OMFBs than radiography, this did not translate into increased safety for patients. Since these studies, many institutions have switched from film-screen radiography to computed radiography (CR) and/or digital radiography (DR). Prompted by a recent case of a radiographically occult OMFB at our institution, we sought to investigate the sensitivity of CR and DR for small OMFBs and evaluate the effect of different source to image distances (SIDs) (with associated changes in magnification and geometric unsharpness) on the conspicuity of OMFBs.

Materials and Methods
Computed radiography and DR were used to image different size iron foreign bodies (FBs) ranging in size from 1 x 0.2 x 0.2 mm to 1 x 1.1 x 1.1 mm. The FBs were imaged suspended on a plastic sheet as well as placed on a skull phantom. A kvp of 75 was used with automated exposure control. Images were obtained in anterior-posterior (AP) and posterior-anterior (PA) orientation and in lateral projection with the foreign body on the detector side or the x-ray tube side. Source to detector distances of 40 and 72 inches were used.

Results
Foreign bodies as small as 1 x 0.4 x 0.4 mm were detected readily with CR and DR, independent of SID and orientation. A 1 x 0.2 x 0.2 mm FB was not detected with CR but was visible on DR. Difference in FB conspicuity on lateral projections between FB in the orbit on detector side or tube side were mild and less pronounced than the effect of superimposed structures. Foreign body conspicuity was improved with SID of 72 inches versus the routinely used 40 inches and with PA rather than AP orientation (Figure 1).

Conclusions
Digital radiography has higher sensitivity for very small OMFB than CR. Increased conspicuity of OMFBs is achieved by using 72 inch SID rather than the routine 40 inch SID and by using PA projection, which also reduces orbit dose compared to AP projection. If an OFMB is suspected on PA images but not seen on lateral radiographs, consider repeat imaging with the suspected orbit on the detector side if the suspected OMFB was in the orbit on the tube side originally. While superimposed anatomy will greatly influence visibility of very small OMFB, adjustment in technique can improve sensitivity.

KEYWORDS: MR Imaging, Orbits, Screening
Reducing Unnecessary CT Scans for Image Guided Neurosurgical Interventions: An Audit of Volumetric Scans Acquired for CSF Diversion

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Purpose
The use of image guidance for neurosurgical interventions such as ventriculostomy or ventriculoperitoneal shunting has been shown to reduce morbidity (1) and as such is becoming a standard of care. This, however, has necessitated a large increase in the number of volumetric CT scans performed for planning. It was of concern at our institution that patients were undergoing additional CT scans purely for the purposes of acquiring an image guidance sequence and that these could have been avoided with foresight and correct protocolling of a prior scan. This could prevent both inefficient use of the CT scanner and additional exposure of the patient to ionizing radiation. We therefore sought to audit the frequency of "unnecessary" scans and institute an intervention to reduce these as part of an audit cycle.

Materials and Methods
Operating room records over a six-month period were searched to identify patients that had undergone image-guided cerebrospinal fluid (CSF) diversion. The PACS system was searched to identify when the last image guidance protocolled scan was performed and if this was "unnecessary". A scan was deemed "unnecessary" if: 1) it was performed solely in order to facilitate image guidance AND 2) there was no new or additional clinical indication for a repeat scan AND 3) if the patient's prior scan had been protocolled for image guidance then a repeat could have been avoided. Interim analysis revealed a large number of unnecessary scans (see results). The "missed opportunity" for correct protocolling of a prior scan commonly occurred out of hours where there is "open access" to the CT scanner and studies are protocolled by the requesting clinician and radiographers. As such, an intervention was planned in the form of both didactic and written education of all those who would be requesting imaging, particularly out of hours.

Results
Following the initial audit of practice over a six-month period 28 patients underwent CSF diversion with image guidance and had complete records. Of these, 14 underwent an unnecessary repeat of their CT scan as defined by our criteria. Following the planned intervention, re-audit found only five out of 25 patients had unnecessary scans in the following three months. This improvement was statistically significant (P=0.043 using a two tailed Fishers Exact Test).

Conclusions
Targeted education of all those who are physically requesting imaging (junior physicians in our institution) towards forethought in the protocolling of scans is an effective means by which to reduce unnecessary imaging of patients undergoing image-guided procedures.

KEYWORDS: Cost-Effective, CT, Image-Guided Procedures
Purpose
Numerous questions in the clinical neurosciences can be tackled by anatomical research and many more remain. The rapid development of sophisticated high-resolution neuroimaging techniques over the past half-century, exemplified by high-field MRI, has made these questions potentially answerable, thus leading to a growth in the symbiotic relationship between anatomy and radiology. In the midst of these changes, anatomical research has been perceived as less prestigious. As a research discipline in its own right, bibliometrics offers quantitative methods for detailed investigation over a period of time of the extent and impact of published anatomical research using neuroimaging techniques. It involves the measurement and evaluation of research articles published in peer-reviewed journals and the number of times published articles are cited subsequently. We aim to use these bibliometric indicators to identify long-term trends in dissemination of publications in neuroimaging anatomy (including both productivity and citation rates), to test the hypothesis that anatomical research has waned in recent years.

Materials and Methods
We examined publications over the last 40 years in two neuroradiological journals, AJNR and Neuroradiology, selecting and categorizing all neuroimaging anatomy research articles according to theme and type. These publications were identified using the Web of Science database. We studied trends in their citation activity over time, and mathematically analyzed these trends for 1977, 1987, and 1997 publications. We created a novel metric, "citation half-life at 10 years post-publication" (CHL-10), and used this to examine trends in the skew of citation numbers for anatomy articles published each year.

Results
We identified 367 anatomy articles amongst a total of 18,110 in these journals; 74.2% were original articles, with 'variant anatomy' the commonest theme (46.7%). We recorded a mean of 18.03 citations for each anatomy article, 35% higher than for general neuroradiology articles. Graphs summarizing the rise in citation rates after publication at different time-points revealed similar trends. CHL-10 trends demonstrated that more recently published anatomy articles were likely to take longer to reach peak citation rate.

Conclusions
Bibliometric analysis suggests that anatomical research in neuroradiology is not languishing, since the number of anatomy publications in relation to general publications in neuroradiology has remained stable over time, as have their citation rates. The increasing CHL-10 suggests that more recently published anatomy articles enjoy greater longevity, possibly due to the increased clinical relevance of modern anatomical research. The novel analytical approaches described can be applied to other aspects of neuroimaging research, and within other subspecialties in neuroradiology and neuroanatomy.

KEYWORDS: Anatomy

P-91

Using Computed Tomography Brain Studies to Predict Osteoporosis

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Purpose
The purpose of this study is to assess the relationship between Dose Length Product (DLP) for computed tomography (CT) studies of the brain and baseline dual-energy x-ray absorptiometry (DEXA) results and whether osteopenia or osteoporosis can be predicted from such DLP values.

Materials and Methods
Patients with a baseline DEXA study performed within an 18-month period following at least two CT brain studies being completed were evaluated. All patients' examinations were completed on a GE Lunar Prodigy Advance. All CT examinations were performed on a single Siemens Somatom Definition AS 64-slice device which employed adaptive dose shield (ADS) and iterative reconstruction in image space (IRIS) technology to reduce patient radiation dosage. Patients were excluded by presence of bone dysplasias/pathology, hardware, hemorrhage, significant brain insult/stroke or neoplasm on the CT examinations. DEXA and CT studies then were reviewed by a single radiologist and patient data were collected for patients meeting the inclusion criteria.

Results
Ninety-five patients met the general inclusion criteria of the DEXA and CT studies being completed according to the chronology and time frame defined. Eighty-seven patients met all inclusion criteria for data analysis. DLP was controlled against patient body mass index (BMI) and number of CT images and labeled "DLP*". A linear regression analysis showed a statistically significant correlation between DLP* and DEXA T-Scores (r = 0.77; p = 0.0013). Furthermore, linear regression showed no correlation between DLP when controlled against number of CT images and T-Scores (r = -0.153; p = 0.2995).

Conclusions
Dose length product values for brain CT examinations and patient BMI can be utilized to identify patients at risk for osteopenia or osteoporosis. As radiology practice models often report these values as part of professional quality initiatives, this could be a reasonable added value to existing radiology workflow.

KEYWORDS: CT, Dose, Osteoporosis

P-89

Value of Advanced Neuroimaging in Emergency Room Patients with Vertigo and Dizziness – Data from a Level I Stroke Center.

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Purpose
Vertigo and dizziness resulted in 3.3 million emergency department (ED) visits in the U.S. in 2010 (most recent national data available). Moreover, these symptoms rank in the top 10 reasons for ED visits for patients aged 65 and over. Neuroimaging is performed in approximately 40% of patients with vertigo or dizziness presenting to the ED (39% CT, 2% MRI) at a cost of approximately $470 million annually. The purpose of our study was to examine the value of
neuroimaging by determining the positivity rate of MRI (magnetic resonance imaging) in an ED population with vertigo/dizziness at Level 1 stroke center. We also investigated any incremental value of concurrent MRI and magnetic resonance angiography (MRA) or computed tomography angiography (CTA) in these patients.

Materials and Methods
The Institutional Review Board (IRB) waived IRB review, as this was a retrospective study performed for quality improvement purposes. We reviewed institutional records of all patients who initially presented to the emergency department and received a MRI from October 1, 2011 to September 30, 2012 (financial year 2012) to identify patients with a primary symptom of vertigo and/or dizziness. MR imaging reports were reviewed to determine characteristics of patients with positive imaging findings. A positive finding was defined as cerebrovascular accident (CVA), acute vascular pathology, or mass lesion. Patients with previously known brain masses were excluded. As a secondary analysis, the results of MRA and CTA were analyzed to determine incremental benefit to the MRI. Results were stratified according to age and sex.

Results
During the study period, 108/2240 (5%) advanced neuroimaging (MR, MRA, CTA) examinations performed on inpatients at our institution were obtained for patients who initially presented to the ED with the primary symptom of vertigo and/or dizziness (Age 24-93 years, 49% female). Concurrent MRA was obtained in 50/108 (46%) patients and 34/108 (31%) patients underwent CTA examinations within 24 hours. A positive finding on MRI was reported in 33/108 (30.5%) patients. Of the 50 patients who underwent a concurrent MRA, only 2/51 patients (4%) had vertebral artery dissection causing cerebellar infarcts. Of the 34 patients who underwent a concomitant CTA, only 4/34 patients (11.8%) had a positive finding, which in each case already was visible on the MRI. The most common imaging finding for patients with vertigo/dizziness was a posterior circulation CVA noted in 20/108 (19%) patients. Categorizing for age, positive findings were found in 1/9 patients age 40 years and under, 8/15 patients between 41-50 years, 6/21 patients between 51-60 years and 18/63 patients older than 60 years.

Conclusions
One in three ED patients presenting with vertigo and/or dizziness undergoing imaging at a Level 1 Stroke Center will have positive findings on MRI. MR angiography and CTA rarely offer information incremental to MRI findings.

KEYWORDS: Cerebrovascular Disease, Dizziness, Vertigo

Monday
6:30AM - 3:00PM
Palais des congrès de Montreal, 220d

Printed Posters - Spine
P-94
6:30AM - 9:00PM

Conus medullaris movement in the flexed lateral decubitus position. An MRI morphometric study with implications for levels of safe high lumbar puncture.

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Purpose
Awareness of the location of conus medullaris termination is important when performing lumbar puncture (LP). Previous studies in supine patients using only midsagittal lumbar spine MRI revealed the average conus position at the lower third of the L1 vertebral body, with a range from mid T12 to upper L3. Conventionally therefore LP should be performed at or below the level of L3-4. However, a high LP, at L2-L3 or above, often is necessary because degenerative spinal stenosis typically is worst below L3, or on account of posterior spinal fusions. Yet, reported rare complications of conus damage after high LP raise the concern of its danger when performance is required clinically. We hypothesized that a high LP might be safer than previously deemed, by considering the movement of the conus within the thecal sac upon additional axial MRI analysis.

Materials and Methods
We retrospectively reviewed the lumbar spine MRIs of 59 supine patients (mean age 64 yr) with mild spondylosis, and recorded the conus termination on midsagittal images. We used electronic calipers on axial images at the T12-L1, L1-2, and L2-3 disk levels to measure the anteroposterior and transverse diameters of the thecal sac, transverse diameter of the conus (A), transverse distance between midpoints of the ligamenta flava (the LP 'window' B), and anteroposterior distance of the conus from the dorsal theca. The percentage occupancy of the LP window by the conus was calculated as A/Bx100. This was considered as the percentage chance of striking the conus during an LP. This likelihood then was recalculated using known literature data on mean displacements of the conus in the flexed lateral decubitus position.

Results
On midsagittal images there was a normal distribution of conus termination, including 25% at upper L1, 20% at lower L1, and 19% at the L1-2 disk. Fifty axial images were available at each of the three disk levels, which corresponded to predicted entry levels of LP needles on midsagittal images. Dimensions of the thecal sac were uniform. At the three levels the mean for (A) was 7.6 mm, 2.9 mm, and 0.4 mm; and for (B) was 12.7 mm, 13.2 mm, and 13.4 mm respectively. The percentage occupancy of the LP window by the conus was therefore 60%, 22%, and 3% respectively. The inverse, i.e., the likelihood safety of an LP if performed in a theoretical supine position was 40% at T12-L1, 78% at L1-2, and 97% at L2-3. However, by factoring theoretical displacements in the lateral decubitus position, the conus would shift considerably to the ventral thecal sac at locations 6.1 mm, 8.1 mm, and 7.0 mm from the posterior theca respectively. Although the conus also would shift laterally under gravity it would remain within the LP window at all three levels. However, lateral shift would displace the conus at L2-3 away from the midsagittal plane.

Conclusions
High LPs at L2-3 theoretically are safer than considered hitherto. This would result mainly from the substantial ventral shift of the conus upon flexion in the lateral decubitus position.

KEYWORDS: Conus, Lumbar Puncture, Lumbar Spine

P-93
Development of high cervical DTI as an imaging marker for distal human spinal cord pathology
Purpose
Diffusion tensor imaging (DTI) at the level of cord compression or cord injury is affected by artifacts and distortions created by small cord area, bony and disk-related cord compression and instrumentation. The high cervical cord, rostral to the level of cord pathology, is unaffected by these distortions and allows for accurate measurement of diffusivity. The purpose of this study was to determine if high cervical DTI could detect altered diffusion metrics in patients with spinal cord injury (SCI) and cervical spondylotic myelopathy (CSM). This would define high cervical DTI as a potential imaging marker for distal spinal cord pathology.

Materials and Methods
We performed cervical spinal cord DTI in three groups of patients: acute spinal cord injury, chronic SCI and CSM. Diffusion indices were measured on axial images within the C1-C3 levels, which were rostral to the level of spinal cord pathology and appeared normal on conventional T2-weighted MR sequences. All scans were performed on a 1.5 T clinical MR scanner, and images processed with in-house custom software programs written in AFNI and MATLAB. Diffusion indices were compared to those of age-matched controls. Correlations between diffusion indices and degree of neurological dysfunction as measured by clinical scores also were investigated.

Results
In patients with acute SCI (n=12), high cervical FA was significantly reduced as compared to controls. The high cervical FA was significantly correlated with both ASIA grade and upper limb ASIA motor score. Significant differences were observed in mean diffusivity (MD), longitudinal apparent diffusion co-efficient (lADC) and transverse ADC (tADC) between chronic SCI patients (n=10) and healthy controls (n=13). Subjects with complete SCI had a significantly lower fractional anisotropy (FA) as compared to those with incomplete injury. Patients with CSM (n=21) showed significantly lower FA at the C2-C3 level, rostral to the level of maximum cord compression. No significant correlations have been observed so far between high cervical FA and clinical myelopathy scores.

Conclusions
High cervical DTI detects anatomical changes in the high cervical cord and avoids imaging distortions at the level of cord compression or cord injury. High cervical DTI is a potential imaging marker for distal spinal cord pathology.

KEYWORDS: Cervical Myelopathy, Diffusion Tensor Image, Spinal Trauma
Purpose
Percutaneous vertebroplasty (PVP) is a minimally invasive procedure used for stabilization and pain control in vertebral compression fractures related to osteoporosis, metastasis, myeloma and aggressive hemangiomas. Its use in the cervical spine, especially the upper cervical spine, is very limited mainly due to technical challenges. There are only three reports of the use of a posterolateral approach under computed tomographic (CT) guidance. Here, we report the first use of an ultra-high viscosity cement and posterolateral approach in a patient with lytic lesions in C2 and C3 and a pathologic fracture of C2 for the purpose of stabilization and pain palliation.

Materials and Methods
We used a posterolateral approach in a patient with unstable lytic metastatic lesions in C2 and C3 and a pathologic fracture of C2 using ultra-high viscosity cement with CT guidance and CT fluoroscopy.

Results
Technically successful vertebroplasties of the C2 and C3 vertebral bodies were achieved with stabilization of the C2 pathologic fracture. There were no complications or cement extravasation. The patient reported pain relief and improved range of motion following treatment.

Conclusions
CT-guided PVP of the cervical spine using a posterolateral approach and ultra-high viscosity cement is a relatively safe procedure and may be used in patients with advanced osteolytic cervical spine metastases who are not surgical candidates for the purpose of pain palliation and fracture stabilization.

KEYWORDS: Cervical, CT Fluoroscopy, Vertebral Augmentation
PET/CT Appearance of Spinal Leptomeningeal Disease

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Purpose
Leptomeningeal disease (LMD) is the presence of metastatic cells in the subarachnoid space and has devastating prognostic implications if left untreated. While MR imaging (MRI) often is used for evaluation of LMD, cerebrospinal fluid (CSF) cytology currently represents the gold standard for diagnosis. Many patients who could potentially have spinal LMD undergo 18F-FDG PET/CT for staging purposes. The purpose of this study was to report on the presence of LMD in the spinal canal on 18F-FDG PET/CT imaging.
Materials and Methods
The clinical data including CSF cytology results, and imaging studies including MRI and 18F-FDG PET/CT, in patients with spinal LMD were reviewed retrospectively. Inclusion criteria included positive CSF cytology, MRI documentation of LMD, and a PET/CT study obtained within one month of the cytology and MRI exam. The presence and extent of LMD and maximum standardized uptake value (SUV) were recorded.

Results
Twenty-two patients met the criteria for inclusion in the study. FDG-avidity was demonstrated in the spinal canal in six of 22 patients (4 men and 2 women, age range 29-69 years, median: 54 years). Primary malignancies included B-cell lymphoma (n=4), follicular lymphoma (n=1), and Waldenstrom's macroglobulinemia (n=1). The PET/CT studies were obtained for restaging (n=5) or initial staging (n=1). The time from PET/CT to MRI ranged from 26 days before to 12 days after (median 1.5 days before), and the time from PET/CT to CSF analysis ranged from 29 days before to three days after (median two days before). In all six cases, the anatomical distribution of increased FDG activity in the spinal canal correlated with sites of abnormal leptomeningeal enhancement on MRI. The maximum SUV ranged from 2.8 to 11.1 (median 6.1). The six patients were treated with intrathecal chemotherapy after placement of an Ommaya reservoir. Follow-up PET/CT was obtained in five of six cases. All five cases demonstrated normalization of FDG activity in the spinal canal that corresponded to the cytological response to intrathecal treatment, as determined by CSF analysis.

Conclusions
The presence of FDG-avidity in the spinal canal on 18F-FDG PET/CT can suggest spinal leptomeningeal disease, even before diagnosis on MRI or CSF cytology. Resolution of FDG-avidity in the spinal canal seems to correlate with treatment response. The spinal canal should be evaluated on 18F-FDG PET/CT for evidence of leptomeningeal disease, which when present necessitates further evaluation with MRI and possibly CSF cytology to avoid delay of appropriate treatment for leptomeningeal disease, including intrathecal chemotherapy.

KEYWORDS: Leptomeningeal Disease, PET/CT, Spinal Canal

P-95

Relationship Between the Spatial Distribution of CSF Flow and DTI Metrics in the Cervical Spinal Cord

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Purpose
Diffusion tensor imaging (DTI) has been used to diagnose and monitor diseases and injury in the spinal cord. A major challenge with this technique is the sensitivity of diffusion encoding to cerebrospinal fluid (CSF) motility. Cardiac gating (CG) is not able to correct CSF motion, but rather reduces variability of derived DTI metrics by acquiring diffusion data at a constant point in the cardiac cycle. Likewise, bulk motion correction also is insufficient to correct CSF motion.
related estimation errors of diffusion metrics, correcting spatial registration but not the CSF flow related signal attenuation for diffusion encoding. The goal of this study was to examine the influence of CSF flow on DTI in the cervical spinal cord and to investigate flow-insensitive measures to improve its predictive value for clinical diagnosis.

Materials and Methods
Axial DTI scans of the cervical spinal cord at the C2-C3 juncture were performed on four healthy adults with and without CG under IRB approval on a GE 1.5 T MR450W. Cerebrospinal fluid flow was measured by a phase contrast MRI sequence in the same slice. Data was motion corrected and analyzed using Prism Process (Prism Clinical Imaging Inc.). Fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (DA) and radial diffusivity (DR) values were calculated, along with a novel metric, the normalized DA (DAn = λ1/Σλ). Diffusion tensor imaging metrics for dorsal, lateral, and ventral sections were correlated to CSF flow.

Results
Cerebrospinal fluid flow in the dorsal segment was significantly lower (P<0.01) than in the lateral sections for three of four subjects. Those subjects also had significant differences (P<0.05) in DTI metrics for the ungated case between dorsal and lateral sections. One of them had significant DTI differences in the CG case, and an overall low CSF flow compared to the other subjects. Subject four showed no significant spatial differences of DTI metrics, which may be explained by a substantially higher heart rate than the others, reducing the overall T2 image contrast based on the chosen scan repetition time TR. Axial diffusivity was significantly correlated with flow in ungated DTI.

Conclusions
There is a correlation between CSF flow and DTI parameters that is significant in ungated acquisitions. Cardiac gating reduces mean differences and variability of the measurements. The magnitude by which gated DTI metrics are affected by flow depends on the trigger time-point relative to the CSF flow cycle (agreeing with previous reports) which can be controlled by carefully selecting the CG trigger time-point or by implementing flow-compensated diffusion sequences. DAn was less sensitive to CSF flow than DA, but further investigation of its sensitivity to disease in clinical patients is needed.

KEYWORDS: Diffusion Tensor Image, MRI Spine, Spinal Cord

P-96

SAPHO Syndrome: Imaging Findings of Vertebral Involvement

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Purpose
The syndrome of synovitis, acne, pustulosis, hyperostosis and osteitis (SAPHO) includes a rare group of chronic, relapsing, inflammatory osteoarticular disorders that commonly is associated with skin manifestations. Imaging findings often are misinterpreted as osteomyelitis/diskitis or metastases, which, in our experience, has led to unnecessary biopsies and delayed diagnosis. The radiology literature contains a few small case series and case reports discussing radiographic
manifestations. The purpose of our study was to evaluate a larger series of patients with vertebral involvement as part of SAPHO syndrome.

Materials and Methods
IRB approval was obtained and electronic medical record review performed for patients with the diagnosis of SAPHO and abnormalities on spine imaging. MR imaging (MRI), CT, bone scan and plain radiographs were reviewed for vertebral body signal abnormality, density, enhancement and pattern of involvement; presence of paravertebral soft tissue mass; subligamentous thickening and disk space involvement.

Results
Thirty-six SAPHO patients were identified, of which 18 [50%; 16 female (88%); range 23-69 years] had spinal involvement. MR imaging was available in 16 (89%) with a corresponding CT scan in 14 (77%). The thoracic spine was involved most commonly (n=13, 72%). MR demonstrated vertebral body signal abnormality in 13 (72%) with a mean of 4.6 (range 1-13) vertebral levels involved. A curvilinear or "semicircle" pattern involving portions of adjacent vertebral bodies about at least one interspace was identified in nine of these patients (69%) (Figure). Corresponding CT scan demonstrated sclerosis (Figure) in all patients (100%) in areas of MR signal abnormality with additional erosions at the attachment of the anterior longitudinal ligament in two (14.2%). Subligamentous thickening was present in 14 cases (87%), while disk space narrowing was seen in 10 patients (55%). A paravertebral soft tissue mass was found in six cases (33%), ranging in size from 9-20 mm and spanning 1-6 vertebral levels. Bone scan was available in 10 patients with concurrent MRI and demonstrated radiotracer uptake in areas of MR signal abnormality in all 10 cases (100%).

Conclusions
A "semicircle" pattern of vertebral involvement was a common finding in patients with SAPHO. Although further work is needed, we believe this finding, particularly when combined with corresponding sclerotic changes on CT and increased radiotracer uptake on bone scan, may be characteristic of SAPHO syndrome in the appropriate clinical setting.

KEYWORDS: Inflammatory, Spinal Imaging
Monday
7:25AM - 7:30AM
Palais des congres de Montreal, 517bc

01 - OPENING REMARKS
Monday
7:30AM - 8:30AM
Palais des congres de Montreal, 517bc

02 - HEAD AND NECK SESSION (SAM)
Frequently Missed Diagnoses in the Head and Neck

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Abstract/Presentation Summary
The head and neck can be a challenging area for the radiologist, in that some findings are easily missed, and others are frequently misinterpreted. Some of the more common "misses" in H&N radiology occur because findings are subtle and will not be obvious to the examiner unless they are the subject of a specific and systematic search. A classic example is fenestral otosclerosis. This relatively common diagnosis (found in up to 10% of autopsy specimens!) will invariably be missed unless the radiologist specifically interrogates its most common site of presentation, the fissula ante fenestram, along the anterior margin of the oval window. There, only a small lucent focus may be discovered, yet this will reflect the etiology of the patient's hearing loss, while the remainder of the scan is entirely normal. The temporal bone is the site of another commonly missed diagnosis, labyrinthitis. In this scenario, the patient presents with sensorineural hearing loss, and the radiologist is able to rule out the most common listed study indication, "acoustic neuroma." Yet, labyrinthitis is a statistically more common cause of hearing loss, though the findings of abnormal signal in the membranous labyrinth may be extremely subtle. When "tunnel vision" is applied in the setting of hearing loss, and scan interrogation is limited to the internal auditory canal and cerebellopontine angle cistern, the findings of labyrinthitis will invariably be missed. Familiarity with some of the diseases specific to the H&N will help reduce the likelihood of misinterpretation of findings. An example that has recently gained attention in the literature is HPV-related squamous cell carcinoma of the oropharynx. These cancers frequently metastasize to upper jugular lymph nodes, and these nodes are frequently cystic. As such, there has been a near epidemic of cystic metastatic lymph nodes mistakenly called second branchial cleft cysts. Beware this diagnosis in the adult patient!

Challenging Cases in Head and Neck Radiology

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Abstract/Presentation Summary
The head and neck is an anatomically complex region of the body, and a strong knowledge of anatomy of this region and an understanding of the disease processes that affect this area is essential for correct interpretation of imaging studies. The anatomical complexity and variability among patients also leads to a large number of anatomical variants and pitfalls that must be recognized by interpreting radiologists. In today's presentation we will focus on areas with difficult anatomy, challenging diagnoses, and imaging of uncommon but interesting or important
disease entities. One area of focus for us will be the jugular foramen. The jugular foramen is a depression on the medial and inferior surface of the petrous pyramid formed by the temporal and occipital bones. It courses anteriorly and laterally as it exits the skull base. It consists of a smaller anteromedial portion, the pars nervosa, and a larger posterolateral portion, the pars vascularis, and the two are separated by a complete or incomplete fibrous or bony septum. The pars nervosa contains CN IX (the glossopharyngeal nerve) and the inferior petrosal sinus. The pars vascularis contains CN X, CN XI, and the internal jugular vein. The classic differential of a jugular foramen mass includes paraganglioma, schwannoma, meningioma, and metastasis. An important pitfall is slow flow in the jugular bulb, which can mimic a mass lesion; conversely, a real lesion of the jugular foramen may be overlooked and mistaken for a prominent jugular bulb. Asymmetry of the larynx due to unilateral vocal cord paralysis (UVCP) is another imaging finding that can be potentially confusing for the unwary radiologist. We will review a case of a subtle lesion resulting in UVCP and will discuss the imaging features of vocal cord paralysis. We will also discuss denervation change in the laryngeal musculature as a potential pitfall in laryngeal imaging. Numerous disease processes may result in abnormalities of the retropharyngeal space, and processes such as infection in the retropharynx are of particular interest and concern as they may extend into the chest and cause severe complications for the affected patient. An uncommon but not rare disorder of this region is calcific tendinitis, and we will review an example of this process, as well as abnormalities of the retropharyngeal space secondary to trauma and foreign bodies. If time permits, we will also review the varied clinical and imaging presentations of fungal sinus disease. These include allergic fungal rhinosinusitis, mycetoma, chronic invasive fungal disease, and acute invasive fungal disease. Many of these cases, as if often true in head and neck imaging, benefit from obtaining both CT and MR scans, as each study provides different information about the disease process and together may allow the most specific diagnosis to be made and/or offer the best chance of detecting important complications.

Questions and Answers

Monday
8:30AM - 10:00AM
Palais des congres de Montreal, 517bc

03 - ASHNR PROGRAMMING: AERODIGESTIVE HEAD AND NECK CANCER
O-03

Imaging Approach to Laryngeal and Hypopharyngeal Cancer
Abstract/Presentation Summary
CT and MRI are the two commonly used imaging modalities for imaging laryngopharyngeal tumors. CT is generally the initial study of choice because of its quicker acquisition time that makes it less susceptible to swallowing artifact compared to MRI. MRI may be reserved to answer specific questions unresolved by CT, such as questionable cartilage invasion, involvement of PES or early extralaryngeal spread. The overwhelming majority of cancers of the laryngopharynx are squamous cell carcinoma (SCC) and will be the focus of this lecture. Remember however that submucosal tumors can be of minor salivary gland origin, sarcomas can arise from the muscle and cartilage framework, thyroid cancer can invade directly, and tumors can rarely metastasize from distant sites. Tumors of the supraglottic larynx are generally asymptomatic and are not detected until later in their natural history. The supraglottic larynx is also richly supplied with lymphatics so that nodal metastases occur early. The majority of patients with supraglottic SCC therefore present with higher stage tumors. Tumors of the glottic larynx cause hoarseness and are therefore generally detected earlier compared to supraglottic tumors. The glottic larynx has sparse lymphatics so that nodal metastasis is rare, and occurs with advanced tumors. Imaging is therefore rarely useful for early glottic tumors, but radiographically demonstrable submucosal subglottic and/or supraglottic extension or cartilage invasion can upstage a clinically "early" lesion. Caudad extension into the subglottis upstages a small glottic tumor to T2 and increases risk for nodal metastases. The hypopharynx is the site with the worst prognosis among all head and neck SCC. Like patients with supraglottic tumors, these tumors are also asymptomatic until they are locally advanced and the majority of patients present with nodal metastases. A peculiar feature of submucosal caudad spread of hypopharyngeal SCC to the cervical esophagus is that it can occur with skip areas of normal intervening tissue. A basic understanding of the mucosal anatomy as visualized through the endoscope is essential for the radiologist when communicating radiographic findings with the clinicians treating the patient. Key endoscopic features of laryngopharyngeal anatomy will therefore also be briefly reviewed during the lecture.

Imaging Approach to Oral Cavity and Oropharyngeal Cancer

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Bexley, OH

Abstract/Presentation Summary
Presentation Summary: Imaging Approach to Oral Cavity and Oropharyngeal Cancer – Claudia Kirsch MD Associate Professor of Neuroradiology and Otolaryngology Section Chief Head and Neck Imaging Director Radiology Medical Student Teaching Wexner Medical Center The Ohio State University College of Medicine The purpose of this lecture is to outline imaging approaches to oral cavity (OC) and oropharyngeal (OP) cancers reviewing the background,
incidence, and critical anatomy radiologists need to assess for treating clinicians be it otolaryngology or radiation therapy. Specifically this talk will cover five major areas including:

1- Incidence – introduce risks factors, resulting in the increased incidence of oral cavity and oropharyngeal cancers. Although risk factors from smoking and drinking have declined, the increased prevalence of the HPV virus, is associated with an increased number of both oral cavity and oropharyngeal cancers.

2- Modalities – review the currently used imaging modalities, namely CT, MRI, PET-CT, and Ultrasound, the protocols for each modality and how each modality can be utilized to help assess patients with oral cavity and oropharyngeal cancer.

3- Anatomy – review the basic anatomy of the oral cavity and oropharynx that is critical in understand cancers behavior, especially the site of cancers origin and spread. Both the basic anatomy of the oral cavity and oropharynx will be reviewed, and more importantly the key subsites where these cancers can occur, and spread, with imaging examples of tumor involving the pertinent anatomical areas, with oropharyngeal carcinomas exhibiting more aggressive growth patterns. The focus is on the anatomical regions the radiologists needs to be aware of and assess, for both the primary tumor and its routes of spread.

4- Getting accurate TNM staging, and the utilization of imaging for that role, Specifically will discuss the new current AJCC (American Joint Committee on Cancer) 7th Edition.

5- Evaluation for the ENT – most importantly, evaluating the critical areas impacting patient outcomes, the ENT surgeon and radiation oncologist want to know about. Evaluation of critical areas radiographically impacts prognosis and treatment planning. This lecture provides an approach for assessing the cancers in the oral cavity and oropharynx, to improve patient treatment and prognosis. These five goals spell out IMAGE – the intention of this talk to provide the radiologists with the information needed to allow one to be more effective when analyzing and approaching imaging studies in patients with either oral cavity or oropharyngeal cancer.

O-05

Imaging Approach to Nasopharyngeal Cancer

Shatzkes, D.
Lenox Hill Hospital
New York, NY

Abstract/Presentation Summary

Nasopharyngeal carcinoma (NPC) differs from other carcinomas of the upper aerodigestive tract (ADT) in a number of important ways. The World Health Organization (WHO) has classified NPC into three types: I. Keratinizing squamous cell carcinoma (SCC) II. Non-keratinizing SCC III. Undifferentiated carcinoma. It is only the relative uncommon Type I tumors (20% of cases in the US) that share similar histology and risk factors with others site of upper ADT SCC. In Types II and III, alcohol and tobacco use do not play a substantial etiologic role, and the primary demographic feature is origin from several southern Chinese provinces. These types are also extremely radiation sensitive and are treated primarily by radiation therapy, with surgery reserved for salvage in some recurrent cases. Other distinguishing features are the very early development of nodal metastases and the high incidence of skull base and intracranial extension.

The American Joint Committee on Cancer assigns Tumor, Nodal and Metastases staging for NPC as follows: • T1: Tumor confined to nasopharynx, or tumor extends to oropharynx and/or
nasal cavity without parapharyngeal extension • T2: Tumor with parapharyngeal extension • T3: Tumor involves bony structures of skull base and/or paranasal sinuses • T4: Tumor with intracranial extension and/or involvement of cranial nerves, hypopharynx, orbit, or with extension to the infratemporal fossa/masticator space • N0: No regional lymph node metastasis • N1: Unilateral cervical met(s), ≤6 cm in greatest dimension, above the supraclavicular fossa, and/or unilateral or bilateral RP met(s), ≤6 cm • N2: Bilateral cervical met(s), ≤6 cm, above the supraclavicular fossa • N3: Met(s) in lymph node(s) >6 cm and/or to supraclavicular fossa • N3a: >6 cm • N3b: Extension to the supraclavicular fossa • M0: No distant metastasis • M1: Distant metastasis Frequency of cervical nodal metastases in NPC is as follows: Nodal group Ipsilateral (%) Contralateral (%) I 7 1 II 82 36 III 31 17 IV 16 6 V 73 41 Supraclavicular 11 7 The frequency of retropharyngeal nodal metastases is approximately equivalent to that of Level II. Intensity modulated radiotherapy (IMRT) is now the modality of choice for primary treatment of NPC. Tightly conformed fields reduce side effects such as mucositis in adjacent tissues, but requires highly accurate tumor mapping. As such, the radiologist plays a crucial role in staging and treatment planning for NPC. As skull base and intracranial invasion is frequent, particular attention should be directed to both osseous and foraminal components of the skull base, and to the cavernous sinuses.

Monday
8:30AM - 10:00AM
Palais des congres de Montreal, 517d

04 - ASFNR PROGRAMMING: PRE-SURGICAL MAPPING (SAM)
O-06

Pre-Surgical Mapping: Context, Limitations, and Potential

Ulmer, J.
Medical College of Wisconsin
Wauwatosa, WI

Abstract/Presentation Summary
Surgical excision of brain tumors is important to prolong survival, reduce steroid dependence, improve neurological function, and establish histological and genetic features that determine post-operative treatment algorithms (1,2). Presurgical brain mapping techniques, such as fMRI and DTI, can help to establish operative risks and guide operative strategies (3-5). The main goal is to better define spatial relationships between lesion borders and functional brain networks. In addition to localizing functional networks surrounding brain lesions, mapping of the actual lesions may have utility in localizing epileptogenic foci and possibly in guiding tumor biopsy site selection. Thus, presurgical mapping may characterize lesions, determine lesion resectability, influence selection of surgical sites to be done awake, guide surgical trajectory, and influence intraoperative testing and resection extent. The overriding goal of presurgical mapping is to help establish functional resection boundaries and thereby help to minimize operative neurological complications. Prior to the era of modern presurgical brain mapping, neurological complication rates for brain tumor resections ranged from 8-32% (6-10). BOLD fMRI has been used for presurgical mapping for two decades, but the technique has significant limitations that render it...
an imperfect indicator of functional risks. The most serious limitation of presurgical fMRI is the lack of functional white matter visualization (11). The addition of presurgical DTI capabilities over the last decade has enhanced the clinical impact of the BOLD technique and vice versa, by providing more complete assessments of functional networks (2). Another major limitation of BOLD fMRI is lesion-induced (or radiation-induced) neurovascular uncoupling (12). BOLD reproducibility is further affected by the indirect nature of the contrast mechanism, such that concurrence ratios of normal reactivated regions range from 55-75%. BOLD fMRI also suffers from constraints in paradigm contrast, relatively low temporal resolution, and patient-dependent variability in task performance. DTI has limitations of its own (2), including lesion-induced decreased anisotropy and distortion of fiber tract orientation. Anatomic constraints may also limit the distinction of functional pathways coursing in the same direction, crossing with other fiber bundles, or coursing at acute angulations at the cortical interface. Because presurgical mapping data are imperfect, an integrative strategy utilizing all available localization sources is crucial. This includes functional localization based on sulcal and gyral anatomy on standard MRI. Clinical presentations including lesion-induced neurological deficits as well as seizure semiology may also provide important insights of lesion proximity to eloquent networks. This may be especially important when functional systems cannot be mapped, due to paradigm constraints or patient deficits. In such cases, Neuropsychology testing may be risk-predictive. Presurgical localization does not obviate the need for intra-operative mapping or testing. Presurgical mapping in fact complimentary to intraoperative mapping strategies, including intraoperative electrical stimulation and functional white matter dissection testing. Presurgical mapping can establish functional border-risk assessments that can be tested intra-operatively to establish functional resection boundaries. Case illustrations shown in this presentation demonstrate how the synergy provided by integrating localization sources, including presurgical mapping, can impact surgical decision making and produce superior postoperative neurological outcomes. A review of post-operative outcomes was recently conducted at the Medical College of Wisconsin in 76 patients with presurgical mapping and surgical navigation for resection of high risk brain tumors. At 1-month follow-up, 4 patients (5%) experienced major morbidities. Two patients experienced persistent post-operative neurologic deficits and 2 experienced regional morbidity (wound infection). Neurologic morbidity included 2 cases (<3%) of perioperative ischemic insult following Anterior Choroidal Artery and Anterior Cerebral Artery distribution strokes. In no case was there direct resection injury to eloquent networks. These outcomes compare favorably to historical controls (6-10). There is growing evidence that presurgical mapping and intraoperative utilization can improve Neurosurgical patient care.

O-07

Clinical Applications of Resting State

Shimony, J.
Washington University School of Medicine in St. Louis
Saint Louis, MO

Abstract/Presentation Summary
Currently, a challenge in the surgical treatment of brain tumors is to preserve eloquent areas of brain function while maximizing the extent of resection. The current gold standard for
localization of eloquent cortex is direct electrocortical stimulation (ECS), during an awake craniotomy where the patient is able to participate in various cognitive tasks [1]. The requirement for patient cooperation limits its use in a significant number of patients (e.g. children and medically tenuous patients) and thus may prohibit an optimal resection for these individuals. Similarly task fMRI requires patient cooperation. Resting state functional connectivity MRI (rsfMRI) has emerged as an alternative method for localization of brain networks that requires no active patient participation and can be done under sedation [2, 3]. The purpose of this study was to explore the use of rsfMRI for localization of eloquent cortex in patients with epilepsy and brain tumors [4]. We will present results from a study in which we scanned patients with intractable epilepsy and patients with brain tumors. Epilepsy patients had electrocorticographic monitoring using an implanted grid to localize the epileptogenic zone of seizure onset and to perform functional mapping with ECS. Patients with tumors underwent intra-operative ECS mapping prior to resection of the tumor mass. Resting state fMRI data was acquired and pre-processed as per prior protocols [3, 4]. Location of the motor and language system was determined using a multi-layered perceptron (MLP) [5]. A comparison was performed between the localization of the motor and language systems using ECS and RS-fMRI via the MLP algorithm. In the epilepsy patients we were able to perform a quantitative analysis by comparing the localization of the eloquent networks using the MLP with the localization on the different grid electrodes. By adjusting the probability threshold for classifying an electrode as eloquent or not we were able to calculate receiver-operator curves (ROC) with an average area under the curve (AUC) of 0.89 for the motor network and 0.76 for the language network. The results from the tumor patients were more qualitative. Networks were preserved in the presence of a tumor, though they were often shifted with respect to their normal anatomic position. In this study [4] rsfMRI has demonstrated utility as an adjunct tool for eloquent cortex localization. We have also determined that a "no-cut" criterion of 15mm around the contour of the network determined from the MLP will limit the false negative probability to less than 2%. Minimizing the MLP false negative results are critical to reduce surgical morbidity, since resection of a false negative area could lead to a clinical deficit.

O-08

The Value of Presurgical Functional Mapping in Neurosurgery

Lim, M.
Johns Hopkins Hospital
Baltimore, MD

Abstract/Presentation Summary
Craniotomies for resection of various pathologies in the brain carry an inherent risk for severe morbidities in patients. The risks of causing neurologic impairment correlate with the proximity of the pathology with eloquent structures of the brain. Pioneers such as Drs. Foerster and Penfield helped define the areas of eloquence in the 1920's that are described in traditional anatomy books. However years of intraoperative mapping have demonstrated that there areas of eloquence can be variable. The use of intraoperative mapping has decreased the morbidities associated with surgery of tumors/vascular malformations in eloquent areas. Patient's who receive intraoperative mapping do well from surgery. Initially, about 20% of patients have
worsened or new speech deficits immediately after surgery but over 90% of those patients recover their function. fMRI now allows us to map eloquent areas of the brain before surgery to account for individual differences in anatomy and to plan for surgery. fMRI measures the amount of deoxygenated blood, which correlates to areas of activity. fMRI has been used a complement to and in some cases in lieu of intraoperative mapping. We will discuss the overall approach to fMRI, nuances associated with fMRI, and assess the appropriate situations for fMRI to replace intraoperative mapping. We will also discuss the situations where fMRI could complement intraoperative mapping.

O-09

DTI and Pre-Surgical Mapping

Wolf, R.
University of Pennsylvania
Philadelphia, PA

Abstract/Presentation Summary
There is enough interindividual anatomic variation such that standard landmarks are not always reliable for motor or language functional cortex (1,2); and thus, there is a need for preoperative and intraoperative mapping strategies. Primary goals are to determine feasibility of resection, plan safest approach, and maximize extent of safe resection. Noninvasive and invasive cortical and subcortical electrophysiologic measurements for clinical mapping of brain function have long been available(3), but noninvasive techniques are increasingly available for routine practical neurosurgical planning. These include cortical mapping using magnetoencephalography (MEG) or functional magnetic resonance imaging (fMRI) and subcortical mapping using diffusion tensor imaging (DTI). Intraoperative electrophysiologic mapping is the reference standard, but this has inherent limitations just as for noninvasive mapping, and so these techniques can provide complementary information (4-7). The purpose of this presentation is to focus on practical aspects of DTI in neurosurgical planning. DTI methods provide microstructural information on local cellular environment and organization and macrostructural information regarding white matter tracts and connections between important cortical and subcortical functional regions in the brain. Microstructural elements including cellularity, intraaxonal organization and fiber density, myelination, and fiber diameter combine with macrostructural organization of fibers to affect diffusion anisotropy, the basis for the color fractional anisotropy (FA) and tractography maps used for planning. The color FA maps provide a 3D image data set showing direction and degree of anisotropy on a voxel by voxel level, while fiber tractography (FT) depicts likely "connections" from voxel to voxel and thus from one region (or regions) of the brain to another. Strategies for tractography include deterministic and probabilistic approaches, deterministic methods like fiber assignment by continuous tracking (FACT) most widely used(8). These create virtual tracts and do not represent real nerve fibers, but do provide a guide for preoperative planning and intraoperative navigation, especially if updated with intraoperative MRI (8-13). DTI fiber tracking (DTI FT) and tracking with other diffusion techniques using non-tensor approaches (e.g., high-angular resolution diffusion MRI with Q ball reconstruction) are currently the only means to perform noninvasive localization of white matter tracts. There is evidence
supporting the role of fMRI and fiber tracking in the presurgical setting not only for planning and navigation but also with regard to safety, postsurgical treatment and outcome.

Questions and Answers

Monday
8:30AM - 10:00AM
Palais des congres de Montreal, 517a

05 - YOUNG PROFESSIONALS PROGRAMMING: ADVANCES IN IMAGING: HOW TO INCORPORATE THEM INTO YOUR PRACTICE
O-10

Vessel Wall Imaging I

Wasserman, B.
Johns Hopkins University
Baltimore, MD

Abstract/Presentation Summary
High-resolution contrast-enhanced MRI has emerged as a powerful tool for characterizing atherosclerotic plaque components, ultimately enabling the identification of anatomic features that are known to predispose to rupture with the consequent clinical event. Recently, much attention has focused on the identification by MRI of the thin fibrous cap, large lipid core, the presence of intraplaque hemorrhage, and the presence of neovascularization, all of which have been shown to be important determinants of stroke risk when identified in carotid plaque. Intraplaque hemorrhage is of particular interest in that it is thought to lead to the development of the thrombogenic lipid core and contributes to plaque progression. More recent advances in high-resolution MRI imaging have enabled the evaluation of intracranial vessels also to assess stroke risk and for diagnosing vasculopathies. In this session, an approach to evaluating these features by MRI will be presented with a focus on equipment needs, sequence considerations, and image interpretation and pitfalls.

O-11

Vessel Wall Imaging II
DeMarco, J.
Michigan State University
East Lansing, MI

Abstract/Presentation Summary
Recent advances of carotid plaque MR imaging has made it possible to directly visualize the atherosclerotic disease in its many stages of development. The hardware and software necessary to obtain and interpret carotid plaque MR imaging will be discussed. The studies validating the in vivo MR appearance carotid plaque components utilizing dedicated research carotid coils and MR plaque sequences with histological comparison of endarterectomy specimens will be reviewed. Next, current prospective trials demonstrating the correlation of research carotid plaque MR characterization with future ipsilateral carotid cerebrovascular disease will be summarized. Recent examples to translate these research carotid MR sequences to the clinical environment by using FDA approved MR sequences and standard FDA approved carotid coils or neurovascular coils will be compared with the histologically validated research carotid MR findings. Lastly, the potential to add value to your referring clinicians by including these "clinical" carotid plaque MR sequences to routine carotid MR angiography will be reviewed.

Discussion

9:10AM - 9:15AM

O-12

Perfusion MRI (Beyond Tumor Imaging - Additional Useful Applications)

Maldjian, J.
Wake Forest University School of Medicine
Winston-Salem, NC

Abstract/Presentation Summary
Arterial spin labeling (ASL) perfusion MRI imaging has been in development for over a decade (1-3). With the recent availability of the technique from a variety of MRI vendors, ASL is now entering more broadly into the clinical realm. Unlike conventional bolus gadolinium techniques, ASL does not require intravenous contrast, is quantitative, and is readily repeatable. There are several frequently encountered artifacts in the clinical population with ASL (4). ASL relies on a subtraction of imaging pairs to obtain the perfusion signal, making it highly susceptible to slight motion artifacts, or transient gradient hardware instability. Post-gadolinium ASL should be avoided. There are a variety of ways of implementing ASL, each of which can be separated into a preparation phase, and an acquisition phase. Some of the more common ASL methods include pulsed ASL (PASL), continuous ASL (CASL), pseudo-continuous ASL (PCASL), and velocity-selective ASL (VS-ASL). ASL applications are evolving as clinical experience is gained with
this technique. Recent studies have revealed many pathologic and physiologic processes readily identified with quantitative perfusion imaging (4-13). Normal Perfusion Patterns. ASL perfusion patterns demonstrate age-related changes in perfusion signal. Pediatric patients in the 5-15 year old range demonstrate high perfusion values (14-17). Adults demonstrate a gradual age-related decline in brain perfusion. Seizure: In the immediate post-ictal state ASL can demonstrate regional hyperperfusion (9). In the inter-ictal state, ASL can demonstrate a regional hypoperfusion pattern. Migraine: Migraine headaches imaged during the acute phase can demonstrate regional cortical hypoperfusion (8). During the headache phase, hyperperfusion can be seen in the cortex corresponding to the prior aura symptoms (8, 18-21). Posterior Reversible Encephalopathy Syndrome: PRES on ASL can have a variety of appearances. We have found that patients who are imaged acutely show hyperperfusion in the affected occipital and frontal hemispheres and patients who are imaged in the subacute phase show hypoperfusion in these regions (22). The variability and apparent discrepancies between studies investigating perfusion changes related to PRES may be secondary to the time-course of the disease. Hypercapnia: Hypercapnia is a potent cerebral vasodilatory stimulus. In the clinical population, common conditions which can result in arterial blood gas disturbances include chronic obstructive pulmonary disease, adult respiratory distress syndrome, and pulmonary edema (10).

O-13

Perfusion MRI (Latest Update on Tumor Pre and Post Therapy)

Cha, S.
University of California San Francisco
San Francisco, CA

Perfusion MRI Discussion

9:35AM - 9:55AM

9:55AM - 10:00AM

Monday
8:30AM - 10:00AM
Palais des congres de Montreal, 520

06 - ADVANCED IMAGING SEMINAR: TRANSLATIONAL ADVANCED METABOLIC IMAGING
O-14

O MRI of Cerebral Oxygen Metabolism and Potential Clinical Applications

8:30AM - 9:00AM
Abstract/Presentation Summary
Oxygen-17 (17O2) is a naturally occurring, chemically stable, non-radioactive isotope of oxygen with low natural abundance (0.037% of atmospheric oxygen). Unlike the bulk of atmospheric oxygen (16O), the 17O nucleus has non-integer spin (5/2), making it detectable using MR spectroscopy or proton MRI methods when metabolized to water (H217O). Detection of the low MR sensitivity 17O nucleus (gyromagnetic ratio 1/7 that of 1H) can be improved at high magnetic fields (e.g. 7T). Proton MRI on 1.5T or 3.0T clinical systems can detect 17O indirectly by utilizing its effect on high sensitivity proton relaxation in metabolized water (H217O). Detection can be further improved by isotope enrichment using concentrated 17O2 gas via inhalation, extracorporeal autologous blood enrichment or synthetic oxygen carriers (e.g. perfluorocarbons). In acute and chronic cerebral ischemia, measurements of cerebral blood flow (CBF) are not sensitive or specific predictors of tissue survival. Measurements of oxygen metabolism are better predictors, especially the "oxygen extraction fraction" (OEF). Elevation of OEF in both acute and chronic Stage 2 hemodynamic failure, or "misery" perfusion, indicates impending failure of oxygen metabolism and cellular necrosis, making it a sensitive and specific biomarker for the "ischemic penumbra" and tissue at risk of infarction distal to vascular stenosis. The methods now used to quantitatively image in vivo human cerebral metabolic rate of oxygen (CMRO2) and OEF include 15O-PET and MRI deoxyhemoglobin sensitive techniques (BOLD methods), which have practical and fundamental limitations for clinical use. 15O-PET is limited by complex infrastructure with an on-site cyclotron for isotope production (15O T1/2 = 2 minutes), sparse availability, radiation exposure and high cost. BOLD MRI methods are limited by dependence on complex, indirect effects of oxygen metabolism on intravascular deoxyhemoglobin concentrations which are also dependent on cerebral blood flow (CBF) and blood volume (CBV), intravascular and extravascular T2 and T2* relaxation effects, field strength, vessel size, perivascular water diffusion and assumptions about unmeasurable variables within the image voxel, including local hematocrit, relative arterial and venous volumes, vessel geometry, oxygen diffusion rates and oxygen concentration gradients. 17O-MRI performed on conventional, clinical MRI scanners may provide a quantitative, widely available and clinically practical method for assessing CMRO2 and OEF in human acute and chronic cerebral ischemia. Quantitative 17O-MRI of oxygen metabolism may also have research and clinical utility in neurodegenerative disease, cardiology and oncology.

O-15

Quantitative PET Biomarkers of Neuroinflammation

Mozley, P.
Nuclear Medicine
New York, NY
Advanced Multislice Spectroscopic Imaging in Routine Clinical Practice

Shungu, D.
Weill Cornell Medical College
New York, NY

Abstract/Presentation Summary
Structural MRI with or without contrast-enhancement has developed into the preferred diagnostic imaging modality for noninvasive examinations of intracranial lesions and pathologies, producing exquisitely detailed anatomic images that have dramatically improved clinical decision-making. However, MRI often lacks the specificity to differentiate pathologic lesions from normal post-operative or post-therapy changes, such as edema and radiation-induced necrosis, and it can miss pathologic changes that do not exhibit contrast-enhancement, such as some low-grade brain neoplasms [1]. Consequently, there has been a great deal of interest in evaluating proton magnetic resonance spectroscopy (1H MRS) – a closely related technique that permits noninvasive assessment of brain chemistry and can be performed in conjunction with MRI on virtually every clinical MR scanner, without the need to change hardware or move the patient – as a complement to MRI in the evaluation of brain lesions and diseases [2]-[5]. The clinical promise and diagnostic power of 1H MRS is in its ability to enable the noninvasive measurement of the brain concentrations of several potential biomarkers of human disease, either from a single volume element (voxel) [3],[5], or from multiple voxels in a single or multiple brain slices simultaneously [2],[4]. The metabolic information derived by 1H MRS can establish neuronal viability and integrity, cellular bioenergetics function or dysfunction, or the presence of rapidly proliferating cells indicative of neoplastic transformation. In this presentation, the speaker, who has had nearly two decades of experience implementing 1H MRS imaging as a diagnostic neuroradiological tool in a clinical setting, will describe and demonstrate the promise and power of the technique as a complement to both structural and function MRI, capable of contributing highly specific information about the metabolic status of normal or diseased brain tissue that can significantly enhance decision-making in routine clinical practice.

Monday
8:30AM - 10:00AM
Palais des congres de Montreal, 524

07 - INTERNATIONAL SESSION-AOSNHNR PRESENTS THE BEST IN 2014-QUANTITATIVE NEUROIMAGING
O-17

Recent Advances in Diffusion Weighted Imaging

Yamada, K.
Kyoto Prefectural University of Medicine
Kamigyo-ku, Kyoto
Abstract/Presentation Summary
Diffusion weighted imaging (DWI) and diffusion-tensor imaging (DTI) has now become one of the essential research/clinical tools in analyzing the brain in both normal and pathological states. Water molecules will preferentially diffuse in a direction parallel to the axon's longitudinal axis. This phenomenon can be represented mathematically by the diffusion tensor. The tensors of cerebral white matter can be reconstructed to track three-dimensional macroscopic fiber orientation. The tractography technique allows in vivo localization of neuronal fiber tracts, which was not previously possible. As a clinical tool, this technique primarily targets the intracranial space occupying lesions. This has been also utilized for other conditions, such as stroke imaging and degenerative diseases. It is important to notice that DTI is prone to partial volume averaging especially at the areas with crossing fibers. Thus, when comparing results from different institutes, it will be ideal to standardize the voxel size. The most important limitations of tractography will be that it has not yet been fully validated. Attempts to validate this technique have been made in the past, but are somewhat limited, and thus one has to interpret the results with cautions. Q-space imaging and diffusion kurtosis will be other recent advances in this field and this will be briefly touched in this talk. One last topic will be the DWI thermometry.

O-18

Quantification of Brain Tissue - Relaxometry Studies in CNS Diseases

Lee, S.
Yonsei University College of Medicine
Seoul, CA

Abstract/Presentation Summary
In the recent decade, CNS imaging has focused on functional imaging, perfusion measurements and brain mapping studies while other many neuroscientists have tried to find quantitative brain imaging techniques in vivo. Characterization of brain tissue by quantitative imaging is a promising field of neuroradiology because the current trends of functional and various anatomical imaging cannot provide absolute data of local tissue in cases of CNS disease. T1, T2 and T2* relaxometry studies have been applied in clinical neurology and their relevance has been proved by many studies. T2 relaxometry has been applied in quantification of signal changes in hippocampal sclerosis. However, the absolute value of T2 relaxation time of brain tissue is quite different from institution by institution. In applying the T2 relaxometry studies in epilepsy, the institute should have their own reference values for exact lateralization in cases of TLE. T2* relaxometry is more sensitive in the areas of high magnetic susceptibilities, angiogenesis and neovascularized areas. It can be applied in the assessment of iron deposition in aging process, neurodegenerative disease and even for the assessment of angiogenesis. Measurement of T1 relaxation time can be achieved by various methods. T1 relaxation time can be varied by aging process, iron deposition, neuromelanin pigmentation in cases of Parkinsonism. T1 mapping is another field of tissue characterization in CNS disease and future clinical application is expected. Although brain tissue characterization is still under progression, it is likely to be the main stream of the future brain imaging because absolute quantification of normal and diseased brain tissue is very important in imaging diagnosis of CNS disease.
Cerebral Perfusion in Angiogenesis and Stroke

Lim, C.
National Neuroscience Institute
Singapore

Abstract/Presentation Summary
Recent advances in acute stroke therapy and antiangiogenic cancer treatment have renewed interest in cerebral perfusion, and quantitative neuroimaging. For many decades, the classical Kety-Schmidt equation to determine cerebral blood flow (CBF) has been applied to positron emission tomography (PET); now, better mathematical models are being developed to study the distribution of tracer (such as contrast media) concentrations using newer MR and multi-detector CT perfusion techniques. Perfusion MR imaging may be helpful to delineate the brain territory representing the "ischemic penumbra", located downstream from vascular occlusion, and is at risk of further infarction. Combined MR angiography, diffusion-weighted (DW) MRI, and perfusion MRI parameters of mean transit time (MTT), or time to peak, may predict tissue at risk, but quantitative evidence from large scale studies have not yet been collected. Arterial spin labeling (ASL) has also become more feasible with higher field MR scanners, but perfusion CT techniques are hampered by the lack of reliable DW MRI equivalent biomarker. Intracranial neoplasm may also be studied with perfusion CT and MRI, which may be helpful for pre-surgical assessment and surveillance. Neovascularity from tumor angioneogenesis may be studied using dynamic first pass or dynamic contrast-enhanced perfusion methods, with rCBV and quantitative permeability markers being applied to research and clinical diagnostic imaging. This presentation will highlight clinical examples of perfusion CT and MRI in cerebral ischemia and brain tumors

Quantitative Neuroimaging of End Stage Liver Disease

Lin, W.
Chang Gung Memorial Hospital - Kaohsiung Medical Center
Kaohsiung

Abstract/Presentation Summary
Although end stage liver disease is the consequence of liver function impairment and liver fibrosis, it can affect multi-systems, including the brain. Liver cirrhosis is frequently associated with a wide range of neuropsychiatric abnormalities. Personality disorders, inappropriate affective, behavioral, and sleep disturbances had been reported. Patients with acute liver failure can succumb to neurological death, with brain edema and intracranial hypertension. However, conventional neuro-images in end stage liver disease are non-specific with less clinical neurological impact. Quantitative investigation of brain in structural and functional aspects by using advanced MRI in liver cirrhosis is limited. There is still a gap between the clinical presentation and neuroanatomy in these particular subjects. Therefore, we focus on cognition
function and MRI findings in these projects and try to bridge the causal-relationship between each others. In addition, liver transplantation re-normalizes the impaired liver function with subsequently cognition function improvement. We further clarified the underlining structural and functional evolution before and after transplantation by using diffusion tensor imaging and resting state functional MRI. We bridge the phenotype, neuropathology and neurophysiology in liver cirrhosis which provide a platform for further clinical assessment.

O-21

From Flat-Detector to Quantitative DSA for Neurovascular Disorders

Guo, W.
Taipei Veterans General Hospital
Taipei, AK

Abstract/Presentation Summary
Quantitative angiography using flat detector DSA (FD-DSA or C-arm CT) is becoming a routine imaging practice in neurovascular disorders. Recently, measurement of cerebral perfusion, namely cerebral blood volume (CBV), cerebral blood flow (CBF) and circulation times, using FD-DSA is becoming feasibly available. Compared with multi-detector CT, FD-DSA provides: wider scanning coverage, better scanning efficacy, one-stop imaging that saving patient transportation, in-room real-time hemodynamics availability, and more importantly, therapeutic guidance for various neurovascular disorders. The presentation covers the contents of quantification of cerebral hemodynamics ranging from diagnostic to intra-interventional procedures and post-therapeutic evaluation. The diseases categories included in the presentation are carotid arterial occlusive diseases (CAOD), dural arteriovenous fistula, cerebral arteriovenous malformation, post-hemorrhagic arterial spasm and moyamoya disease. The treatments employed for this patient cohort included re-vascularization and de-vascularization procedures, namely, extracranial and intracranial carotid artery stenting (CAS), intra-arterial thrombectomy/thrombolysis, EC-IC bypass, microsurgery, radiosurgery, embolization and/or their combinations. The improvement of imaging technology (high efficacy flat detector with high spatial resolution and improving contrast resolution) allows us to quantitatively study cerebral hemodynamics of patients with neurovascular disorders by using only FD-DSA. It will definitely change the scenario of our future imaging practice in neurovascular disorders.

Monday
10:30AM - 12:00PM
Palais des congres de Montreal, 517bc

08 - ASHNR PROGRAMMING: PRACTICAL HEAD AND NECK RADIOLOGY
O-22

Imaging of Facial Pain
Abstract/Presentation Summary

Facial pain is common in the population, but must be distinguished from headache, throat pain, ear pain, and other types of pain in the head and neck region. Facial pain is typically localized to an area limited by the forehead superiorly, the masseter region laterally, and the chin inferiorly. The major mediator of facial pain is cranial nerve 5, the trigeminal nerve. Trigeminal neuralgia is a frequent indication for referral to imaging, though many patients with "classic" trigeminal neuralgia do not undergo imaging. Trigeminal neuralgia is a unilateral disorder characterized by brief electric shock-like pains, abrupt in onset and termination, limited to the distribution of one or more divisions of the trigeminal nerve. Diagnostic criteria for "classic" TN include: A. Paroxysmal attacks of pain lasting from a fraction of a second to 2 minutes, affecting one or more divisions of the trigeminal nerve and fulfilling criteria B and C B. Pain has at least one of the following characteristics: 1. intense, sharp, superficial or stabbing 2. precipitated from trigger areas or by trigger factors C. Attacks are stereotyped in the individual patient D. There is no clinically evident neurological deficit E. Not attributed to another disorder The pain usually involves V2 or V3, with V1 affected in <5%. Many if not most patients with classic TN have compression of the trigeminal root by tortuous or aberrant vessels in the posterior fossa. In "symptomatic" TN, the pain is indistinguishable from classic TN, but it is due to a demonstrable structural lesion (neoplasm, infection, inflammation, demyelination…) other than vascular compression. In all patients with TN, the course of the trigeminal nerve should be assessed from brainstem through cisternal and foraminal segments to the end-organ points of innervation as, for the radiologist, TN is a diagnosis of exclusion. Additionally, important potential sites of disease that should be assessed in all patients with facial pain are the temporomandibular joint, paranasal sinuses, dentition/maxillary alveolus/mandible, and the salivary glands and ducts.

O-23

Skull Base Developmental Lesions

Phillips, C.
Weill Med. College Of Cornell/NY Presby'n
New York, NY

Abstract/Presentation Summary

Developmental Lesions of the Skull Base represent uncommon lesions encompassing CNS-sinonasal lesions, maldevelopmental lesions of the skull base, and potential normal variations of the skull base. It is important to recognize these lesions to avoid complications that may arise from misdiagnosis and also to properly diagnose them. Developmental lesions of the anterior skull base are largely abnormalities of the CNS that manifest via sinonasal lesions, such as encephaloceles. All nasal pathology discovered on imaging studies should prompt the radiologist to carefully scrutinize the anterior skull base. The interplay of the anterior fossa structures and the developing normal nasoethmoid region leads to a large array of potential pathology, including dermoid lesions, dermal sinuses, glial heterotopia and encephaloceles. Common
encephaloceles include the frontonasal and nasoethmoidal encephaloceles. Knowledge of the normal embryology in this region is very helpful in understanding the potential imaging manifestations. In the central skull base, encephaloceles may be seen. Again, these lesions are important to diagnose to properly direct surgical management and avoid potential complications from misdiagnosis. The presence of a skull base defect must again be carefully excluded. Abnormalities of the pituitary and sella may accompany several of these central skull base abnormalities. There are a wide range of potential normal variations of the central skull base which must not be diagnosed as pathology. The posterior skull base is commonly involved in craniocervical maldevelopmental conditions. The posterior fossa structures and upper cervical spine must be carefully reviewed. Several more common variant foramina are also seen in the basiocciput. The association of posterior fossa maldevelopmental lesions and craniocervical junction abnormalities is an important one.

O-24

Imaging of Referred Otalgia - What You Should Look For

Gentry, L.
University of Wisconsin Hospital
Madison, WI

Abstract/Presentation Summary
Otalgia (ear pain) is most often attributable to diseases within the middle or external ear. It is not uncommon, however, for ear pain to be seen in patients with a normal ear exam and pathologies remote from the ear (referred otalgia). When patients present for workup of ear pain, it is important for the radiologist to consider the many different types of lesions that can manifest as referred otalgia. Referred ear pain is usually due to temporomandibular joint disease and dental pathology. Any lesion within the head and neck in the distribution of branches of cranial nerves 5, 7, 9, and 10, as well as the 2nd and 3rd cervical nerves can cause referred otalgia. The imaging workup should be tailored to exclude lesions along these nerves. This lecture will look at the varied pathologies that can cause referred otalgia.

Discussion

11:45AM - 12:00PM

09 - PARALLEL PAPERS: Adult Brain: Aneurysms
Comparison of the Hemodynamics between Growing and Stable Cerebral Aneurysms

J Cebral\textsuperscript{1}, C Putman\textsuperscript{2}, D Sforza\textsuperscript{1}

\textsuperscript{1}George Mason University, Fairfax, VA, \textsuperscript{2}Texas Neurointerventional Surgery Associates, Dallas, TX

Purpose
Increased detection of incidental cerebral aneurysms requires an objective evaluation of rupture risk for selecting the best possible patient care. However, the detailed mechanisms of cerebral aneurysm evolution are poorly understood but important for better understanding the natural history of aneurysms and improve their evaluation and treatment. Thus, the purpose of this study was to identify hemodynamic conditions that may predispose aneurysms for growth and rupture in a series of aneurysms conservatively followed without treatment.

Materials and Methods
A total of 33 untreated intracranial aneurysms longitudinally followed with 3D imaging were identified in 21 patients (19 females and 2 males) and selected for study from our database. The criteria for inclusion in the study were untreated aneurysms with at least two 3D images spaced over a period of time. Expert neuroradiologists initially identified growing aneurysms by size measurements on the images. After segmentation and geometry reconstruction, vascular models at different times were aligned and geometrical differences were measured. Aneurysms exhibiting an increase in size of more than 0.5 mm in any direction from the initial examination were classified as "growing". Aneurysms that did not enlarge more than 0.5 mm for at least nine months were classified as "stable". Patient-specific computational fluid dynamics (CFD) models were constructed and used to quantitatively characterize the hemodynamics environments of these aneurysms. Hemodynamic characteristics of growing (n=16) and stable (n=17) aneurysms then were statistically compared. Logistic regression models were constructed to test the predictability of aneurysm growth by hemodynamic features.

Results
Growing aneurysms had significantly smaller shear rate ratios (p=0.01), higher concentration of wall shear stress (p=0.03), smaller vorticity ratios (p=0.01), and smaller viscous dissipation ratios (p=0.01) than stable aneurysms. These same associations previously were found when comparing ruptured and unruptured aneurysms in cross-sectional series. Growing aneurysms also had larger areas under low wall shear stress (p=0.06) and larger aspect ratios (p=0.09); however these trends were only marginally significant. Mean wall shear stress was not significantly different between growing and stable aneurysms. Logistic regression models based on hemodynamic variables were able to discriminate between growing and stable aneurysms with a high degree of accuracy (94-100%).

Conclusions
Growing aneurysms had on average more concentrated wall shear stress distributions, more complex flow structures, lower viscous dissipation than their parent artery, and lower local deformation and rotation of fluid elements than their parent artery. The mean wall shear stress was not significantly different between growing and stable aneurysms. Statistical models based on hemodynamic features seem capable of discriminating between growing and stable aneurysms, and could be used to complement current aneurysm evaluation.
Purpose
The interactions between the hemodynamics, wall biomechanics and biology, and the pathways leading a cerebral aneurysm to progress to rupture are not well understood. It is thought that aneurysm evolution is driven by progressive degradation and weakening of the wall in response to abnormal hemodynamic conditions characterized by either low or high wall shear stress (WSS). Our work seeks to investigate the effects of these two different hemodynamic pathways in a series of cerebral aneurysms in which the site of rupture is known.

Materials and Methods
Nine ruptured aneurysms with associated focal intraparenchymal hemorrhages in which the rupture site could be identified in 3D images were analyzed. The wall shear stress distribution was obtained from image-based computational fluid dynamics (CFD) simulations. Wall stresses then were computed using 3D structural wall models under hemodynamic loads determined by the CFD models. Wall properties (thickness and stiffness) were modulated with the wall shear stress distribution, i.e., increased or decreased in regions of high or low WSS, in order to test possible wall degradation pathways. Regional rupture probability indices (RPI) were calculated to compare the different wall models.

Results
All possible combinations of wall thinning/thickening or stiffening/softening were compared both qualitatively and quantitatively. Qualitatively, wall models were ranked by looking at: a) the RPI within the known rupture regions, and b) the location of the maximum RPI. Quantitatively, models were compared by computing the relative rupture probability indices at the known sites of rupture. It was found that the model that best explained the rupture site (produced higher RPI) in eight of the nine aneurysms (89%) had thinner and stiffer walls in regions of abnormally high WSS. The remaining case (11%) was best explained by a model with thinner and stiffer walls in regions of abnormally low WSS. Additionally, it was observed that the regions of high RPI were in general displaced downstream towards the dome with respect to the regions of high WSS.

Conclusions
Aneurysm evolution seems to be driven by localized degradation and weakening of the wall in response to abnormal hemodynamics. Image-based computational models assuming wall thinning and stiffening in regions of abnormally high WSS were able to explain most of the observed rupture sites.

KEYWORDS: Aneurysm Rupture, Biomechanical, Hemodynamics
Novel Applications and Quantitative Analysis of Dynamic Contrast Enhanced MRI in Neurovascular Diseases For Stroke Prediction

P Vakil¹, M Hurley¹, S Prabhakaran¹, T Carroll¹, S Ansari²
¹Northwestern University, Chicago, IL, ²Northwestern University Feinberg School, Chicago, IL

Purpose
Dynamic contrast-enhanced (DCE) MR imaging (MRI) is an established method for quantifying blood-brain barrier permeability, commonly used for assessing contrast agent leakage in brain tumors (1), multiple sclerosis (2), and infectious diseases (3). However its application to neurovascular pathologies are not as thoroughly explored. In this study we demonstrate for the first time, the utility of DCE MRI in assessing the permeability of the vessel wall in patients with intracranial atherosclerotic disease (ICAD), intracranial aneurysms (IAs), marfan's syndrome, and vasculitis.

Materials and Methods
We imaged the lumen and the vessel walls in the intracranial circulation of N=34 patients using a standard dynamic contrast-enhanced protocol based on a multiphase spoiled gradient echo pulse sequence. The imaged vessels had the following pathologies: (n=6) atherosclerotic plaques, (n=23) saccular aneurysms, (n=3) fusiform aneurysms, (n=1) Marfan's syndrome, (n=1) vasculitis. Dynamic contrast-enhanced MRI parameters kTrans, vL, and area under the curve (AUC) were derived in each case and compared against other imaging modalities (diffusion-weighted imaging, T1-SPACE dark blood imaging) and clinical findings (symptomology). Optimal imaging parameters such as slice thickness and imaging time were identified for each imaging protocol.

Results
Higher KTrans was observed in symptomatic versus asymptomatic atherosclerotic plaques verus healthy vessel walls (0.18 min⁻¹ versus 0.02 min⁻¹ versus 0.0083 min⁻¹ respectively, p<0.001). Intracranial aneurysms demonstrated larger arterial wall permeability than healthy vessel walls (IA: 0.1778 ± 0.0230 min⁻¹ versus healthy vessel: 0.0083 ± 0.0012 min⁻¹ respectively, p<0.001) but smaller contrast uptake rates than in the choroid plexus (0.4058 ± 0.0567 min⁻¹, p<0.001). Intracranial atherosclerotic disease plaques associated with acute stroke had much larger plaque KTrans than nonstroke ICAD patients (0.31 min⁻¹ versus 0.105 min⁻¹, p<0.05). Finally all ICAD and vasculitis patients with positive kTrans findings had corroborating postgadolinium enhancement on T1-SPACE Imaging.

Conclusions
Dynamic-contrast-enhanced MRI can be used to quantify the permeability of the vessel wall in a variety of neurovascular pathologies with parameters kTrans and vL. Initial results show these parameters may be used to stratify symptomatic and asymptomatic patients as well as identify those at risk for suffering stroke. Dynamic contrast-enhanced MRI studies on patients with neurovascular disease may provide useful information about disease progression especially in a longitudinal study of patients.

KEYWORDS: Aneurysm, Aneurysmal Subarachnoid Hemorrhage, Intracranial Atherosclerosis
Local Hemodynamics at Known Aneurysm Rupture Sites

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Purpose
Understanding the reasons for aneurysm formation and the mechanisms leading an aneurysm to progress and ultimately rupture are important for formulating innovative medical treatments and better select factors used for future risk assessments for the many unruptured aneurysms now more frequently found on noninvasive imaging. Previous studies have identified possible pathways for aneurysm wall weakening due to both high and low wall shear stress. Thus, the purpose of this study was to investigate the local hemodynamic environment in the vicinity of the site of aneurysm rupture.

Materials and Methods
A total of nine ruptured cerebral aneurysms with associated focal intraparenchymal hemorrhages were selected from our databases of aneurysms imaged with 3D rotational angiography (3DRA). The rupture sites were identified by expert neuroradiologists by inspection of extravascular blood in volume rendered 3D angiograms and/or additional computed tomography (CT) images. Computational fluid dynamics (CFD) models were constructed using the patient-specific geometries derived from 3DRA images, and typical physiologic pulsatile flow conditions. Visualizations of the inflow jet, intrasaccular flow structures and distribution of wall shear stress...
were created and used to analyze the relationship between these flow features and the regions identified as the most likely point of rupture.

Results

Inspection of flow visualizations revealed that the rupture sites tended to be aligned with the inflow stream and typically were located near regions of primary or secondary flow impingement. In most of the cases (eight out of nine) the locations of aneurysm rupture did not seem to coincide with regions of sluggish flow, or with either the regions of the highest or lowest wall shear stress. All cases had at least one region of relatively high wall shear stress, and the rupture sites tended to be found downstream of the high wall shear stress region, towards the dome. In one case, the rupture point was located at the fundus of the aneurysm where the wall shear stress was the lowest.

Conclusions

In general, observed rupture sites did not coincide with regions of either low or high wall shear stress. However, they tended to be aligned with the main intrasaccular flow stream and to be located downstream of regions of high wall shear stress, towards the dome of the aneurysm. These results suggest that both the hemodynamics as well as the status of the wall are important to explain the rupture locations observed in this series.

KEYWORDS: Aneursym, Aneurysm Rupture, Hemodynamics

O-29

Comparison of 3D Semi-Automatic with Manual Post-Processing for Quantification of Aneurysm Pulsation

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Purpose

Due to the small volume changes encountered in the analysis of four-dimensional computed tomography angiography (4DCTA) data, precise postprocessing is critical in aneurysm pulsation analysis. We hypothesized that semi-automatic 3D segmentation offers advantages to manual 2D postprocessing.

Materials and Methods

Four-dimensional CTAs of 10 patients with a cerebral aneurysm were processed by two readers manually and semi-automatically with an in-house developed software tool. The latter creates a 3D model of the vasculature where the aneurysm/parent vessel border is defined by placing points on its surface. Then the aneurysm is segmented automatically in all time points and volumes are calculated. Absolute volumes, pulsatilities (maximum volume/minimum volume) and length of postprocessing were compared between both groups.

Results

Two-dimensional and 3D postprocessing show high correlations regarding aneurysm volumes (0.92, p=0.01) and pulsatilities (.87, p=0.02). Bland-Altman analysis shows similar limits of
intra-observer agreement in both 2D (-1+4%) and 3D (1+5%). Total postprocessing time was 5.2+4.1min in 3D versus 12.2+6.1min in 2D.

Conclusions
Semi-automatic segmentation in 3D shows high reliability and reproducibility and considerably reduces the postprocessing time, making it a useful tool in the analysis of aneurysm pulsation.

KEYWORDS: Aneursym

O-30

Global Cerebral Edema in Patients with Subarachnoid Hemorrhage: Correlation with Blood Brain Barrier Permeability.

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1New York Presbyterian Hospital, Weill Cornell Medical College, New York, NY, 2Weill Cornell Medical College, New York, NY, 3New York Presbyterian Hospital, Weill Cornell Medical Center, New York, NY, 4New York Presbyterian Hospital, Cornell University, New York, NY

Purpose
Global cerebral edema (GCE) in aneurysmal subarachnoid hemorrhage (SAH) is an important predictor of morbidity and mortality. Early detection of GCE remains challenging. Perfusion deficits in SAH patients who develop GCE are thought to be related to impaired autoregulation and blood-brain barrier permeability (BBBP) dysfunction. Computed tomography perfusion (CTP) with full pass technique allows measurement of BBBP in the clinical setting. We assessed whether alterations in BBBP correlate with GCE by studying PS (permeability surface area product), K-trans (flow rate constant from blood plasma to the extravascular extracellular space (EES)), Kep (flow rate constant from EES to blood plasma), and F (blood flow per unit volume of tissue).

Materials and Methods
IRB approval was obtained. Thirty-three SAH patients underwent CTP on admission and at subsequent time points in the early (days 0-3) and delayed phases (days 4-16). Patients were stratified into three outcome groups as GCE, non-GCE and indeterminate based on their admission noncontrast CT using established criteria via blinded consensus reading from two board-certified neuroradiologists. Computed tomography perfusion data were postprocessed into BBBP quantitative maps of PS, K-trans, Kep and Flow using Olea Sphere software (Olea Medical, LaCiotat, France). A total of 2401 ROIs were obtained from the 31 patients included in the analysis. Unpaired t-Tests were performed. In the primary analysis comparing the GCE and non-GCE groups, the indeterminate patients were excluded. A secondary analysis was performed to include indeterminate patients with the GCE group and then the non-GCE group, separately.

Results
A total of 31 patients were included in the statistical analysis; 48.4% (15/31) were classified as GCE, 31.9 % (13/31) as non-GCE and 9.7% (3/31) as indeterminate. The primary analysis revealed that PS, K-trans and F were decreased significantly in GCE compared to non-GCE both in the early and late phases. However, Kep was elevated significantly in GCE compared to non-GCE in both the early and late phases. The secondary analysis demonstrated that the results from
the primary analysis are not altered when Indeterminate patients are added to the GCE or non-GCE groups (Figure 1).

Conclusions
Our findings support the hypothesis that altered BBBP function occurs early and remains altered in GCE after SAH. Patients with GCE have significantly decreased PS and Ktrans and significantly elevated KEP, likely due to predominance of flow in the EES to plasma direction given the high volume in the EES. These findings further contribute to our understanding of the pathophysiologic mechanisms underlying GCE.

KEYWORDS: Aneurysmal Subarachnoid Hemorrhage, Cerebral Edema, CT Perfusion
Three-dimensional Analysis of Time-dependent Coil Changes after Embolization for Intracranial Aneurysms

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Purpose
With progress in the modern technology, coil embolization is now comparable to high quality surgical clipping. But, postoperative recurrence and bleeding rates for coil embolization compared to clipping are relatively high. Three-dimensional analysis of time-dependent coil changes after embolization may be effective to predict recurrence.

Materials and Methods
A total of 13 cases of saccular unruptured intracranial aneurysm, treated with coil embolization within the period between January and December at our hospital were studied. Fusiform and dissecting aneurysms were excluded. The DICOM data of coils obtained through cerebral angiography were analyzed using Workstation, adopting the volume rendering method. On volume rendering, the threshold was set after calculating the full width at half maximum of the coil profile curve. The skull bone was regarded as a reference for the calculation of position changes, and volume changes and the lengths of shift in the center of gravity and parallel transition immediately after treatment and on follow up were analyzed and compared between those with and without recurrence. The presence of recurrence was defined as an aggravated condition, based on the classification scale established by Roy.

Results
We found that the epoch-making parameter of the recurrence following endovascular treatment was the coil occupation volume. The coil occupation volume compared to that immediately after treatment significantly increased by 23.9% in the recurrence and 3.3% in the nonrecurrence group (P=0.05).

Conclusions
In this study, increase in coil occupation volume, not coil compaction, was the mechanism associated with recurrence after initial coil embolization. The necessary modality is only less invasive mask images in cerebral angiography.

KEYWORDS: Aneurysm Embolization, Angiogram, Computer Modeling
Natural history of basilar trunk artery aneurysms

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¹Toronto Western Hospital, Toronto, ON, Canada, ²University Health Network/Toronto Western Hospital, Toronto, ON, Canada

Purpose
Basilar trunk artery aneurysms (BTA) are rare and challenging to manage due to difficult surgical access, frequent occurrence of broad-neck, and the incorporation of the branches of the BA within the aneurysm (1-8). We describe the epidemiology, natural history and management in 52 consecutives basilar trunk aneurysms.

Materials and Methods
Retrospective review approved by UHN Research Ethics Board performed on all patients with basilar trunk aneurysms followed at our institution from January 2000 to September 2013. We reviewed medical charts and images (head CTA, MRI and cerebral angiography). Basilar trunk artery aneurysms were classified into five subtypes (9): acute dissecting aneurysms, segmental fusiform ectasia, dolichoectatic chronic dissecting aneurysms, saccular aneurysms and atherosclerotic aneurysms.

Results
From January 2000 to September 2013, 2425 patients who had at least one cerebral aneurysm
(58.3% unruptured and 41.7% ruptured) were referred to our institution. Four hundred ninety-one patients had one or more brain aneurysms in the posterior circulation (53.6% unruptured and 47.3% ruptured) and 52 patients had a BTA (Table 1). Among them, 12 (23%) had multiple intracranial aneurysms. Three patients had a second aneurysm located in the basilar tip (n=2) or superior cerebellar artery (n=1) and nine patients had at least one aneurysm located outside of the basilar artery. The mean age was 55 years old (median: 55 years old; SD±19; range: 0.8-6.9). There were 29 (56%) females and 23 (44%) males. All except one of the acute dissecting aneurysms were saccular, with a total of 18 blisters-like aneurysms. All of the chronic dissecting, segmental ectasia and atherosclerotic aneurysms were fusiform, with a total of 34 fusiform aneurysms. During follow-up, nine patients (5 with segmental ectasia and 4 with chronic dissecting aneurysms) presented with an increase in the size of their aneurysm. Two of them had a SAH due to aneurysm rupture and died (1 segmental ectasia and 1 chronic dissecting aneurysm) and one patient (chronic dissecting) died from an ischemic brainstem stroke two days after surgical treatment with a bypass. Two patients had spontaneous ischemic stroke attributed to the aneurysm (2 chronic dissecting aneurysms) without any increase in aneurysm size.

Conclusions
There appear to be gender differences within the subtypes with saccular and acute dissecting aneurysms having a female preponderance and atherosclerotic/fusiform aneurysms being more common in males. Saccular aneurysms seem stable over time and are likely to represent an underlying predisposition to aneurysm development given that more than half of these cases are associated with multiple intracranial aneurysms. Intervention should be considered in segmental ectasia and chronic dissecting aneurysms which demonstrate an increase in size over time especially in males with significant vascular risk factors because of the increased risk of SAH.

KEYWORDS: Aneurysm Classification, Aneurysm Treatment, Basilar Artery

<table>
<thead>
<tr>
<th>Type of aneurysm</th>
<th>n</th>
<th>mean age (±SD)</th>
<th>Mean clinical FU m (±SD)</th>
<th>male gender</th>
<th>SAH</th>
<th>TIA/ Stroke</th>
<th>incidental</th>
<th>multiple aneurysms</th>
<th>≥2 risk factors†</th>
<th>Inc</th>
<th>CIC</th>
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<tbody>
<tr>
<td>Acute dissecting</td>
<td>6</td>
<td>44 (±23)</td>
<td>71 (±39)</td>
<td>2 (33%)</td>
<td>5 (83%)</td>
<td>1 (17%)</td>
<td>0</td>
<td>0</td>
<td>1 (17%)</td>
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<tr>
<td>Segmental ectasia</td>
<td>11</td>
<td>56 (±18)</td>
<td>56 (±59)</td>
<td>6 (55%)</td>
<td>0</td>
<td>4 (36%)</td>
<td>7 (64%)</td>
<td>2 (18%)</td>
<td>5 (45%)</td>
<td>6</td>
<td>(6%</td>
</tr>
<tr>
<td>Chronic dissecting</td>
<td>19</td>
<td>59 (±19)</td>
<td>5 (±5)</td>
<td>11 (58%)</td>
<td>0</td>
<td>6 (32%)</td>
<td>11 (58%)</td>
<td>3 (16%)</td>
<td>9 (47%)</td>
<td>4</td>
<td>(25%</td>
</tr>
<tr>
<td>Saccular</td>
<td>13</td>
<td>53 (±12)</td>
<td>48 (±42)</td>
<td>2 (15%)</td>
<td>5 (38%)</td>
<td>0</td>
<td>8 (62%)</td>
<td>7 (54%)</td>
<td>5 (38%)</td>
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<tr>
<td>Atherosclerotic</td>
<td>3</td>
<td>71 (±3)</td>
<td>21 (±28)</td>
<td>2 (67%)</td>
<td>0</td>
<td>0</td>
<td>3 (100%)</td>
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<td>3 (100%)</td>
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O-33

Spontaneous SAH and negative initial vascular imaging- should further investigation depend upon the pattern of haemorrhage on the presenting CT?

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Purpose
Multiple repeat investigations usually are performed in patients with computed tomography (CT) or lumbar puncture proven spontaneous subarachnoid hemorrhage (SAH) who have negative
initial digital subtraction angiography (DSA) or CT angiograms. Further imaging primarily is, but not exclusively, performed to identify missed intracranial aneurysms (or other significant pathologies) but there is little consensus on the most appropriate use of additional imaging studies and how this may be influenced by the findings of the initial diagnostic CT.

Materials and Methods
A retrospective analysis was performed on a prospectively collected cohort of patients referred to our neuroscience center with spontaneous SAH. Patients were included in the study if there was CT or LP confirmation (xanthochromia) of SAH and initial CTA or DSA was negative. The patients were divided into four categories based upon the distribution of blood on the initial CT (i) perimesencephalic (pSAH), (ii) diffuse (dSAH), (iii) sulcal (sSAH) and (iv) CT negative [cerebrospinal fluid (CSF) positive] (nCT-pLP). The number and the nature of the repeat imaging investigations were reviewed and the results were correlated with the findings of the presenting CT.

Results
Between January 2007 and April 2013, a total of 114 patients presented to our center with confirmed SAH and the first neurovascular investigation was negative. This cohort was classified into 41 cases of pSAH, 50 dSAHs, 6 sSAHs and 17 nCT-pLPs. The diagnostic pathway for these patients is summarized in Table 1. Repeat imaging found a total of five relevant abnormalities (3 cases of vasculitis, 1 ICA dissection and 1 spinal ependymoma). The three cases of vasculitis were diagnosed on first DSA following a negative CTA and presented with either diffuse SAH or with normal CT. The dissecting ICA aneurysm presented with diffuse SAH and only was revealed on the third neurovascular study (after normal CTA and DSA). A hemorrhagic spinal tumor presented with xanthochromia. No subsequent abnormality was found on third DSA or MRI head. No patient presenting with perimesencephalic SAH had a positive finding if the initial CTA was negative.

Conclusions
Certain patterns of SAH, perimesencephalic and sulcal, are associated with a low yield of abnormalities on repeat imaging if the initial vascular study is normal and do not warrant multiple repeat examinations. Patients that present with either diffuse SAH or proven xanthochromia had a higher incidence of abnormalities on repeat imaging and therefore we advocate up to 2 DSAs and MR imaging for these patients.

KEYWORDS: Cerebral Angiography, CT Angiogram, SAH

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<tr>
<td>pSAH</td>
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<tr>
<td>41</td>
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<td>sSAH</td>
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<tr>
<td>nCT-pLP</td>
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<tr>
<td>CTA (initial angiography) no of cases</td>
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<tr>
<td>39</td>
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<tr>
<td>46</td>
</tr>
<tr>
<td>5</td>
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<td>15</td>
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<tr>
<td>DSA (initial angiography without CTA) no. of cases</td>
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<td>2</td>
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<td>DSA following negative CTA</td>
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<td>1 ICA dissection (1/17)</td>
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<th>MRI head</th>
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<th>24</th>
<th>27</th>
<th>5</th>
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<td>0</td>
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<th>MRI spine</th>
<th>no. of cases</th>
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<th>14</th>
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<td>cause of SAH identified</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1 spinal tumour (1/5)</td>
<td></td>
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O-34

Delayed Angiogram in Angiography-Negative Subarachnoid Hemorrhage: A Systematic Review and Meta-Analysis

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Purpose

To systematically review and meta-analyze the evidence on the yield of performing delayed DSA on initial DSA-negative adult subarachnoid hemorrhage (SAH) patients to: (1) determine an estimate of the overall frequency of detection of occult ruptured aneurysms, and (2) determine...
whether this differs between perimesencephalic (PM-SAH) and nonperimesencephalic (non-PM-SAH) subgroups.

Materials and Methods
A comprehensive search was performed to detect all relevant literature. Studies had to include adult SAH patients with initial negative digital subtraction angiography (DSA), who underwent follow-up DSA at any time interval. Outcomes had to be reported as proportion of patients with aneurysm identified on follow-up DSA among those initially DSA-negative. Risk of bias was assessed using a modified version of the Newcastle-Ottawa scale. The results of the included studies were combined using a random effects model; heterogeneity was assessed using the I-squared index. Analyses were performed for both patients with PM-SAH and non-PM-SAH.

Results
Twenty-one studies met the inclusion criteria. Overall, the studies had a low to moderate risk of bias. The overall rate of aneurysm detection on repeat DSA was 9.26% (95% CI = 6.57% to 12.36%; P = 70%). However, the rate in PM-SAH was 1.92% (95% CI = 0.90% to 3.32%; P = 9.4%), whereas that in non-PM-SAH was 14.72% (95% CI = 9.31% to 21.13%; P = 77%).

Conclusions
Despite limitations regarding heterogeneity, one out of seven patients with non-PM-SAH with initial negative DSA was found to have an aneurysm on repeat DSA, while the rate of detection in PM-SAH was very low. These findings have important implications for management in patients with initial DSA-negative SAH.

KEYWORDS: DSA, SAH

O-35 11:40AM - 11:47AM

Cost-effectiveness of Follow-up in Isolated Perimesencephalic Subarachnoid Hemorrhage

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Purpose
To determine the cost-effectiveness of follow-up imaging in isolated perimesencephalic subarachnoid hemorrhage as assessed on computed tomography angiography (CTA).

Materials and Methods
Two hundred thirteen CTAs containing the words "perimesencephalic hemorrhage" based on keyword search performed at a single, large academic institution in the past five years were evaluated retrospectively after obtaining IRB approval. Perimesencephalic subarachnoid hemorrhage was defined as hemorrhage centered in the anterior mesencephalon without greater than trace blood in the interhemispheric and/or proximal Sylvian fissures. Studies were excluded if there was a history of trauma or imaging findings showed extensive/diffuse subarachnoid hemorrhage. Seventeen patients met inclusion criteria. Patients ranged in age from 26 to 75 years (mean 50.4, SD 12.6) with 10 men and seven women. Number of follow-up imaging studies, including CT/CTAs, MRI/MRAs, DSAs, and transcranial dopplers, were tabulated. Literature search was performed to determine incidence of isolated perimesencephalic subarachnoid hemorrhage in the U.S. population. Costs were assessed using 2013 regional Medicare reimbursements.
Results
Of the 17 patients with isolated perimesencephalic subarachnoid hemorrhage, as confirmed with negative CTA, follow-up imaging was obtained in 15 patients. Follow-up studies of CTAs, MRI/MRAs, and DSAs were negative in all patients. There were a total of 41 follow-up CT/CTAs, 40 MRI/MRAs, and 15 DSAs, resulting in an average of 2.41 CT/CTAs, 2.35 MRI/MRAs, and 0.88 DSAs per patient. A total of 15 follow-up transcranial dopplers was performed, which showed unexplained left MCA vasospasm in three patients, with all spontaneously resolving without intervention. Using published incidence of subarachnoid hemorrhage of 8/100,000 person-years and an estimated incidence of 10% of these being isolated perimesencephalic subarachnoid hemorrhage, there are an estimated 2,560 cases per year in the U.S. Extrapolating costs from our dataset, this costs the U.S. population $27.4 million annually using 2013 regional Medicare reimbursement values.

Conclusions
Imaging follow-up in patients who meet the strict radiographic criteria for isolated perimesencephalic subarachnoid hemorrhage with no source identified on CTA has been described as unnecessary in a previously published study from two large academic centers of 28 patients that showed completely negative DSAs and other follow-up imaging. Our study of 15 patients, all also with negative follow-up imaging, further supports that follow-up imaging is not necessary if the initial CTA is negative when strict radiographic criteria for isolated perimesencephalic subarachnoid hemorrhage are being followed. Extrapolating from our dataset, we estimate that this results in significant direct financial costs in addition to indirect and intangible costs of time lost from work and patient stress/anxiety.

KEYWORDS: Economics, Health Outcomes, Hemorrhage

O-36

CT perfusion demonstrates changes in blood brain barrier permeability and cerebral blood flow that are associated with delayed cerebral ischemia and outcome after subarachnoid hemorrhage.

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Purpose
Multiple factors may contribute to poor outcomes after aneurysmal subarachnoid hemorrhage (SAH) (Sanelli et al., 2013; Dankbaar et al., 2010). Computed tomography perfusion (CTP) has been used to quantify perfusion values associated with an increased risk of delayed cerebral ischemia (DCI) and poor outcome although some studies have not shown this (Cremers et al., 2013). We used a standardized management protocol for patients with SAH that included CTP. We hypothesize that changes in CTP parameters, including decreased blood flow (CBF), increased mean transit time (MTT), and increased blood-brain barrier permeability (PS) in the early stage of SAH would be associated with worse outcomes and a greater need for rescue therapy after SAH.
Materials and Methods
In this single-center prospective investigation, there were 88 subjects with aneurysmal SAH who had CTP performed within 72 hours after admission. Computed tomography perfusion was performed at admission (day 0) and then 3-5 and 7-10 days after SAH. Admission Glasgow coma, World Federation of Neurologic Surgeons and Fisher scores were recorded, as well as systolic blood pressure, glucose and sodium levels and baseline intracranial pressure. Primary outcomes included: (1) mRS at 90 days, where poor outcome was defined as ≤ 2 and (2) infarction, quantified on MRI at discharge. Secondary outcomes were (1) DCI and (2) medical or endovascular rescue therapy. Regions of interest were drawn using standardized vascular territories; a weighted average with respect to ROI area was used to calculate the region with the lowest CBF, highest MTT, and highest PS.

Results
Of 88 patients, 25 patients have been analyzed so far. There was no difference in admission (day 0) or day 3-5 CTP parameters between subjects with and without DCI, with and without a poor outcome, or with and without infarction (p>0.05). However, the percent change in PS between day 0 and day 3-5 was significantly greater in subjects that subsequently developed DCI (47.2 ± 13.5%) compared to those that did not have DCI (-0.17 ± 0.4%) (p = 0.03). All of the subjects that developed DCI required induced hypertension treatment. The decrease in CBF between day 0 and day 3-5 was significantly greater in subjects with a poor outcome (p=0.03) and in subjects who subsequently received additional treatment with iv milrinone (p=0.04).

Conclusions
The results of our standardized management algorithm in SAH demonstrate that alterations in cerebral perfusion in the early stage of SAH may help identify patients at risk of DCI and poor outcome, with an increased need for aggressive medical or endovascular therapy. Specifically, increasing blood-brain barrier permeability and decreasing CBF may be important imaging parameters to consider in the early (<72 hours) evaluation of SAH patients. We advocate for an imaging protocol that provides CTP measurements both prior to and following aneurysm securement for early identification of patients at risk of poor outcome and potentially in need of more aggressive management.

KEYWORDS: Aneurysmal Subarachnoid Hemorrhage, CT Perfusion

CT Angiography versus Transcranial Doppler in the Assessment of Cerebral Vasospasm Following Intracranial Aneurysm Rupture

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Purpose
Cerebral vasospasm (CV) is a complication of subarachnoid hemorrhage (SAH) from ruptured intracranial aneurysm, with a peak incidence between four and 10 days. Of those patients who survive a ruptured intracranial aneurysm, 25-30% are at risk of delayed cerebral ischemia DCI (1). Traditionally, the gold standard for assessment of CV has been digital subtraction angiography (DSA). Both transcranial Doppler (TCD) and computed tomography angiography
(CTA) are modalities with less inherent risk than DSA, which even if employed strictly as a diagnostic modality is subject to procedure-related complications. While CTA does provide other useful nonvascular information, artifact from clips or coils might obscure the vessel, patients are exposed to radiation and require transport from the critical care setting to the diagnostic imaging department. Transcranial Doppler, however, does not utilize ionizing radiation, can evaluate vessels obscured by artifact on CT and is performed at the bedside. The purpose of this study is to evaluate the relationship between TCD and CTA in the assessment of cerebral vasospasm following SAH from ruptured aneurysm.

Materials and Methods
The study population included patients admitted to the Hamilton General Hospital between August 2011 and October 2013 for SAH from cerebral aneurysm rupture. Thirty-six patients were included in our final analysis. To meet the inclusion criteria, patients required (i) a CTA at presentation, (ii) TCD monitoring, and (iii) a subsequent CTA within 24 hours of TCD. Of the 36 patients, 44 such TCD/CTA pairs were identified. Two neuroradiologists retrospectively analyzed the CTAs, measuring the bilateral MCAs, ACAs, PCAs and the basilar artery. The agreement between TCD and CTA then was assessed.

Results
Of the 33 SAH patients, there were 23 female and 10 male. The average age at presentation was 54.8 years. Twenty aneurysms were treated with coiling, 10 were clipped. Metallic artifact from the surgical material and anatomical variants limited CTA measurement of certain vessels. The number of segments for which complete data were available for both modalities was: right MCA (40), right ACA (36), right PCA (35), left MCA (39), left ACA (38), left PCA (38) and basilar (13). Correlation was low but statistically significant for MCA segments (right MCA -0.533, p = 0.0004, left MCA -0.486, p=0.0017). The remaining segments, though not statistically significant, had correlations ranging between -0.067 to -0.318.

Conclusions
We found a stronger correlation between CTA and TCD for the MCA measurements, which in combination afforded the best evaluation of CV. This may relate to the larger caliber of the vessel. The dynamic nature of vasospasm could in part contribute to the variability of our findings in the other vessels, with improved correlation expected between cases conducted in shorter time intervals. The MCA will be our target for further investigation, particularly for assessment of TCD velocity and CTA percent stenosis and for stratification of vasospasm based on severity.

KEYWORDS: Aneurysm Rupture, CT Angiogram, Vasospasm

O-38 12:01PM - 12:08PM

Hippocampal damage and affective disorders after treatment of cerebral aneurysms

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Purpose
Despite good neurological outcome after the treatment of ruptured or incidental cerebral aneurysms, many patients complain about mood disturbances such as anxiety and depression.
The present study investigated the nature of these affective disorders, their trigger factors, and corresponding structural brain changes.

Materials and Methods
We assessed 64 patients matched by history of previous subarachnoid hemorrhage (SAH) and treatment modality (clipping versus coiling) by a test battery including the Hospital Anxiety and Depression Scale (HADS) and Beck Depression Inventory-II (BDI-II). MR imaging for the evaluation of structural changes included H1-MR spectroscopy, hippocampal volumetry, and diffusion tensor imaging (DTI).

Results
The applied multimodal imaging revealed no significant differences between patients with previous SAH and patients with incidental aneurysms; there also were no substantial differences between patients with and without previous SAH with respect to depression and anxiety. However, we observed significantly higher mean HADS scores in patients treated surgically versus patients treated by coiling (p<0.01). BDI-II tended to be higher in surgically treated patients, but this difference appeared statistically insignificant. Surgically treated patients displayed substantial hippocampal damage in all imaging techniques: reduction in mean concentrations of N-acetylaspartate (p = 0.04), hippocampal volume reduction (p = 0.012), and diffusion disorder (p = 0.02). The structural alterations correlated significantly with the increased HADS scores.

Conclusions
In contrast to the endovascular treatment, aneurysm surgery seems to be associated with an increased incidence of mood disorders corresponding to the hippocampal neuronal loss, independent of the preceding SAH.

KEYWORDS: Aneurysm, MR Imaging, Stroke

Monday
10:30AM - 12:00PM
Palais des congres de Montreal, 517a

10 - PARALLEL PAPERS: Adult Brain: Degenerative/Inflammatory/Infectious
O-39

MR Imaging in Clinically Isolated Syndromes and Relapsing Multiple Sclerosis after Single-Dose and Cumulative Double-Dose of Gadobutrol at 3.0T: the CUDOMS Study

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Purpose
Several strategies have been proposed to increase the sensitivity of contrast-enhanced MR imaging (MRI) for assessing disease activity in multiple sclerosis, such as use of contrast agents achieving high T1 shortening and/or delaying scanning at least 10 minutes after gadolinium injection. The aim of this study was to prospectively compare the gadolinium-enhancing lesion detection rate with a single and a cumulative dose of one-molar gadobutrol at 3.0 T with different time intervals after contrast injection in patients with clinically isolated syndrome (CIS)
and relapsing MS. The hypothesis was that the combined advantages of increasing delay and cumulative contrast dose will significantly increase the detection rate of active lesions. This would be important in terms of patient care: in CIS patients, the diagnosis of MS could be established and treatment initiated earlier, and in relapsing MS patients, MRI confirmed active disease might influence therapeutic decisions, such as initiating or changing a disease-modifying treatment.

Materials and Methods

The present study was a single site open-label Phase IV study, which was conducted according to GCP. Institutional review board and regulatory approval were granted, and written informed consent was obtained from all participating patients. A total of 115 valid patients finally were included in the study. Twenty-six (22.6%) and 89 (77.4%) were CIS and MS patients, respectively [(83 female (72%)], mean age 35 years; range 23-50 years. Forty-one patients were under treatment with immunomodulatory drugs (all but 2 with relapsing MS) at the time of the MRI examination. Patients underwent 3.0 T brain MRI consisting of transverse proton-density, T2-weighted and unenhanced T1-weighted sequences, and four sets of contrast-enhanced T1-weighted sequences performed five and 15 minutes after a single (0.1 mmol/kg) and a cumulative (0.1 + 0.1 mmol/kg) dose of gadobutrol. Each of the four sets of contrast-enhanced T1-weighted scans was evaluated for the number of gadolinium-enhancing lesions in a random fashion and using objective image interpretation criteria by three experienced neuroradiologists. They were blinded to the time point at which the enhanced sequences were obtained and used the unenhanced sequences as references. The primary efficacy analysis was based on the number of patients presenting at least one gadolinium-enhancing lesion in the four MRI scans provided by the independent and blinded readers. Poisson regression based on generalized estimation equations were used to compare the four scans.

Results

Average number of patients showing at least one gadolinium-enhancing lesions among the three observers was 56, 54, 61 and 68 for the four scans (early and delayed single dose; and early and delayed cumulative dose), indicating that the proportion of active patients increase from 46.9-48.7% in the single dose scans to 53.0-59.1% in the cumulative dose scans (maximum increase of 12.2%). These numbers differed significantly between the image sets with highest values for the early and delayed cumulative dose (p=0.0008) (Figure 1). Confidence in the diagnosis of an enhancing lesion was significantly different between the four sets, with higher values obtained with increasing delay time and dose for all readers: average proportion (%) of lesions in which the diagnosis was very confident was 15.2, 18.7, 31.7 and 34.4 for the four sets of images among the three observers (p=<0.001).

Conclusions

A cumulative gadobutrol dose associated with a longer delay time after contrast injection significantly increases the detection of gadolinium-enhancing lesions in patients with clinically isolated syndromes or relapsing multiple sclerosis, and provides higher confidence in the diagnosis of enhancing lesions. This data should be considered in clinical studies in which detection of active lesions on MRI is considered clinically relevant, as happens for the initial diagnosis of the disease, and for monitoring and predicting response to immunomodulatory treatments.

KEYWORDS: Contrast-Enhanced MR Imaging, Multiple Sclerosis
DKI-based White Matter Modeling Identifies Decreased Myelin Integrity in Normal Controls with Hippocampal Atrophy

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Purpose
There is a critical need to develop noninvasive imaging biomarkers capable of identifying the earliest stages of Alzheimer disease (AD). While hippocampal atrophy has been identified as one such possible biomarker, other techniques may identify concomitant changes in other regions and tissue. Thus, the purpose of this work was to investigate if diffusional kurtosis imaging (DKI)-based white matter tract integrity (WMTI) metrics could reveal alterations in white matter of normal control (NC) older adults with hippocampal atrophy.

Materials and Methods
Twenty-seven (19 female) cognitively healthy NC (age = 70.59 ± 8.26 years; range = 55-82 years) were studied, of whom 12 had hippocampal atrophy. MR imaging (MRI) experiments were conducted on a 3 T Tim Trio Siemens MR system as described previously (1) and included MPRAGE and DKI with 3 b-values (0, 1000, 2000 s/mm²) along 30 diffusion encoding directions. White matter tract integrity metrics also were estimated as previously described (1). For this analysis, we concentrated on the two WMTI metrics of axonal water fraction (AWF) and the extra-axonal radial water diffusivity (De,rad). Hippocampal atrophy was measured using NeuroQuant (i.e., hippocampal volume z-score ≤ -1.5 ). All parametric maps were normalized to the 1mm (isotropic) MNI-152 standard space. Voxelwise analyses were performed with Track Based Spatial Statistics (TBSS) (2) running in FSL, with analyses of covariance (controlling for
age and sex) performed only in the voxels of the white matter skeleton (FA threshold = 0.4). Permutation-based statistics were computed using randomized (10,000 permutations), applying threshold-free cluster enhancement to correct for familywise error from multiple comparisons (p<0.05).

Results
Normal control subjects with (n=12) and without (n=15) hippocampal atrophy did not differ in demographic characteristics or on neuropsychological testing. However, covarying for age and sex, NC with hippocampal atrophy had increased De,rad (p=0.05) in several white matter tracts that have been implicated previously in AD (3), primarily in the left hemisphere. Axonal water fraction showed no differences between NCs with and without hippocampal atrophy when covarying for age and sex. Both (increased) De,rad and (decreased) AWF were associated with age and female gender.

Conclusions
Previously, we reported that De,rad discriminated NC from amnestic mild cognitive impairment (aMCI), while AWF discriminated aMCI from AD, with high classification accuracy (1) and that WMTI metrics reflect the vulnerability of late-myelinating tracts in AD (4). We have provisionally proposed that De,rad may be a marker of myelin integrity, whereas AWF may reflect axonal density, albeit these interpretations require further validation. In extension of our prior work, in the preliminary analysis presented here we demonstrate that De,rad potentially identifies changes in the "preclinical AD" phase (5), suggesting that decreased myelin integrity may be observed very early in the AD process.

KEYWORDS: Aging, Alzheimer Disease, Diffusional Kurtosis Imaging,

O-41
Periatrial White Matter Lesions: Potential Marker for Diagnosis of Multiple Sclerosis on MR Imaging

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Purpose
The classic multiple sclerosis (MS) plaque is an ovoid lesion within the periventricular white matter, perpendicular to the long axis of the corpus callosum. Other typical intracranial locations include the juxtacortical white matter, brainstem, brachium pontis, and cerebellum. Many MS patients present with visual findings, unaccounted for by optic neuritis. The purpose of this study was to determine whether there is a correlation between the presence of periatrial lesions, along the optic radiation, and the diagnosis of MS, and whether periatrial lesions can be used to distinguish MS from ischemic diseases.

Materials and Methods
Five hundred fifty patients with MS, ischemic disease, infarction, and combined Ischemic disease and infarction, who had an MR examination of the brain between July 1, 2010 and August 1 2011, were included initially in the study. Seventy-one examinations were excluded due to insufficient numbers in patients < 20 and > 89 years, follow-up studies of the same patient, and studies without axial T2 FLAIR images. MR examinations of patients with ischemic
disease, infarction, combined ischemic disease and infarction were grouped together as "ischemic diseases". Three contiguous axial T2 FLAIR images from each examination at the level of the atrium of the lateral ventricles were evaluated by four reviewers (R1-R4), blinded to patient demographics and history. Each reviewer was asked to determine whether a lesion was present or absent in the periartrial region on any one of the images. The data were analyzed by a statistician.

**Results**

Of the final 479 examinations included in the study, 52.3% had a clinical diagnosis of MS while ischemic diseases accounted for the remaining 47.7%. Periartrial white matter lesions were more likely to be present in MS patients younger than 60 years than in the "ischemic diseases" group (p<.001) and as expected, MS patients tended to be younger (p < .001) than patients with ischemic diseases. Patients with "ischemic diseases" were less likely to have a periartrial lesion, compared to the MS group, except in the 70-79 age group.

**Conclusions**

The presence of lesions within the periartrial white matter favors a diagnosis of MS, compared to ischemic diseases, in patients younger than 60 years. Therefore, white matter lesions in the periartrial region should be considered as one of the criteria for MS, and may facilitate earlier diagnosis in patients who do not have lesions in traditionally typical locations.

**KEYWORDS: MR Imaging Brain, Multiple Sclerosis**

**Periartrial Lesions in MS and Ischemic Disease by Age**

(Filename: TCT_O-41_Chart.jpg)

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**O-42**

10:51AM - 10:58AM

**Diffusion Tensor Tractography of the Nigropallidal-Nigrostriatal Tract Complex in Parkinson’s Disease**

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Purpose
Degeneration of dopaminergic nigrostriatal and nigropallidal tracts arising from the substantia nigra is a pathologic feature of Parkinson's disease (PD). Diffusion tensor imaging (DTI) is a magnetic resonance imaging (MRI) tool that can indirectly evaluate the integrity of white matter tracts by measuring the anisotropic diffusion of water. We hypothesize that DTI parametrics of the nigropallidal and nigrostriatal fiber tracts, as opposed to regional parametrics of the substantia nigra (SN) alone, may be a more sensitive biomarker for the diagnosis and prognostication of PD. Utilizing a case control methodology, we examined DTI parameters along the striatal tracts in PD and healthy controls.

Materials and Methods
MR imaging scans were carried out in 39 subjects (21 PD patients and 18 age- and gender-matched healthy controls). Diffusion tensor imaging data were acquired using a 3 T Siemens Trio scanner (1.875x1.875x2mm resolution, b-value 800 s/mm², 30 noncollinear directions). Deterministic whole-brain tractography was performed using Diffusion Toolkit (trackvis.org, Version 0.6.2.2), and manual tract dissection and tract data analysis were performed with TrackVis (trackvis.org, Version 0.5.2). Regions of interest (ROIs) were placed in the ventral SN and ipsilateral globus pallidus (GP) to isolate the nigropallidal-nigrostriatal tract complex. Fiber count and average DTI parametrics - fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (AD), radial diffusivity (RD) - along the tract were computed. Point-to-point profiles of the DTI metrics along the tract also were extracted. Results were analyzed using the average of the left and right tracts. The average fiber count and DTI metrics were compared statistically using Student's T-test, and the DTI tract profiles were compared with linear mixed effects models. The average DTI metrics also were correlated with clinical data (disease duration and Tinetti score, a validated scale for postural instability) using Pearson's correlation.

Results
Tractography was successful in 18 PD patients (age 72.2 ± 4.5, 14M:4F, Hoehn & Yahr score 2-4, disease duration 5.1 ± 2.9 years) and 17 controls (age 71.2 ± 5.2, 14M:3F). Average FA (p<0.05) and fiber count (p<0.0001) were significantly lower in the PD group compared to the control group. Radial diffusivity was significantly higher in the PD group (p<0.05), whereas MD and AD were higher in the PD group without achieving significance. Average fiber count of the right tract correlated significantly with Tinetti score (p<0.05). Average AD of both tracts, FA of the left tract, and the MD, AD, RD of the right tract correlated significantly with disease duration (p≤0.05). For the DTI profiles, preliminary modeling using DTI values at the tract midpoint suggests that AD and FA (more significantly) may be useful in predicting the odds of having PD compared to controls.

Conclusions
By isolating and quantifying the nigropallidal-nigrostriatal tract complex, we demonstrated abnormal DTI parameters of this fiber tract complex in PD patients compared to controls. Tractography of the nigropallidal-nigrostriatal tracts may be useful in the longitudinal evaluation of clinical progression in PD.

KEYWORDS: DTI Tractography, Parkinson Disease, Substantia Nigra

O-43
Diffusion Tensor Imaging in SPG4-Related Hereditary Spastic Paraplegia
Purpose
Hereditary spastic paraplegia is a clinically and genetically heterogeneous neurodegenerative disorder characterized by a progressive spasticity of lower limbs. Our aim was to identify microstructural changes in corticospinal tracts (CSTs) by diffusion tensor imaging (DTI) and their relationship to clinical impairment in a group of patients diagnosed with SPG4-related HSP.

Materials and Methods
Twenty-one patients with pure SPG4 mutation and 18 aged-matched healthy controls were recruited. The patients performed the Spastic Paraplegia Rating Scale (SPRS) and Mini Mental State Examination MMSE. The evolution time of the disease is not correlative with the age of the subjects and presented from 0 to 54 years. Data were acquired with a 1.5 T MRI including a T1-weighted high-resolution image and a DTI study using a single-shot spin echo-planar imaging sequence for a b-value 50 and 800 s/mm² over 32 noncollinear directions. Diffusion-weighted studies were processed using the software package FSL 4.1. To parcel the individual FA maps into different tracts, we used the ICBM-DTI-81 white matter atlas. We extracted the mean FA values of CSTs using a region of interest (ROI) analysis in order to generate an individualized atlas for each subject in native space. Mean FA measurements obtained were analyzed using the Univariate General Linear Model with "Group" as a fixed factor. We also explored the correlation between the FA values and SPRS in the group of the patients.

Results
Compared with healthy controls, SPG4 patients presented decreased FA in CST (p = .015 for the right CST, p=.009 for the left CST) Figure 1. Significant correlations were found between CST and SPRS (Pearson r=-.50 p=.024 for left side; r=.58 p=.005 for right side) Figure 2.

Conclusions
Diffusion tensor imaging could be a sensitive technique to detect microstructural changes in SPG4 patients. The FA values in CSTs are related to disease severity.

KEYWORDS: Brain White Matter, Degenerative, DTI Tractography
Meta-analysis of Grey Matter Atrophy and Connectivity in Progressive Supranuclear Palsy

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Purpose
Progressive supranuclear palsy (PSP) is a neurodegenerative tauopathy which presents with gaze palsies, postural instability, bradykinesia, and dementia (1). Structural MRI (VBM) studies utilizing either voxel-based morphometry (VBM) or visual inspection have demonstrated patterns of gray matter atrophy affecting the basal ganglia and brainstem (2). However, it is unclear if these are the result of underlying anatomical pathways between affected regions, or concomitant areas of primary disease. The purpose of our study was to identify functional connectivity between areas of gray matter atrophy in PSP through the use of meta-analytic techniques.

Materials and Methods
Whole brain meta-analysis was performed, using the revised anatomical likelihood estimation method (3), on a set of 10 published voxel-based morphometry studies that met inclusion criteria (consisting of 156 PSP patients). Meta-analytic connectivity models (MACM), which have been shown to correlate with diffusion tensor imaging (DTI) and resting-state functional connectivity maps, then were generated based on the most consistent areas of grey matter structural change (4, 5).

Results
The medial dorsal nucleus of the thalamus was found to be the most significant region of gray matter atrophy in PSP based on the ALE meta-analysis. Meta-analytic connectivity models demonstrated functional co-activation of this region of interest with the bilateral insular cortices and midbrain, which also demonstrated significant convergence for gray matter atrophy in PSP (Figure 1).

Conclusions
Our results suggest that there are anatomical pathways between regions of gray matter atrophy in PSP, which may lead to transynaptic spread of disease. A similar process has been proposed for other neurodegenerative disorders such as human spongiform encephalopathy (6). This hypothesis will be further validated with DTI, including probabilistic tractography.

KEYWORDS: Meta Analysis, Neurodegenerative, Voxel-Based Morphometry
MRS In The Retrosplenial Cortex May Differentiate Between aMCI, AD and Controls

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Purpose
To investigate whether the spectroscopic profile of metabolites in the retrosplenial cortex (RSC) could differentiate between amnestic mild cognitive impairment (aMCI), Alzheimer disease (AD), and cognitively healthy individual.
Materials and Methods
Single voxel proton MRS in the RSC was performed for 32 individuals aged 55-80 years: 10 patients with aMCI, 12 with mild to moderate AD, and 10 cognitively healthy individuals. Only individuals with no history of active neurological or psychiatric disorders and/or therapy that could potentially interfere with cognitive functions were included. Studies were performed with a 1.5 T system. Spectroscopy (1H MRS) was performed using the point resolved spectroscopy (PRESS) technique (TR=1500ms, TE=35ms). Spectral analysis was performed using standard software provided by the manufacturer. One voxel was located in the RSC and the second in the anterior cingulate gyrus (ACG). Nonparametric Mann-Whitney-U tests and Kruskal Wallis tests were used for statistical comparisons.

Results
A statistically significant decrease in the N-acetyl-aspartate to creatine ratio (NAA/Cr) in the RSC was found in AD patients as compared to aMCI patients and healthy individuals. The NAA to myo-Inositol (mI) ratio was found to be significantly lower in the RSC of aMCI patients than in healthy individuals.

Conclusions
N-acetyl-aspartate to creatine ratio and NAA/mI ratios in the RSC, measured by MRS, may be regarded as possible biological markers for differentiation between aMCI, AD, and cognitively HI. These markers may play an important role for clinical purposes and in clinical trial settings with potential disease-modifying drugs. Further investigation is needed to strengthen our results.

KEYWORDS: MR Imaging/Diffusion

O-46

Neuroimaging of Pathologically Proven Cerebrovascular A-Beta Amyloid Compared to Cerebral Amyloid Angiopathy and Cerebral Amyloid Angiopathy – Related Inflammation: A Single Institution’s 25 Year Experience

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Purpose
Describe our institution’s 25-year neuroimaging experience with pathology proven cerebrovascular amyloid, a heterogeneous group of hereditary and sporadic diseases that include cerebral amyloid angiopathy (CAA), A-beta-related angiiitis (ABRA), and CAA-related inflammation (CAA-RI). Discuss the integral role of SWI and GRE imaging in guiding biopsy and elucidating the proper diagnosis.

Materials and Methods
Following approval by an Institutional Review Board, review of our pathology database identified 69 patients presenting from 1987 – 2011 with surgically and/or biopsy proven cerebrovascular amyloid. The corresponding relevant medical records and neuroimaging were reviewed to categorize the type of imaging findings, corresponding pathology results, patient presentation, and demographics. Sixty-seven unique neuroimaging time points were available for analysis from 81 amyloid cases.
Results
Three pathologic forms of amyloid were encountered: CAA (29 cases), ABRA (24 cases) and CAA-RI (14 cases). Twelve cases had CT alone, 25 cases had MRI alone, and 30 cases had a combination of the two. Twenty-nine cases had either a GRE or SWI sequence performed. Twenty-six out of 67 patients presented with lobar intraparenchymal hemorrhage, which occurred more frequently in the CAA (20/26) group than with ABRA (4/26) and CAA-RI (2/26) (p < 0.0001). Twenty-nine patients presented with leptomeningeal enhancement with or without underlying infiltrative T2 signal or underlying cortical infarcts. This was more common in patients with ABRA (13/29) and CAA-RI (11/29) than in patients with CAA (5/29) (p < 0.0001). Nine patients presented with an infiltrative white matter process mimicking a low grade astrocytoma. Although not statistically significant, this was more common in ABRA (7/9) than CAA (2/9) and not present in CAA-RI. One case of CAA-RI presented with acute multiple cortical infarcts, one case of CAA presented with focal subarachnoid hemorrhage, and one case of CAA presented as an enhancing intraparenchymal mass. Six patients (ABRA = 2, CAA-RI = 1, CAA = 3) had recurrence of their disease process at a different location. A-beta-related angiitis and CAA-RI tended to occur in younger patients.

Conclusions
A-beta-related angiitis and CAA-RI are likely part of the spectrum of one clinicopathological entity, with a distinctly different imaging presentation from CAA. The diagnosis of ABRA and CAA-RI should be suggested when the following is seen: diffuse lobar or multilobar infiltrative T2 hyperintensities, lobar hemorrhage, and/or leptomeningeal enhancement seen in association with microhemorrhages at the gray-white junction on SWI/GRE. The neuroradiologist should be aware of the findings seen with CAA, ABRA and CAA-RI, which could significantly impact patient management (immunomodulation versus biopsy). In patients where biopsies are performed, this should guide the surgeon to biopsy the gray-white junction as well as the leptomeninges rather than the underlying white matter abnormality. At our institution, we have added a susceptibility sequence to all cases that have the appearance of an infiltrative low grade glioma as well as leptomeningeal enhancement, to aid in narrowing the differential diagnosis and avoid nondiagnostic white matter biopsies in these cases.

KEYWORDS: Amyloid, GRE, Susceptibility-Weighted Imaging

O-47

Simultaneous Pulsed Arterial Spin Labeling (PASL) MRI and 18F-FDG-PET in Neurodegenerative Dementia: a PET/MR Study

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Purpose
Previous studies in Alzheimer disease (AD) and mild cognitive impairment (MCI) reported disease-typical abnormality patterns and also high pattern similarity in brain perfusion arterial spin labeling (ASL) magnetic resonance imaging (MRI) and brain metabolism (18-fluorodeoxyglucose positron emission tomography, 18F-FDG-PET) relative to healthy controls. Though these studies either applied only one modality or were performed on separate MRI and
PET scanners at different time points. We now compare these two methods, for the first time, using a simultaneous acquisition protocol on an integrated PET/MR system in different dementia groups and healthy controls.

Materials and Methods
So far 19 patients with AD, 14 patients with MCI and 11 matched healthy control subjects (HC) have been examined on a Siemens mMR Biograph using a simultaneous acquisition protocol including pulsed arterial spin labeling (PASL: 11 slices aligned with the hippocampus and including the parietal cortex), T1-weighted MPRAGE MRI and 18F-FDG-PET. Matlab and SPM8-based preprocessing of cerebral blood flow (CBF) and FDG-PET images comprised motion correction, coregistration, segmentation, partial-volume correction, spatial normalization and smoothing. Voxelwise statistical comparisons between patient groups and controls were performed using t-tests (threshold p>0.001; kE=20). Additionally regional perfusion and metabolism values were extracted using a region of interest (ROI) analysis.

Results
Large regional overlap between the patterns of hypoperfusion and hypometabolism was detected in patients with AD (left figure) as well as MCI (right figure) relative to HCs, while abnormalities were restricted to the bilateral parietal cortex in patients with MCI, more widespread abnormalities including temporal and frontal cortex were detected in patients with AD. Peak overlap areas between hypometabolism and hypoperfusion were detected in the bilateral posterior cingulate gyrus and bilateral superior parietal cortex for AD and the left posterior cingulate gyrus as well as left superior parietal cortex for MCI. Patients with MCI and AD had significantly lower perfusion and metabolism values in the posterior cingulate gyrus and the parietal cortex compared to HC.

Conclusions
In patients with MCI and AD there was a good congruence between the patterns of hypoperfusion and hypometabolism, especially with overlap in the posterior cingulate gyrus and parietal cortex. Our preliminary data suggests that PASL MRI is comparable to 18F-FDG-PET in the evaluation of patients with varying cognitive impairment due to neurodegenerative AD. Pulsed arterial spin labeling MRI, having the advantage of being absolutely noninvasive, needs further validation but may come up as an alternative to the well established 18F-FDG-PET in the diagnosis of AD in the near future.

KEYWORDS: Alzheimer Disease, MR Imaging/PET, PASL
Regional Brain Volume and Cognition: A Population-based MRI Study

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Purpose
The Montreal Cognitive Assessment (MoCA) is a clinically useful tool for detecting mild cognitive impairment and early Alzheimer disease (AD). Previous studies have shown that low volume of the posterior cingulate cortex (PCC), precuneus and hippocampus may serve as preclinical biomarkers for vulnerability to AD. Our goal was to determine if low volume in these regions measured by volumetric brain MR imaging (MRI) was associated with lower clinical measures of cognitive performance, and if the best predictor varied among the older versus younger members of our cohort.

Materials and Methods
We examined volumetric brain MRI data from a subset of the population-based Dallas Heart Study, mean age 49.9 ± 10.6 years, without a diagnosis of dementia or stroke who underwent cognitive testing using the MoCA (n = 1675). Cortical and subcortical segmental volumes were generated automatically using FreeSurfer. Regions of interest in this study included the PCC, precuneus and hippocampi. Total brain volume also was evaluated. Multiple linear regression analysis was performed with a threshold for significance of p < 0.05 predicting MoCA performance using PCC, precuneus, hippocampal and total brain volumes as regressors. Data
were adjusted for age, gender, ethnicity and education. Secondary analysis was performed stratified for age above and below 50 years.

Results
In the multiple regression model, PCC volume correlated with performance on MoCA \((p < 0.001)\), with no other volume independently significant. Total brain \((p = 0.004)\) and hippocampal \((p = 0.04)\), but not precuneus volumes \((p = 0.07)\), correlated with MoCA scores when considered individually. In secondary analysis, PCC volume also had the strongest association with MoCA scores among those below age 50 \((n = 834, p = 0.001)\) but after age 50 \((n = 841)\) hippocampus \((p = 0.05)\) and precuneus \((p = 0.02)\) were the best independent predictors of MoCA scores.

Conclusions
The MoCA is a clinical tool with validated utility for detecting mild cognitive impairment and early AD. In our population, lower performance on the MoCA was associated with decreased PCC volume. As shown in previous studies, low PCC volume may be an early finding in both sporadic and early-onset AD. In secondary analysis, PCC was the best predictor below age 50, but after age 50 the hippocampal and precuneus volumes were better predictors. Our findings suggest that low PCC volume may be a biomarker for vulnerability to cognitive insult in a younger community population but hippocampus and precuneus volumes may be better predictors in late adulthood.

KEYWORDS: Atrophy, Cognitive Deficit, Volumetric Measurements

O-49
11:40AM - 11:47AM

The brain damage in patients with early type 2 diabetes: a preliminary cognitive functional imaging study using fMRI, DTI and MR spectroscopy

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Purpose
Diabetes mellitus (DM) is a common metabolic disease and is associated with impaired cognitive function and an increased risk of dementia. Cognitive impairments are more pronounced in type 2 than in type 1 diabetes patients. There are few studies about the brain dysfunction in early type 2 diabetes using advanced functional MR techniques. We try to evaluate the cognitive dysfunction in early type 2 diabetic patients with psychological tests and BOLD functional MR imaging (fMRI); To detect the microstructure change and metabolite abnormality with diffusion tensor imaging (DTI) and MR spectroscopy.

Materials and Methods
Twenty patients with early type 2 diabetes mellitus and 15 demographically similar, healthy subjects were enrolled. All subjects with microalbuminuria, hypoglycemia and ketonic acidosis, visible cerebral lesions on MR were ruled out. Psychology tests-Wechsler memory scale-revised (WMS-R), trail making test A and the personality and affective states were assessed in both groups. Then nback task fMRI and single-voxel MRS with TE 30 on bilateral Prefrontal cortex (PFC) and DTI were performed. Regions of interest (ROIs) were located on prefrontal white matter area (PF WM), corpus callosum, internal capsule, anterior cingulate. The statistic
differences of neuropsychological tests and MRS result and DTI parameters (FA, MD) between the two groups were evaluated. The fMRI data were analyzed by SPM2.

Results
(1) psychological tests showed that the scores of cognitive tests in diabetes group were significantly lower than those in control group. Diabetic patients were more depressive and anxious than controls. (2) Functional MRI examinations revealed that the activation pattern in diabetes group was similar with the control group, but less activation in prefrontal, parietal lobe and cerebellar was demonstrated on figure. There was additional activation in right temporal lobe(including inferior temporal gyrus and parahippocampus gyrus) and anterior cingulate cortex in diabetes group. (3) MR spectroscopy data showed that comparing with control group, the mean value of Glx/Cr, Glx/Cho, Glx/(Cho+Cr) were significantly elevated in right PFC(p<0.05), while the value of Cho/Cr was significantly reduced (p<0.01). The value of NAA/Cr was reduced in right side, but did not reach statistical significance. Transit memory was negatively correlated with Glx/Cho (F=-0.546, P value =0.013) and Glx/(Cr+Cho) (F=-0.471, P value = 0.036). The number of errors in trail making test A was positively related to NAA/Cr (4). Diffusion tensor imaging data showed that the mean FA value in prefrontal white matter area in diabetes group was significant lower (0.32±0.008) than in control group (0.38±0.01), there was no significant difference in other areas between two groups.

Conclusions
Early type 2 diabetic patients have cognitive dysfunction, especially decreased memory at verbal working memory. Functional MRI using nback test shows the hypofunction in PFC, DTI showed reduced FA in prefrontal white matter. The hypofunction in PFC plays an important role in cognitive dysfunction and the emotional abnormality. The MRS results reveal that increase of Glx and the degeneration of choline neuron system may contribute to the pathophysiological basis of PFC hypofunction in early type 2 diabetes.

KEYWORDS: Brain Abnormalities, Diffusion Tensor Image, MR Spectrocopy

O-50  
11:47AM - 11:54AM

The Role Of T2*-Weighted Perfusion MRI In Therapeutic Response Assessment Of Brain Tuberculomas
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Purpose
The purpose of this study was 1) To evaluate the rCBV values in patients with brain tuberculomas before the start of standard treatment with antituberculous therapy (ATT) and after completion of treatment. 2) To compare the rCBV values in responders and nonresponders to treatment and thereby assess the response to treatment.

Materials and Methods
Nineteen patients in the age range of 4–50 years were serially evaluated using T2* Perfusion on 3 T MR imaging system. rCBV ratio was calculated. All patients were proven to have brain tuberculomas based on the response to the ATT (n = 13), detection of pulmonary tuberculosis and associated tubercular meningitis (n = 3), and histopathology (n = 3). All patients subsequently were treated with standard antituberculous treatment for 12-22 months. Patients were classified into two groups based on clinical and imaging findings after treatment. Responders (n = 13) included those patients who showed clinical and imaging improvement. Nonresponders (n = 6) included patients who did not show response to treatment. Out of the six in three patients the lesions were excised.

Results
The rCBV values measured from central area of the lesions in responders group ranged from 0.25 to 1.85 (mean ± SD: 0.98 ±0.44). The rCBV of the peripheral wall of lesions in responders group varied from 0.87 to 3.5 (mean ± SD: 1.57 ± 0.66). The rCBV values measured from central area of the lesions in nonresponders ranged from 0.10 to 0.74 (mean ± SD: 0.29 ±0.26). The rCBV of peripheral wall of the lesions in nonresponders varied from 0.15 to 1.44 (mean ± SD: 0.66 ± 0.51). Nonresponders showed very low rCBV values on initial scan. Follow-up scan of three patients showed same low rCBV values. The lesions in the responders had significantly higher rCBV ratios in the center and periphery of lesions than those in the nonresponders (p < 0.05).

Conclusions
Treatment responders showed statistically significant higher values of rCBV as compared to both nonresponders and surgically excised lesions. We conclude that presence of very low rCBV values on initial scan in a tuberculoma may be the reason for nonresponse to antituberculous therapy.

KEYWORDS: Tuberculosis

O-51

Changing Face of Intracranial Cryptococcal Infection

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Purpose
To characterize the changing imaging characteristics of intracranial Cryptococcal infection with correlation to CD4 count and prior treatment with protease inhibitor and highly active antiretroviral therapy (HAART).

Materials and Methods
Fifty-seven patients with culture-proven Cryptococcal infection and with brain MRIs performed between 11/2005-11/2013 at the LAC+USC Medical Center were assessed retrospectively for the presence of pseudocysts, perivascular space abnormality, hydrocephalus, cryptococcoma and stroke. Abnormal enhancement of leptomeninges, choroid plexus and ependyma also was assessed. Imaging findings were reviewed by two neuroradiologists and correlated with CD4 counts and prior treatment with protease inhibitor and HAART. Chi-square odds ratios with Pearson significance values were calculated using JMP 10.

Results
Of the 57 patients identified, 32 had CD4 counts <50, 20 were actively on HAART therapy, and 11 were receiving treatment with at least one protease inhibitor. Those patients with a CD4 count <50 were significantly more likely to have perivascular space enhancement and cerebritis, with ORs of 5.23 and 3.53, respectively. Those patients who had been treated with protease inhibitors were significantly more likely to have pseudocysts with enhancement, although there was only one recorded case. Patients on protease inhibitors also were more likely to have leptomeningeal enhancement with an OR of 3.47, although this did not reach the level of statistical significance (p-value 0.08). In contrast, none of the imaging characteristics of HAART versus non-HAART patients were statistically significant. Overall, the most common imaging findings were leptomeningeal enhancement, cerebritis, perivascular enhancement, perivascular space edema, hydrocephalus, and stroke with total incidence rates of 49%, 35%, 21%, 17%, and 15%, respectively (Table 1).

Conclusions
The imaging characteristics of intracranial Cryptococcal infection has changed over the past few decades, with findings previously thought to be atypical becoming more common. Awareness of imaging trends in relation to clinical lab values as well as treatment will assist in accurate diagnosis and management.

KEYWORDS: Cryptococcal Meningitis

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>CD4 &lt; 50</th>
<th>Protease Inhibitor</th>
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<tr>
<td></td>
<td>Incidence</td>
<td>Incidence</td>
<td>OR</td>
</tr>
<tr>
<td>Total</td>
<td>57</td>
<td>32</td>
<td>11</td>
</tr>
<tr>
<td>Pseudocyst</td>
<td>4 (7.0%)</td>
<td>4 (12%)</td>
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<tr>
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<td>2 (3.5%)</td>
<td>2 (6.2%)</td>
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<td>Pseudocyst w/ enhancement</td>
<td>1 (1.7%)</td>
<td>1 (3.1%)</td>
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<tr>
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<td>7 (12%)</td>
<td>5 (15%)</td>
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<td>Perivascular space edema</td>
<td>11 (19%)</td>
<td>7 (21%)</td>
<td>1.47</td>
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<tr>
<td>Perivascular space enhancement</td>
<td>12 (21%)</td>
<td>10 (31%)</td>
<td>5.23</td>
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<tr>
<td>Lepto-Meningeal Enhancement</td>
<td>28 (49%)</td>
<td>17 (53%)</td>
<td>1.44</td>
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<td>1 (3.1%)</td>
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<tr>
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<td>1 (1.7%)</td>
<td>1 (3.1%)</td>
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<tr>
<td>Hydrocephalus</td>
<td>10 (17%)</td>
<td>4 (12%)</td>
<td>0.45</td>
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Cerebritis 20 (35%) 15 (46%) 3.53 *0.03 6 (54%)
Enhancing Mass/ cryptococcoma 8 (14%) 5 (15%) 1.36 0.70 1 (9.0%)
Stroke 9 (15%) 4 (12%) 0.57 0.44 1 (9.0%)

Monday
10:30AM - 12:08PM
Palais des congres de Montreal, 520

11- PARALLEL PAPERS: Adult Brain: Neoplasms and New Techniques
O-52

SWI micro-hemorrhages do not represent metastases in patients with primary breast cancer or melanoma.

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Purpose
Susceptibility-weighted imaging (SWI) has substantially increased detection of hemorrhage in intracranial lesions and it has been suggested that microhemorrhages may serve as markers of small metastases even in absence of contrast enhancement (1). We sought to examine SWI findings in commonly hemorrhagic brain metastases to better understand if its presence is related to lesion size.

Materials and Methods
Patients with either melanoma or primary breast cancer underwent SWI imaging and high resolution T1 images (immediate postcontrast T1 MPRage, Multihance 0.1 ml/kg) at either 1.5 T or 3.0 T. Lesion volume was estimated by measuring three orthogonal dimensions and calculating it for an ellipsoid (V= 4/3 πabc). All enhancing lesions were presumed to be metastases based on clinical history of primary tumors. Susceptibility-weighted imaging findings on the corresponding image slices were categorized as either positive or negative based on presence/absence of signal dropout in the same locations. The percentage of SWI positivity then was estimated as a function of lesion size using 0.1 cm3 as a cutoff for micrometastases. A two-tailed Fisher exact test was performed to examine differences in the contingency tables.

Results
We studied 73 patients with 1173 enhancing metastases for which 952 had SWI. Thirty-eight patients had breast cancer (467 analyzed lesions) and 35 had melanoma (485 analyzed lesions). Only 10 of 342 micrometastases had SWI abnormalities while 410 of 610 larger ones were SWI positive (67.2%, p-value of < 0.0001). When examined by primary tumor type, 76.9% (melanoma) versus 55.6% (breast cancer) were SWI positive (p-value < 0.0001). No melanoma lesions larger than 1.5 cm3 were SWI negative while 14 of 15 of similar breast cancer lesions were SWI negative.

Conclusions
Using SWI and contrast-enhanced high resolution imaging we found that presence of hemorrhage is uncommon in micrometastases but common in larger metastases regardless of primary source. Thus, microhemorrhages even in presence of a primary breast cancer and
melanoma cannot be used as sole markers of underlying metastases. Large metastases commonly harbor hemorrhage which occurs more often in presence of melanoma than in primary breast cancer.

KEYWORDS: Adult Brain, Advanced MR Imaging, Brain Metastases

O-53

Brain radiation-related black dots on Susceptibility-Weighted Imaging

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Purpose
Brain irradiation may result in changes months to years after treatment of intracranial tumors and small-vessel injury is a prominent feature of delayed injury. Susceptibility-weighted imaging (SWI) is a technique that exploits the magnetic properties of tissues, such as blood and iron content. The purpose of this study is to describe the SWI findings following cranial irradiation.

Materials and Methods
We evaluated 13 patients with MR imaging (MRI) follow up who underwent cranial irradiation for primary or metastatic tumors. From the clinical records, the latency interval, type of radiation, and total dose were established. The number and the distribution of “black dots” were analyzed. We also compared the findings on SWI with the those on conventional MRI.

Results
In all patients, black dots were clearly identified on SWI, while on conventional MRI (T2 and FLAIR) none were visible. In 10 patients (83%) diffuse black dots were observed and in two patients (17%) these were located near the surgical beds. All black dots were seen after whole brain radiation. When it could be established, the latent period for development of black dots was four months and doses varied from 45-54 Gy. None of these dots showed enhancement making them unlikely to represent hemorrhagic metastases. Black dots occurred in the cerebrum, cerebellum, and even choroid plexuses. Follow-up (3-6 months) in four instances showed that the numbers of these black dots increased.

Conclusions
Radiation-related black dots are not an uncommon effect of cranial irradiation. Susceptibility-weighted imaging is an accurate technique for evaluation of black dots presumably induced by radiation. The etiology of these black dots is uncertain and they could be related to microbleeds, capillary telangiectasias, and/or small cavernomas but they are unlikely to be metastases as none enhanced.

KEYWORDS: Radiation, Susceptibility-Weighted Imaging

O-54

Dynamic contrast enhancement MR perfusion of pituitary adenomas
Purpose
To evaluate and describe pituitary adenomas with dynamic contrast enhancement MR perfusion.

Materials and Methods
Fourteen patients with pituitary adenomas were explored with on optimized digital contrast enhancement (DCE) MR perfusion sequence between June 2013 and December 2013. Three patients presented with microadenomas, and the rest with macroadenomas. The dynamic acquisition was performed in a coronal plane with 1.2 mm thickness slices and a temporal resolution of 5 seconds acquired with time-resolved angiography with stochastic trajectories (TWIST) sequence on a 3 T machine. The dynamic acquisition was preceded by two T1 volumetric interpolated breath-hold examination (VIBE) sequences with 2 and 15 degrees flip angle, in order to compute the T1 map. Model-independent semiquantitative maps and quantitative maps based on multiple pharmacokinetic models [Tofts extended, adiabatic approximation of tissue homogeneity (AATH) and AATH with delay] were generated with commercially available software. Analysis of quantitative parameters based on the pharmacokinetic models for both normal pituitary gland and pituitary adenomas was performed using Spearman's coefficient of correlation and Mann-Whitney test.

Results
Visual analysis of the enhancement curves showed in two out of the three cases of microadenomas that the difference between normal pituitary tissue and tumor tissue was most striking during the first minute after gadolinium injection, with a vascular peak of enhancement of the normal tissue and a slow washin of the adenoma; after one minute, the differences become minimal (Figure). Quantitative analysis showed that normal pituitary tissue and tumor tissue could be differentiated with most parameters used (Ktrans, ve, vp, washin, and washout) and with all the pharmacokinetic models (p<0.01). Tofts extended model had the worst correlation with the other models (Spearman's rho between 0.552 and 0.670) for Ktrans measurements of adenomas; the Spearman's rho between the other models was more than 0.8 (excellent correlation). Area under the curve (AUC) could not differentiate normal tissue and tumor tissue on any of the models used.

Conclusions
Based on this preliminary experience, microadenomas are best depicted during the first minute after gadolinium injection. Most quantitative parameters derived from multiple pharmacokinetic models differentiate tumor from normal pituitary tissue.

KEYWORDS: Dynamic Contrast Enhancement, Pituitary Adenoma
Apparent Diffusion Coefficient (ADC) and Pituitary Macroadenomas: Preoperative Assessment of Tumor Atypia
Purpose
Pituitary macroadenomas are predominantly benign intracranial neoplasms that can be locally aggressive with invasion of adjacent structures. This often renders gross total resection challenging, resulting in higher recurrence rates and potentially adjuvant radiation for disease control. Although these tumors can be invasive, they are seldom histologically atypical and biomarkers of aggressive behavior have been identified previously in the pathology literature, including the proliferative marker MIB-1. In the radiology literature, diffusion-weighted imaging with low apparent diffusion coefficient (ADC) values have been reported as imaging markers of aggressive behavior in tumors of the brain and head and neck. The purpose of this study was to determine whether there was any correlation between ADC values, cellular atypia and MIB-1 in pituitary macroadenomas.

Materials and Methods
A retrospective review of imaging and immunohistochemical characteristics of pituitary macroadenomas was performed. A total of 25 patients were identified over a five-year period with MR imaging (MRI) including ADC maps at time of diagnosis. Patients with adenomas <2cm in size, with predominantly hemorrhagic or cystic components were excluded. The MR imaging features of the adenomas were evaluated for local invasion and restricted diffusion. The ADC values were normalized to ADC value of white matter to account for scaling factors during imaging acquisition (normalized ADC ratio). Tumor proliferation indices were reported as a percentage of tumor nuclei labeling with Ki-67 (clone MIB-1) monoclonal antibody in resected tissue. Linear regression analysis was performed to compare the normalized ADC ratio and MIB-1.

Results
Of the 25 patients, 21 demonstrated local invasion on imaging, which was confirmed intraoperatively. The mean ADC ratio was 0.91 in these patients. A subset of six patients was identified within this group in which the ADC values were significantly lower, with a mean ratio of 0.59. In these six patients, MIB-1 (Ki-67 index) was reported, ranging from 2-5%. Linear regression analysis of normalized ADC values versus MIB-1 demonstrates a negative correlation, with a linear slope significantly different from zero (p = 0.02, r squared = 0.80) (Figure 1).

Conclusions
Prior studies involving both ADC and MIB-1 have independently demonstrated the potential of these indices in the assessment of tumor behavior. To our knowledge, this is the first study to evaluate the relationship between ADC and MIB-1 in pituitary macroadenomas. We determine a strong correlation of low ADC values and MIB-1, demonstrating the potential of diffusion imaging as a possible biomarker for cellular, proliferative tumor, which may ultimately affect the surgical approach and postoperative management.

KEYWORDS: Pituitary Adenoma
Accuracy and Reproducibility of ADC maps and CT for Diagnosis of Solid Pineal Masses

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Purpose
Pineal region tumors usually are of either germ cell or pineal cell origin [including pineal parenchymal tumor of intermediate differentiation (PPTID)]. These two groups have different prognoses and treatments. Apparent diffusion coefficient (ADC) values on MR imaging (MRI) and pineal calcification characteristics on computed tomography (CT) have been proposed for their differentiation. However, other lesions also arise in this location, which may exhibit overlapping imaging characteristics. The purpose of this study was to establish the accuracy and reproducibility of pineal mass differentiation using ADC maps and calcification patterns.

Materials and Methods
Four radiologists retrospectively reviewed imaging studies of 55 patients with histologically confirmed solid pineal masses at two institutions from 2003 to 2012. Reader experience spanned resident to neuroradiologist with 13 years of practice. Each blinded reader independently compared lesion signal intensity on ADC maps to normal brain (similar, darker, or brighter), and, in a separate session, the morphology of the pineal calcification on CT (preserved or
"exploded"). Low ADC signal and exploded pineal calcification were the criteria for pineal cell tumors and atypical teratoid rhabdoid tumor (ATRT), while isointense to high ADC signal and intact calcification were considered consistent with germ cell tumors. Readers selected one of four options: definitive pineal cell tumor/ATRT, favor pineal cell tumor /ATRT, favor germ cell tumors, or definitive germ cell tumor. Interobserver agreement was assessed using kappa statistics. Final imaging diagnosis was established by the most senior neuroradiologist via evaluation of all available images.

Results
Both CT and MRI were available in seven patients, with ADC maps showing higher accuracy and interobserver agreement. Apparent diffusion coefficient maps had 100% sensitivity for germ cell tumors, with only 50% specificity. Computed tomography had a sensitivity of 88.9% for pineal cell tumors/ATRT and 100% for pineoblastoma, with lower specificity. Two cases of PPTID showed either low ADC values with preserved calcifications or "exploded" calcifications with higher ADC values. Overall sensitivity of 94.1% was found for germ cell tumors on ADC maps, with specificity under 50%. Apparent diffusion coefficient maps demonstrated a high specificity for pineal cell tumors/ATRT (89.5%), with a poor sensitivity (65.4%). Computed tomography showed a very high sensitivity for pineal cell tumors/ATRT (88.9%) and even higher for pineoblastoma (100%), with lower specificity (72.7%). Gliomas of various grades and metastases simulated germ cell tumors based on calcification pattern and ADC signal. The agreement between pairs of raters was substantial in four and moderate in two cases for the ADC maps, substantial in two and moderate in four for the CT scans. Readers' experience did not appear to have an impact on kappa statistics.

Conclusions
Apparent diffusion coefficient signal intensity appears more reproducible than CT calcification pattern for pineal masses. Apparent diffusion coefficient maps are very sensitive but not specific for germ cell tumors, while CT is very sensitive and ADC maps are very specific for pineoblastoma and ATRT. "CT/MRI mismatch" ("exploded" calcification with isointense ADC signal or intact calcification with low diffusion values) appears suggestive of PPTID. Some of the pineoblastomas before the 2007 WHO classification actually might have been PPTIDs.

KEYWORDS: MR Imaging/Diffusion, Pineal Calcification, Pineal Cell Tumor

O-57 11:05AM - 11:12AM

Magnetic Resonance Fingerprinting of Brain Tumors: Initial Clinical Experience

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Purpose
Magnetic resonance fingerprinting (MRF) is a novel framework for simultaneous accurate quantitation of multiple MR tissue properties (1). The purpose of this study is to apply MRF for evaluating intra-axial brain tumors.

Materials and Methods
Seven patients (4 females 3 males, age 56-82) with intra-axial brain tumors, three high grade
gliomas (HGG), two low grade gliomas (LGG) and two metastases (esophageal and lung adenocarcinoma) were scanned using a previously described MRF protocol (1). Clinical MRI images were used for region of interest (ROI) planning. T1 and T2 quantification of solid tumor, perilesional white matter (PWM), and contralateral white matter (CWM) was performed. In HGG, abnormal signal beyond the enhancement but within the expansile portion of lesion also was analyzed separately. Student's t-test for paired data was performed to compare T1, T2 values between different locations across subjects.

Results
Mean T1 and T2 values of solid parenchyma in gliomas (n = 5) were 1890 ± 170 ms and 219 ± 60 ms, respectively. Mean T1 and T2 of abnormal signal beyond the enhancement but within the expansile portion of lesion in HGG (n =3) were 1789 ± 223 ms and 128 ± 24 ms. Intralesional T1, T2 of cystic metastasis from esophageal adenocarcinoma were 3177 and 335 ms and of lung adenocarcinoma metastasis were 1324 and 126 ms. Mean T1 and T2 of perilesional white matter (n =7) were 1272 ± 311 ms and 104 ± 25 ms. Mean T1 and T2 for (n= 7) contralateral normal white matter were 982 ± 77 ms and 77 ±13 ms. Tumor relaxometry values are in good agreement with the limited published literature (2, 3). T1 and T2 values of tumor were significantly different than those of CWM (n=7, p<0.002, p<0.003 and PWM (n=7, p<0.02, p<0.02). There was significant difference between T1 and T2 of PWM and CWM (n=7, p<0.02, p<0.03). Figure 1 shows distribution of T1/T2 for all tumors. As seen, tissue characteristics for each region are distinct from each other, suggesting quantitative distinction between normal and neoplastic tissue using this technique.

Conclusions
These preliminary results suggest that MR Fingerprinting can quantitatively distinguish tumors, PWM changes and CWM from each other. Preliminary measurements also support using MRF to identify regions of infiltrative nonenhancing tumor in high grade gliomas. These results suggest application of this technique in tumor differentiation, delineation of tumor margins beyond enhancing borders, and therapeutic response evaluation.

KEYWORDS: Brain Neoplasms, MR Imaging, Relaxivity
Is Remote Site Diffusion Restriction an Early Marker of Tumor Progression in Patients with Known Glioblastoma Multiforme?

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Purpose
The most commonly accepted method of assessing tumor progression in treated glioblastoma multiforme (GBM) is the presence of a new enhancing lesion. However, at sites that are remote from the original tumor, we propose that diffusion restriction precedes enhancement, as an early marker of tumor progression.

Materials and Methods
A retrospective review of standard protocol MR imaging (MRI) examinations of the brain, including diffusion-weighting imaging and their associated apparent diffusion coefficient (ADC) maps, was performed in patients with a known history of GBM. The inclusion criteria included all GBM patients that had been followed longitudinally at Monmouth Medical Center over a 5.5 year period, from January 1, 2008 to August 6, 2013. Ninety patients were identified, and a board-certified neuroradiologist (S.L.) reviewed all of the images for these patients, in order to identify those patients with remote-site diffusion restriction. The patients were followed radiographically and/or surgically (i.e., re-resection) to determine the etiology of the remote-site diffusion restriction. Patients who subsequently developed an enhancing mass at the remote site were considered to have tumor progression. Patients with eventual resolution of the remote-site diffusion restriction or with subsequent development of encephalomalacia at the remote site were presumed to have had a focal infarct.

Results
In 18 of the 90 patients with GBM (20%), remote-site diffusion restriction without enhancement was seen following diagnosis and treatment. Upon longitudinal follow up, 10 (56%) of these 18 patients developed enhancing tumor at the remote site of diffusion restriction. Six (33%) of these patients were determined to have developed infarct. Two (11%) of these patients expired prior to an established etiology.

Conclusions
Remote-site diffusion restriction can be an early marker for the progression of tumor in patients with known glioblastoma multiforme. However, a significant portion of these patients with remote-site diffusion restriction suffer from focal infarction, rather than progression.

KEYWORDS: GBM, Glioblastoma, Glioma

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Predicting the spread of glial tumors: Lessons from the Insular Connections to the Frontal Lobe

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Purpose
To demonstrate the 4 U-fiber tracts which are responsible for the spread of glioma between the insula (Brodmann area 13) and the frontal lobe (Brodmann areas 6, 43, 44 and 45/47).
Materials and Methods
One thousand histologically proven gliomas in adults were analyzed retrospectively by MR imaging prior to surgical resection of tumor. One hundred and seven cases of insular tumor were subdivided into: a) 42 cases confined to the insula, b) 24 of the remaining 65 cases demonstrated glioma spread between the insula and frontal lobe.

Results
In the 24 cases of insular tumor with spread to the frontal lobe, 12 occurred via the U fibers to the pars opercularis (Brodmann area 44), 9 occurred via U fibers to the pars orbitalis/pars triangularis (Brodmann area 45/47). Two cases spread via the U fibers between the insula and the subcentral gyrus (Brodmann area 43). Only one case used the U fibers between the opercular part of Brodmann area 6. Tumor infiltration between the concentric fibers which make up the U-fiber tracts occurred in 4 locations relative to the Sylvain fissure. Tumors which expanded the entire U fiber tract formed superficial rounded masses on both sides of the Sylvian fissure. This shape contrasted with the tumors which arose from either the insular or opercular limbs of the U fibers. Their growth displaced the Sylvian away from the expanded gyrus. The last location of tumor growth was in the junctional U fibers. These deep white matter tumors could reach considerable size. Tumors in any of the 4 locations can have a crescentic-shaped internal architecture which represents successive layers of neoplastic growth shaped by the U fiber partitions.

Conclusions
Insular gliomas can arise and dissect in 4 U-fiber tracts. They form unique shapes that can be described by using Brodmann area nomenclature. In our tertiary referral hospital 24/65 (37%) of insular tumors have spread to the frontal lobe at the time of diagnosis. Better understanding of these pathways of tumor spread is useful in planning neurosurgery and radiotherapy treatment. Figure legend. Coronal postcontrast MR images of a large astrocytoma trapped in the junctional part of the U fibers between the insula and Brodmann 44. Comparison of the preoperative (A) and postoperative (B) images confirms the site of tumor origin.

KEYWORDS: Insula

Comparison of Qualitative Assessment Versus Semi-automated, Computer-assisted Quantitative Neuroimaging Feature Analysis of Glioblastomas in The Cancer Genome Atlas

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Purpose
Careful evaluation of the MR features of glioblastomas (GBM) is important for treatment planning and prognosis. VASARI, a standardized vocabulary set that describes the 30 most common imaging features of GBMs, has been created to guide GBM evaluation. Our institution has developed a semi-automated, computer-assisted volumetric (CAV) algorithm that can potentially evaluate a subset of the VASARI features in a reproducible and objective way. Previous studies have shown the feasibility of semi-automated CAV algorithms for the assessment of GBM tumor core. In addition, researchers have demonstrated concordance between qualitative technique and semi-automated CAV assessment of GBMs. The purpose of this study is to assess concordance of traditional qualitative assessment versus a semi-automated CAV technique and to assess the inter-reader variability of these two techniques in evaluating GBMs from the Cancer Genome Atlas (TCGA) database.

Materials and Methods
This was a retrospective review using pathology results and images from the TCGA database and Cancer Imaging Archive, respectively. The Cancer Imaging Archive maintains images corresponding to TCGA patients. Only patients with presurgical MR imaging (MRI) with T1 precontrast, T1 postcontrast, and FLAIR imaging were included. Each tumor was assessed by two neuroradiologists independently using qualitative and semi-automated, quantitative CAV techniques. For the qualitative assessment, four key features based on VASARI scoring criteria were evaluated for each tumor: proportions of enhancement, noncontrast enhancement, necrosis, and surrounding edema. For semi-automated CAV assessment, the same criteria were evaluated by drawing a region of interest on one image of the tumor and using a CAV algorithm to automatically propagate that region of interest to the rest of the images. The semi-automated algorithm used combines a region-based active contours and level set approach. Intraclass correlation coefficient (ICC) analysis was performed to assess concordance between the qualitative technique and the semi-automated CAV technique to grade the four GBM features. Additional ICC analysis was examined for each technique. All analyses were performed with SPSS.

Results
Preoperative imaging with pathology was available for 59 GBMs obtained from the TCGA database. The ICC to assess concordance between the qualitative technique and semi-automated CAV technique were 0.85 (95% CI 0.75-0.91), 0.85 (95% CI 0.74-0.91), 0.96 (95% CI 0.93-0.98), and 0.90 (95% CI 0.83-0.94) for proportions of enhancement, noncontrast enhancement, necrosis, and surrounding edema, respectively. The ICC to assess inter-reader agreement for the qualitative technique were 0.75 (95% CI 0.57-0.85), 0.73 (95% CI 0.55-0.84), 0.68 (95% CI 0.46-0.81), and 0.72 (95% CI 0.57-0.83) for the same features. The ICC to assess inter-reader agreement for the semi-automated CAV technique were 0.87 (95% CI 0.79-0.93), 0.98 (95% CI 0.96-0.99), 0.90 (95% CI 0.82-0.95), and 0.89 (0.81-0.94) for the same features. Figure 1 shows a comparison of the inter-reader agreement for qualitative and semi-automated CAV techniques.

Conclusions
Our study shows high concordance between the qualitative technique and semi-automated CAV technique for evaluating GBM features. The ICC was higher using the semi-automated CAV technique. This study shows that semi-automated CAV technique is a viable quantitative tool for the evaluation of GBM characteristics in the clinical setting because of its reliability and reproducibility.
Key points:

- **Keywords:** Glioblastoma, Volumetric Analysis

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**Figure 1.** Intraclass correlation coefficients to assess inter-reader agreement of qualitative versus semi-automated CAV technique.

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**O-61**

**Characteristic Computed Tomography and Magnetic Resonance Imaging Findings of Myeloid Sarcoma: A Retrospective Study**

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1. Chaudhry A, Gul M, Chaudhry A, Dunkin J. Characteristic Computed Tomography and Magnetic Resonance Imaging Findings of Myeloid Sarcoma: A Retrospective Study. *TCT_O-60_Figure1.jpg*
Purpose
Myeloid sarcoma is a rare cause of extramedullary leukemia presenting as soft tissue mass and can occur anywhere in the body. It can be the initial presentation of aleukemic leukemia that either resulted from myelodysplastic syndrome conversion into leukemia, de novo aleukemic leukemia or leukemia relapse. It can present weeks to months before the peripheral presence of leukemia. The purpose of this study is to retrospectively evaluate imaging characteristics of myeloid sarcoma on computed tomography (CT) and MR imaging (MRI). Additionally, we aim to identify if there is a possible age, sex, organ system predilection and if specific subtypes of leukemia are more likely to result in development of myeloid sarcoma.

Materials and Methods
A retrospective study of 100 patients with pathologically proven myeloid sarcoma included 29 patients (18 men, 11 women; mean age, 55 years; range, 9–80 years) who underwent pretreatment CT and/or MRI at our institution from January 1993 to December 2012. A total of 60 examinations (25 MRI and 35 CT) were evaluated by two radiologists in consensus.

Results
There were 82 total sites of involvement of myeloid sarcoma were noted, most commonly CNS (30/82, 36.6%), head and neck (16/82, 19.5%), abdominopelvic viscera (13/82, 15.9%), thorax (11/82, 13.4%), musculoskeletal (7/82, 8.5%), lymphatics (6/82, 7.3%), gonads (3/82, 3.7%) and breast (2/82, 2.4%). Most of these sarcomas were AML subtype of which majority were M3 and M5. Of all of the patients, only 40% had evidence of leukemia on peripheral smear. The mean size of measurable lesions was 2.8 cm (range, 1-8 cm). On CT, 30 of the 35 lesions were solid and measurable. These lesions were isodense to spleen, liver and muscle measuring 40-70 HU on unenhanced CT. Twenty-five sites were noted on MR images obtained for evaluation of a new sign or symptom, most commonly CNS (20 sites), MSK (4 sites) and abdomen (1 sites). Compared with gray matter and muscle, the lesions were isointense (78.4%) or hypointense (21.6%) on T1-weighted images and hyperintense (96%) on T2 and FLAIR images and had homogeneous enhancement (88%). On diffusion-weighted imaging (DWI), 96% images showed restricted diffusion. Only 16% of images showed susceptibility artifact on gradient and none of these lesions demonstrated observable calcium on CT.

Conclusions
Myeloid sarcoma is a rare form of extramedullary leukemia which can be initial presentation of leukemia (de Novo, concurrent or recurrence) and commonly is seen without evidence of leukemia in peripheral blood. In patients with history of leukemia or other lymphoproliferative disorder, identification of a soft tissue mass can be indicative of myeloid sarcoma. Our study shows that the nervous system and head & neck are the two most common systems in which myeloid sarcoma arises. Imaging characteristics of myeloid sarcoma include homogenous mass isodense to muscle on CT, T1 isointense, T2/FLAIR hyperintense with restricted diffusion and homogenous postcontrast enhancement without significant susceptibility artifact.

KEYWORDS: MR Imaging, MR Imaging Brain, MR Imaging/Diffusion
Usefulness of Diffusion Tensor Imaging based Intra tumoral fiber tracking magnetic resonance imaging for the differentiation of schwannoma and classic meningioma in the cerebellopontine angle.

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Purpose
The differentiation between schwannoma and meningiomas may have implications in pre-operative planning but may not be possible on the basis of conventional MR imaging (MRI). Diffusion tensor imaging (DTI) provides information about magnitude and directionality of water diffusion and thus fiber tracking may be able to measure the differences in intratumoral diffusion anisotropy as a result of histologic differences between schwannoma and classic meningiomas.

Materials and Methods
Pre-operative DTI was performed in eight schwanomma and six classic meningiomas. In addition to MR imaging with all basic sequences, Medium DTI was acquired using a 3 T MR imaging scanner (Philips, Achieva) and postprocessed with fibretrak package to obtain intratumoral fiber tracking.

Results
Classic meningiomas showed whorly pattern of fibers inside the tumors. Intratumoral fiber tracking in all schwanomma is due to displaced facial nerve which was confirmed with surgical findings.

Conclusions
Diffusion tensor imaging-based intratumoral fiber tracking showed that the degree of contribution of intracellular environment is responsible for fiber track findings. This feature may allow for noninvasive differentiation between schwanomma and classic meningiomas.

KEYWORDS: Diffusion Tensor Image

O-63

Primary CNS Lymphoma : Is Absence of Intratumoral Hemorrhage a Characteristic Finding on MRI?

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Purpose
Previous studies have shown that intratumoral hemorrhage is a common finding in glioblastoma multiforme (GBM), but rarely is observed in primary central nervous system lymphoma (PCNSL). Our aim was to re-evaluate whether intratumoral hemorrhage observed on T2-weighted imaging (T2WI) as gross intratumoral hemorrhage (GITH) and on susceptibility-weighted imaging (SWI) as an intratumoral susceptibility signal (ITSS) can differentiate PCNSL from GBM.
Materials and Methods
A retrospective cohort of brain tumors from August 2008 to March 2013 was searched, and 58 patients (19 PCNSL, 39 GBM) satisfied the inclusion criteria. Absence of GITH was examined on T2WI, and ITSS was graded using a 3-point scale on SWI. Results were compared between PCNSL and GBM, and values of P < .05 were considered significant.

Results
Gross intratumoral hemorrhage on T2WI was absent in 15 patients (79%) with PCNSL and 23 patients (59%) with GBM. Absence of GITH could not differentiate between the two disorders (P = 0.20). However, ITSS grade 1 or 2 was diagnostic of PCNSL with 79.0% sensitivity and 67.5% specificity (P < 0.0001), irrespective of GITH.

Conclusions
Gross intratumoral hemorrhage on T2WI had no differential capability, whereas ITSS score on SWI could differentiate PCNSL from GBM. However, specificity was not as high as previously reported. Primary central nervous system lymphoma cannot be excluded based solely on the presence of positive ITSS.

KEYWORDS: Lymphoma, Primary CNS Neoplasms, Susceptibility-Weighted Imaging

Follow-Up MR in Inflammatory Cerebral Amyloid Angiopathy

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Purpose
Inflammatory form of cerebral amyloid angiopathy (CAA) is rare. The aim of this study is to report MR imaging (MRI) follow-up findings in patients presenting with inflammatory CAA disease and in those presenting with primary CAA complicated with an inflammatory evolution.

Materials and Methods
We report a series of four patients (3 females and 1 male, ranging in age from 78 to 83 years). Two patients with an already known common form of CAA (i.e., microbleeds, macrobleeds, intracranial hemorrhages, hemosiderosis and T2 hypersignal in periventricular white matter) presented with acute neurological deficit (hemianopia 1 case, brachiofacial deficit 1 case). Two other patients were admitted with confusion (1 case) and hemianopia (1 case). MR protocol included diffusion imaging, axial T1, T2 FLAIR, T2 *-W images. 3D TOF MRA was performed in all of the four cases. Magnetic susceptibility images (SWAN) were obtained in three cases. Axial T1-weighted images and/or 3D T1 acquisition after gadolinium injection were performed in all cases. MR follow up ranged from four to nine months.

Results
In all patients, multiple large areas of high intensity signal on T2-weighted images were observed in the white matter associated with bilateral and asymmetrical U fibers and cortex involvement. The lesions were hypointense on T1-weighted images. There was no diffusion restriction. The data were in favor of vasogenic edema. The sulci adjacent to the parenchymal abnormalities were collapsed. Faint focal leptomeningeal cortical enhancement was observed in two cases. In the patients with previously diagnosed CAA, MR images showed an acute
parenchymal hemorrhage in contact with the T2 parenchymal hyperintensities in addition to typical CAA findings. On the follow-up MR studies, a quite complete regression of the edematous lesions was observed. Nevertheless the number of microbleeds lesions increased.

Conclusions
In our series, inflammatory CAA occurred in patients with previously diagnosed common form of CAA or with the primary manifestation of CAA. Clinical presentation of inflammatory form of CAA is not specific. MR imaging, including T2* and SWAN images, and MR follow up are crucial to confirm the diagnosis and avoid invasive diagnostic procedure as cerebral biopsy.

KEYWORDS: Amyloid, Inflammatory, MR Imaging Brain

O-927

High-Resolution CT/MR Fusion Demonstrates Sites and Patterns of Flow in Patients with Skull Base CSF Leaks

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Purpose
Cerebrospinal fluid (CSF) leaks present with variable symptoms, including diplopia, tinnitus, nausea, and headaches relieved or diminished by supine positioning. Traditional diagnosis depended on history of such symptoms with detection of beta-2-transferrin from collected fluid and imaging confirmation. Computed tomography cisternography is frequently used modality, requiring intrathecal injection of contrast and provocative positioning to opacify a leak site. However this is invasive and relies on adequate opacification of CSF. Other techniques, such as nuclear cisternography, require intrathecal In-111 injection and placement of six pledgets in the nasal cavity, which can be uncomfortable and is a time-consuming process. A noninvasive modality to assess CSF leaks may make diagnosis more pleasant for patients, and might increase the diagnostic yield. Computed tomography/MR fusion has been described previously but at lower resolution (Mostafa). The purpose of this investigation was to determine what patterns of leak or defect can be seen in fusion of HRCT/MR in patients with abnormalities proven surgically.

Materials and Methods
Candidates included patients suspected of CSF leak in whom high resolution CT and MR were obtained on the same day, between 10/2011 and 11/2013. Patients derived from the practices of otolaryngology and neurosurgery in our institution. Patients were included if they ultimately underwent surgery at our site, and had a surgically proven leak or a defect such as meningo(encephalo)coele. Computed tomography and MR data were fused on a dedicated postprocessing workstation to match position, scale, and rotation, which ensured portrayed planes matched perfectly. For all cases, images were generated as a fused set (CUBE T2 in colorscale superimposed over CT in grayscale), and as separate CT and T2 datasets in grayscale alone. For some cases a similar set of sagittal images was generated, if the interpreting radiologist felt a different plane would add to diagnosis. The same radiologist interpreted all of the studies. Recorded data included the following: 1) site of defect(s) or other osseous
abnormalities such as bony remodeling on the CT; 2) presence and location of T2 hyperintense fluid near any of these osseous abnormalities; 3) whether a change in such fluid was resolvable during the course of the exam; 4) site of any herniated tissue [i.e., meningo(encephalo)coele]; 5) ancillary findings such as prominent arachnoid granulations or pitting, or changes in the sella such as sellar expansion or pituitary flattening.

Results
During the time period surveyed, we found 16 patients who underwent same-day CT and MR and had surgical exploration at our site. In 15/16 (94%) the site of the defect matched the site or the surgically confirmed lesion; in one patient (6%), a definite site could not be resolved. The presence of fluid on T2 (13 cases) or local air (1 case) was a strong indicator of sidedness of leak: this conformed in 14/16 cases (88%), while lateralization could not be determined in one case and there was no clear extracranial fluid in another. Changes in CSF configuration (including pooling) during the scan session were seen in six of the 13 studies that had high resolution series at the start and end of the MRI (46%). Empty sella was identified in 11/16 (69%), and ancillary findings of CSF pulsatility other than empty sella were seen in 13/16 (82%), including enlarged Meckel's caves (+/- Meckel's meningoceles) in 5/16 (31%) and prominent arachnoid granulations in 8/16 (50%). Although superimposition of colorscale T2 over CT may obscure some findings, the superimposed image can nicely demonstrate abnormalities efficiently and effectively once they are diagnosed (for example, see the left sphenoid encephalocele in Figure 1).

Conclusions
Fusion of high resolution CT and MR allows advantages of each to be exploited in characterizing CSF leak defects, without requiring intrathecal contrast. Site of fluid, or changes during the imaging session, can aid in ultimate localization of skull base defect.

KEYWORDS: CSF Leak, Fusion, Postprocessing
Developmental Trajectories of Cerebrovascular Reactivity in Healthy Children

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Purpose
Noninvasive imaging strategies can assess vessel distensibility by quantifying the relative changes in cerebral blood flow (CBF) in response to a vasoactive stimulus. The resulting measure
is expressed as cerebrovascular reactivity (CVR) and is a useful tool in the clinical assessment of cerebrovascular disease (1, 2). Although we know that baseline CBF undergoes significant developmental changes during childhood (3, 4), very little data are currently available on how this affects CVR in children. Understanding the healthy developmental trajectories of CVR in relation to CBF could aid in the interpretation of future studies in children with cerebrovascular disease. The purpose of this study was to measure CVR at various ages and compare them to corresponding changes in CBF throughout childhood.

Materials and Methods
Sixteen healthy volunteers (7 males, 9 females) between nine and 18 years old were imaged on a clinical 3 T MRI scanner (MAGNETOM Tim Trio; Siemens Medical Solutions, Erlangen, Germany) using a 32-channel head coil. Blood-oxygen level-dependent (BOLD) imaging was used to assess changes in CBF during the administration of a CO2 stimulus via a computer-controlled gas sequencer (RespirAct; Thornhill Research Inc., Toronto, Canada). The BOLD sequence parameters were as follows: TR/TE=2000/40ms, FOV=220mm, matrix size=64×64, slices=25, thickness=4.5mm, volumes=240, time=8min. Cerebrovascular reactivity maps were computed offline using FSL v4.1 (http://www.fmrib.ox.ac.uk/fsl/) by correlating the voxel-wise BOLD signal change to the measured end-tidal CO2 waveform. Baseline CBF was measured using a PICORE Q2TIPS pulsed arterial spin labeling sequence (TR/TE=2500/13ms, TI1=700ms, TI2=1800ms, FA=90°, FOV=220mm, matrix=64×64, slices=13, thickness=4.5mm) and quantified using the vendor processing pipeline (5). Cerebrovascular reactivity and CBF maps were averaged over gray matter (GM) and white matter (WM) regions and Pearson correlation analysis was performed on the resulting data.

Results
Cerebral blood flow and CVR values in each subject are plotted as a function of age. A linear decline in CBF was observed for both GM and WM with respective correlation coefficients $r^2=-0.375$ and $r^2=-0.531$. The change in mean GM and WM CVR exhibited an opposite pattern as CVR linearly increases with age up to age 17. The relation does not hold afterwards as CVR values showed a dramatic decline. The correlation for a linear fit was $r^2=0.660$ and $r^2=0.600$ for GM and WM, respectively, for data points up to age 17.

Conclusions
Our study shows a linear upward trend in the evolution of CVR with age in healthy subjects, corresponding to the normal change in CBF. The eventual peak and decline in CVR, however, indicate that other factors beside CBF may be influencing CVR in the late teen years. Additional data will further substantiate this finding and provide a more comprehensive understanding of CVR changes with age.

KEYWORDS: BOLD FMRI, Cerebral Hemodynamics, Cerebrovascular Reserve
Reproducibility of MR Based Measures of Cerebrovascular Reactivity in Children Using a Computer Controlled Vasoactive Stimulus

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Purpose
Cerebrovascular reactivity (CVR) is a measure that assesses vessel distensibility in the brain, which is important for maintaining normal blood flow and pressure. Noninvasive CVR imaging strategies that quantify cerebral blood flow (CBF) changes in response to a vasoactive stimulus has become a useful tool in the clinical assessment of cerebrovascular disease (1, 2). A successful approach for mapping regional CVR is by measuring MRI blood-oxygen level dependent (BOLD) signal changes during the administration of a computer-controlled CO\textsubscript{2} stimulus. This method has been shown to be reproducible in adults (3), but not yet in children. The purpose of this study was to demonstrate BOLD-CVR reproducibility using precise targeting of end-tidal partial pressures of CO\textsubscript{2} (PetCO\textsubscript{2}) in pediatric subjects.

Materials and Methods
Three healthy volunteers (1 male, 2 females) between 15 and 16 years old were imaged on a clinical 3 T MRI scanner (MAGNETOM Tim Trio; Siemens Medical Solutions, Erlangen, Germany) using a 32-channel head coil. We assessed long-term reproducibility by collecting test-retest BOLD-CVR measurements performed on two separate days, approximately two weeks apart. BOLD-CVR data was acquired during an eight minute long CO\textsubscript{2} breathing challenge consisting of four block cycles of normocapnia (PetCO\textsubscript{2} = 40 mmHg) and hypercapnia (PetCO\textsubscript{2} = 45 mmHg), which was administered via a computer-controlled gas sequencer (RespirAct\textsuperscript{TM}; Thornhill Research Inc., Toronto, Canada). Cerebrovascular reactivity maps were computed offline using FSL v4.1 (http://www.fmrib.ox.ac.uk/fsl/) by correlating the voxel-wise BOLD signal change to the measured end-tidal CO\textsubscript{2} waveform, followed by normalization into units of % BOLD change/mmHg (CO\textsubscript{2}). High resolution T1-weighted anatomical images also were acquired for the purposes of coregistration of the CVR maps as well as brain tissue segmentation into gray matter (GM) and white matter (WM) regions. Mean CVR values over GM and WM were calculated for each subject. Reproducibility was assessed using the between-day coefficient of variation (CV).

Results
Representative test-retest BOLD-CVR maps overlaid on T1 images are provided in the figure. Mean (± SEM) BOLD-CVR measures exhibited good between-day reproducibility for both the GM and WM regions (CV < 14%) as shown in the table.

Conclusions
In this study, we have demonstrated the reproducibility of BOLD-CVR data in children using a precisely controlled vasoactive stimulus. While additional data needs to be acquired to expand on these initial results, they provide support for the feasibility of pediatric CVR imaging studies.

KEYWORDS: Cerebrovascular Reserve, Pediatric Brain, Reproducibility
Assessing the Effect of Red Cell Transfusion on MR Based Cerebrovascular Reactivity in Children with Sickle Cell Disease

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Purpose
Sickle cell disease (SCD) is a genetic disorder and the most common cause of ischemic stroke in the pediatric population. More than 10% of SCD patients will experience an overt stroke by the age of 20 (1). Patients presenting with abnormal cerebral arterial blood flow velocities (> 200cm/s), as measured by transcranial Doppler, are treated with prophylactic monthly blood transfusions to reduce the rate of either primary or recurrent stroke (2). The attenuation of stroke risk following transfusion may be due potentially to the restoration of cerebrovascular reactivity, which is known to be compromised in SCD (3, 4). Cerebrovascular reactivity (CVR) is a marker that reflects the cerebral vasculature's capacity for vasodilation in the presence of a vasoactive stimulus (3) and can be assessed using blood-oxygen-level-dependent (BOLD) MRI. The purpose of this study was to assess the effect of transfusion on cerebrovascular reactivity using MR-based measures of CVR in children with SCD.

Materials and Methods
Three SCD patients (11-12 years old) without a history of overt stroke, requiring transfusion therapy were imaged on a 3 T MRI (Siemens). Imaging data were acquired at two time points, just prior to transfusion and a few days afterwards. Cerebrovascular reactivity data were obtained using a standard BOLD MRI sequence in combination with a CO2 breathing challenge. The BOLD parameters were: TR/TE=2000/40ms, FOV=220mm, matrix size=64×64, slices=25, thickness=4.5mm, volumes=240, time=8min. CO2 was administered using a re-breathing mask in cycles of targeted normocapnia for one minute followed by a 5mmHg step increase in CO2 tension for 45 seconds. Correlations of voxel-based BOLD change to end-tidal CO2 waveforms were performed on FSL v4.1 to generate CVR maps that then were coregistered on T1-weighted anatomical scans. A Student's T-test was used to compare significant changes (p<0.05) in mean CVR pre- and post-transfusion. The equation by Levin, et al. was used to account for the effect of hematocrit (Hct) on the BOLD signal (6).

Results
Representative CVR maps are provided in the figure. Following transfusion, mean CVR increased in the gray matter from 0.131 ± 0.011 to 0.167 ± 0.019 (p<0.05) and in the white matter from 0.077 ± 0.021 to 0.086 ± 0.014 (p=0.11). After correcting for Hct, mean CVR following transfusion increased in the gray matter from 0.116 ± 0.012 to 0.149 ± 0.02 (p=0.052) and in the white matter from 0.062 ± 0.023 to 0.068 ± 0.015 (p=0.2) (refer to Figure).

Conclusions
In this study, we have demonstrated that CVR increases following transfusion in patients with SCD. The increase in CVR probably is due to an increased capacity for cerebral vasculature to dilate, which plays an important role in preventing cerebral ischemia. Further studies are needed to validate this.

KEYWORDS: Cerebrovascular Reserve, MR Imaging Brain, Sickle Cell Disease
Effect of Obstructive Sleep Apnea on Cerebrovascular Health in Children with Sickle Cell Disease

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Purpose
Sickle cell disease (SCD) is a genetic disorder that causes hemolytic anemia and occlusive vasculopathy (1). Previous work has demonstrated that cerebrovascular reactivity (CVR), a
measure for vascular health, was globally reduced compared to healthy controls in the pediatric SCD population (2). Cerebrovascular reactivity reflects the capacity of blood vessels to regulate blood flow in the presence of a vasoactive stimulus. In addition, a high percentage of individuals with SCD suffer from obstructive sleep apnea (OSA) (3). This can lead to repeated episodes of nocturnal hypoxia, hypercapnia and sleep disruption. It is currently unknown if the presence of OSA in the pediatric SCD population will further impair cerebrovascular health. Therefore, by comparing the MRI derived CVR values in the OSA versus the non-OSA cases in the pediatric SCD population, we will gain valuable insight into their combined effect on cerebrovascular health.

Materials and Methods
Seventeen SCD patients, seven with OSA (8-18 years) and 10 without OSA were imaged on a 3 T MRI scanner using a 32-channel head coil. Cerebrovascular reactivity data were acquired using a blood-oxygen level dependent (BOLD) sequence during a computer-controlled administration of a vasoactive stimulus delivered in programmed cycles of low and increased levels of CO2 through a rebreathing mask. The BOLD images were acquired with TR/TE = 2000/40ms, FOV = 220mm, matrix size = 64×64, slices = 25, slice thickness = 4.5mm, volumes = 240, time = 8 min. High resolution CVR maps were computed using FSL v4.1 and then converted into surface maps through the CIVET pipeline (4). Next, the surface maps were coregistered into the MNI pediatric MRI Atlas, which was segmented manually into the corresponding Brodmann regions. The MATLAB based program SurfStat was used to perform Student's t-tests on CVR between the groups (5).

Results
From the CVR group comparison analysis, we observed that global CVR levels in gray matter was significantly lower in SCD patients with OSA compared to the non-OSA group. The regions of interest analysis revealed several Brodmann areas that showed significantly reduced CVR levels in the OSA SCD group (p < 0.05).

Conclusions
In this study, we have demonstrated significantly reduced CVR values in SCD patients with OSA compared to SCD patients without OSA in different parts of the brain. Reduced CVR may expose individuals who suffer from SCD and OSA to a higher risk for serious vasculopathies such as stroke and they should, therefore, be considered for treatments such as adenotonsillectomy or CPAP therapy to reduce stroke risk.

KEYWORDS: Cerebrovascular Reserve, Obstructive Sleep Apnea, Sickle Cell Disease
Pediatric syndromic CNS vascular disorders: imaging clues to a diagnosis

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Purpose
Syndromic central nervous system (CNS) vascular disorders are being increasingly recognized. Imaging is performed for screening in family members of affected individuals or may be obtained only after a catastrophic complication in a child not diagnosed previously. Imaging patterns may be specific or could be useful in suggesting a diagnosis. The purpose of this study was to describe the CNS and non-CNS vascular and nonvascular imaging manifestations of these disorders.

Materials and Methods
Two hundred fifty patients with syndromic CNS vascular disorders were identified via an IRB/REB approved retrospective radiology text search. Arterial MIP reconstructions were evaluated for specific patterns. Additional clues to the diagnosis were sought on extra CNS imaging studies.

Results
Our findings could be grouped into conditions with predominantly CNS involvement (Neurofibromatosis 1- NF1, moyamoya disease and PHACES association were the most common), predominantly extra-CNS with frequent CNS manifestations [ACTA2 mutation, Takayasu arteritis, Loeys-Dietz syndrome (LDS)], and predominantly extra-CNS with infrequent CNS involvement (Blue rubber bleb nevus syndrome, velocardiofacial syndrome and hereditary hemorrhagic tenangiectasia-HHT). Characteristic CNS vascular patterns were found that could define certain conditions, like arterial straightening in ACTA-2, tortuosity in LDS and progressive stenosis in moyamoya disease. Complementary nonvascular CNS findings aided diagnosis in several cases, like posterior fossa abnormalities with persistent primitive arteries and steno-occlusions in PHACES, characteristically distributed white matter abnormalities (FASI) with steno-occlusions in NF1 and colobomas associated with congenital vascular occlusions in Morning Glory syndrome. Some less specific CNS imaging findings were complemented by extra-CNS findings. Examples are aneurysms in polycystic kidney disease and microcephalic-osteodysplastic-primordial-dwarfism type-II, cerebral and pulmonary arteriovenous malformations in HHT, aortic ectasia in LDS and ATS, aortic and branch steno-occlusions in Takayasu arteritis, medially deviated pharyngeal carotid arteries in 22q11 deletion and steno-occlusive lesions in Hutchinson-Gilford progeria.

Conclusions
Central nervous system vascular abnormalities may be specific like the arterial straightening in ACTA-2 mutation. Less specific vascular patterns such as tortuosity or moyamoya appearance may be seen. Additional CNS and non-CNS imaging clues may aid in suggesting and planning an appropriate diagnostic approach.

KEYWORDS: Loeys-Dietz Syndrome, Moyamoya, MR Angiography
ACTA 2 - ARTERIAL STRAIGHTENING

PHACES - CAROTID OCCLUSIONS
Vascular Causes of Pediatric Intracranial Hypertension

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Purpose
After space-occupying lesions and mechanical disruptions of CSF drainage have been excluded, intracranial venous hypertension (ICVH) often is the central mechanism leading to intracranial hypertension and its causes can be categorized into primary venous outflow compromise (PVOC), arteriovenous shunting (AVS) and idiopathic intracranial hypertension syndrome (IIH). We identified pediatric cases of intracranial venous hypertension (ICVH) to investigate the precipitant vascular causes and the role of endovascular intervention.

Materials and Methods
Following IRB approval, a retrospective pediatric neurointerventional database review identified patients with known ICVH. Cross-sectional imaging and catheter studies were reviewed for direct intravascular pressure measurements and angiographic evidence of disturbed cerebral venous drainage including venous dilation, stenosis, occlusion and abnormal collateral drainage. Demographic data, clinical presentation, type and grade of the underlying vascular lesion, treatment strategy, follow-up imaging and clinical course were obtained accordingly.

Results
Eleven patients (3F/8M) with mean age of 4.6 years (range: 20 days - 13 years) at the time of presentation were identified. The presenting signs and symptoms included increased head circumference (IHC) (n=6), failure to thrive (n=3), visual disturbance/papilledema (n=3), seizure (n=2), prominent scalp and/or facial veins (n=2), head tilt (n=1), and cardiovascular/respiratory complications (1). Preprocedural imaging findings included: hydrocephalus (n=5), ventriculomegaly (n=4), anatomical sinus variant (n=4), venous sinus thrombosis (n=2), and bilateral subdural hematoma (n=1). ICVH was verified by transcatheter venous pressure measurement in four cases. The underlying vascular lesions leading to ICVH were subclassified into three groups: PVOC, AVS and IIH. Three cases were classified as PVOC including 2 cases of focal web-like stenosis of the dominant sigmoid sinus and 1 case of venous sinus thrombosis. Six cases of AVS included vein of Galen aneurysmal malformation (n=2), high-flow pial/dural AVF (n=2) and congenital high-flow torcular arteriovenous fistula (n=2) with one of the latter complicated by a secondary venous outflow obstruction. Two cases were consistent with IIH. The AVS group comprised younger patients (mean age: 2.6 months) and the most common clinical findings were IHC and hydrocephalus compared with headache, decreased visual acuity and papilledema in IIH. PVOC had a more heterogenous presentation with an overlap of presenting symptoms and signs with the AVS group (IHC and hydrocephalus) and IIH group (headache, papilledema). The endovascular treatment included multiple sessions of endovascular embolization, stent placement, and intra-arterial thrombectomy/thrombolysis depending on lesion type and was technically successful without perioperative complications in all cases.
Follow-up imaging and clinical outcome revealed significant improvement in intracranial venous drainage and remarkable clinical and developmental improvement except for one case.

Conclusions
Intracranial venous hypertension may be caused by primary outflow obstruction, arteriovenous shunting or idiopathic intracranial hypertension, with significant overlap of clinical presentations as well as hybrid lesions mandating a thorough endovascular work up. Whereas most lesions are amenable to endovascular therapy, the management of idiopathic intracranial hypertension remains controversial.

KEYWORDS: Intracranial Hypertension, Pediatric Brain, Venous Malformations

O-71 11:12AM - 11:19AM

Degree of Collateralization Predicts Symptomatic Cerebral Vasospasm Among Pediatric Patients: Correlation Between Angiography, TCD, and Clinical Findings.

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Purpose
Cerebral vasospasm is a significant cause of morbidity and mortality following subarachnoid hemorrhage (SAH). Although vasospasm has been investigated extensively in the adult population, minimal data exists about this phenomenon in the pediatric population primarily because vasospasm is rarely diagnosed clinically in children. We hypothesize that even though children have highly vasoreactive arteries, they rarely develop clinically evident symptoms of cerebral vasospasm due to robust cerebral collateral blood flow.

Materials and Methods
Retrospective review of our tertiary care hospital's neurointerventional radiology database and medical records was performed under an IRB-approved protocol. Thirty-seven children (21 boys) who presented with SAH (32 aneurysmal: Hunt Hess 1-5, Fisher 1-4 and 5 traumatic) under the age of 18 years (average age 11.8 years) were identified. Digital subtraction angiograms (DSA) were analyzed for degree of vasospasm based on luminal narrowing (none, mild (<30%), moderate (30-50%), or severe (>50%). To assess degree of collateralization in our vasospasm patients, we adapted a scoring system which has been established in ischemic stroke (Table 1) (1). Transcranial Doppler (TCD) ultrasound was correlated with DSA. Vasospasm on TCD was defined using established adult criteria (MCA ≥120 cm/s and Lindegaard ratio [(LR)>3, basilar artery ≥90 cm/s). Clinical outcome was assessed by the pediatric modified Rankin Scale (mRS) (2).

Results
Seventeen (46%) children demonstrated angiographic vasospasm (21% mild, 50% moderate, 29% severe). Only three children demonstrated symptomatic vasospasm and all three demonstrated poor collaterals (collateral score of 5). Ten (71%) of the asymptomatic children demonstrated some degree of collateralization (collateral score 1-4). All 5 five children with traumatic SAH demonstrated angiographic vasospasm. Sixteen children had TCDs that could be correlated with catheter angiography. Thirteen (81%) of these children demonstrated vasospasm by TCD criteria. Only one of these children demonstrated symptomatic vasospasm, however. In
12 instances that vasospasm was identified in a particular vascular territory by TCD criteria, there was no evidence of vasospasm in that vessel by DSA. Time to onset of vasospasm by TCD was 5+/-3 days (range 2-10). Twenty-five (68%) of children had good outcomes (mRS of 0-2) (average follow-up time 19.7 months).

Conclusions
Based on DSA, children appear to have a relatively high incidence of vasospasm, which often is moderate to severe in nature possibly due to their increased vasoreactivity as compared to adults. However, children rarely develop symptomatic vasospasm and have good long term outcomes, perhaps due in part to their robust cerebral collateral blood flow. Transcranial Doppler using adult criteria tends to overestimate the incidence of cerebral vasospasm in the pediatric population. Future studies with larger populations are needed to help define TCD vasospasm criteria for children.

KEYWORDS: Aneurysmal Subarachnoid Hemorrhage, Pediatric Cerebrovascular Disease, Vasospasm

| Table 1. DSA-Based Scale for Collateral Blood Flow in Pediatric Cerebral Vasospasm |
|-----------------|-------------------------------------------------|
| Score | Description |
| 1 | Collaterals reconstitute the distal portion of the narrowed segment |
| 2 | Collaterals reconstitute proximal portion of segment adjacent to narrowed segment |
| 3 | Collaterals reconstitute distal portion of segment adjacent to narrowed segment |
| 4 | Collaterals reconstituted two segments distal to narrowed segment |
| 5 | Little or no significant reconstitution of the territory served by the narrowed vessel segment. |

O-72

Semi-automated Computer Segmentation of Core Infarct Volume and Percentage of Infarcted Brain Parenchyma in Pediatric Acute Stroke: Developing Quantitative Metrics for Outcome Prediction

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Purpose
The purpose of this study was to quantify core infarct volume and percentage of infarcted brain parenchyma on diffusion-weighted imaging in the setting of acute infarct in pediatric patients and to compare these quantitative metrics with clinical outcome.

Materials and Methods
Twelve male and 11 female patients, (age range 0-17.6 years, mean age 4.6 years) presenting with acute stroke were included. Exclusion criteria (4 patients) included inadequate follow up,
inadequate imaging, prior infarction, and/or hemorrhagic transformation. Clinical follow up ranged from 0.8 to 19.3 months (mean 5.1 months). Clinical outcome was scored using the Pediatric Stroke Outcome Measure (PSOM). PSOM typically are scored as good (normal or mild deficit) and poor (moderate or severe). Validity of PSOM is not significantly affected when performed retrospectively (1-2). Using semi-automated computer-assisted segmentation, core infarct volumes and total brain parenchymal volume were quantified by a medical student, radiology resident, and neuroradiologist with CAQ. Core infarct volumes and percentage of infarcted parenchymal volumes were compared among patients with good and poor outcomes using Wilcox rank sum test. Linear regression analysis was performed comparing PSOM to core infarct volume and percent volume of brain infarction. Inter-rater reliability was assessed using intraclass correlation coefficient (ICC).

Results
The ACA was affected in 30.0% (n=7), the MCA in 91.3% (n=21) of patients, and PCA and vertebrobasilar system in 52.1% (n=12) of patients. Eighteen patients had poor outcomes, including five deaths, and five had good outcomes. Mean core infarct volume for the good outcome group was 7.4 cc, 95% CI (0-24.2cc) and 75.7cc, 95% CI (35.5cc-177cc) for the poor outcome group, which was statistically significant (p < .007). Mean percentage of infarcted brain parenchyma was 0.6% for the good outcome group (95% CI of 0-2.1%) and was 10.4% for the poor outcome group (95% CI 1.8-31%), which was statistically significant (p<0.006). There was a significant relationship between PSOM and infarct volume (p < .01) and percentage of brain parenchymal infarction (p < .04). Core infarct volumes greater than 32cc and percentage of infarcted brain parenchyma greater than 3% had poor outcomes in all cases. There was significant agreement between all the raters with an intraclass correlation coefficient (ICC) of 0.915 ( range 0.831-0.961), p<0.001.

Conclusions
Both core infarct volumes and percentage of infarcted brain parenchyma correlated with severity of outcome in pediatric acute infarct. Cut-off values above 32 cc for core infarct volume and 3% for percentage of infarcted brain parenchymal volume always were associated with a bad outcome.

KEYWORDS: Pediatric Brain, Stroke

O-73

Brain Maturation is Delayed in Fetuses with Congenital Heart disease

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Purpose
Congenital heart disease (CHD) is the most common birth defect. Brain injury and long term neuropsychological sequelae are common in children with complex congenital heart disease. Often these injuries are similar to the injuries seen in the immature brains of preterm neonates despite being born at term. Previously, it has been shown that infants with CHD have delayed
brain maturation compared to normal newborns and brain immaturity is an important
independent risk factor for brain injury in these patients. The purpose of this study was to assess
prenatal brain maturation in fetuses with complex CHD in the second half of pregnancy.

Materials and Methods

Fetal brain maturation was assessed by MR imaging (MRI) in 46 fetuses with CHD and
compared to 48 normal controls. No fetus with a brain malformation or focal detectable
abnormality was included in the study. A previously validated semiquantitative fetal total
maturation score (fTMS) based on fetal brain MRI was utilized. The fTMS assesses fetal cortical
sulcation in the frontal and occipital regions, insula, and temporal lobes, the degree of fetal brain
myelination, and evolution of the germinal matrix, providing a single combined numerical value
as a marker of brain maturity. Intraclass correlation coefficient was calculated to assess inter-
rater reliability of the two independent and blinded readers. Linear regression analysis of fTMS
versus gestational age was performed in the two groups and compared by an F test. Subgroup
analysis also was performed for fetuses with the diagnosis of transposition of the great arteries
and hypoplastic left heart syndrome as these two groups have a relatively high incidence of
postnatal brain injury.

Results

The fetuses ranged from 25.1 to 36.7 weeks gestational age (median 29.0 weeks). The intraclass
correlation coefficient for the readers was 0.89. Regression plots were constructed for normals
(adjusted R2=0.94, p<0.001) and fetuses with CHD (adjusted R2=0.91, p<0.001). Statistical
comparison of the regression analyses revealed that fetuses with CHD had a slower rate of brain
maturation compared to healthy control fetuses (p<0.001). The digression of the brain maturation
trajectories started in the beginning of the third trimester. There was no difference in fetuses with
transposition of the great arteries and hypoplastic left heart (p=0.31).

Conclusions

Brain maturation is delayed in fetuses with congenital heart disease compared to healthy
controls, even in those without overt brain abnormalities, starting as early as the beginning of the
third trimester. Future therapeutic trials aimed at prevention of brain injury in CHD should
probably start during the fetal period.

KEYWORDS: Fetal Brain Development, Fetal Brain Injury, Fetal MR Imaging

O-74

Susceptibility-weighted imaging in predicting neurodevelopmental outcome of early
childhood in neonatal hypoxic ischemic injury after hypothermia therapy

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Purpose

Susceptibility-weighted imaging (SWI) is a high-spatial-resolution, 3D, fully velocity
compensated, gradient-echo magnetic resonance imaging (MRI) technique which accentuates the
magnetic properties of blood, blood products, non-heme iron and calcification. The blood
oxygen level dependent (BOLD) venography principle in SWI determines the signal intensity and prominence of the veins: veins draining critically perfused brain regions are more prominent/hypointense due to increased oxygen extraction fraction and increased deoxyhemoglobin in the sulcal, subependymal and intramedullary veins. Hypoxic-ischemic injury (HII) occurs in 1-6/1000 live full-term newborns and carries a high-risk for subsequent neurodevelopmental disabilities. In neonatal HII, biomarkers for long-term neurodevelopmental prognosis are needed. In this preliminary study, we aim to study the role of SWI as a potential biomarker for HII. We hypothesize a correlation between hypointensity and prominence of veins on neonatal SWI and neurodevelopmental outcome at two years of age.

Materials and Methods
Inclusion criteria for this retrospective study were: neonates with HII and hypothermia therapy, SWI dataset in postcooling MRI and measurement of neurodevelopmental outcome at two years of age. Intubation and ventilation during MRI was an exclusion criterion. Susceptibility-weighted imaging acquisition parameters were: TR 49 ms, TE 40 ms, flip angle 15°, bandwidth 80 kHz, slice thickness 1.2 mm, FOV 201x230, matrix size 320x221, iPAT factor of two and axial minIP thickness accounts for 9.6 mm (8 slices). The prominence of intramedullary, sulcal and subependymal veins were graded for severity as: grade 0 = normal (healthy term neonate), grade 1 = mildly prominent and grade 2 = markedly prominent. Neurodevelopmental assessment using the Mullen Scales of Early Learning was conducted with all surviving children between 20 and 32 months. Statistical analysis with Spearman Rho was performed to correlate SWI grading with individual Mullen score criteria.

Results
Seven boys and seven girls with mean gestational age of 39 weeks (range: 37-41 weeks) and MRI performed at a mean postnatal life of 8.3 days (range: 4-14 days) were included. A significant correlation between higher hypointensity/prominence of subependymal veins and a lower standard Mullen score (p=0.014) as well as lower Mullen scores for visual reception (p=0.026) and expressive language (p=0.009) was identified. A positive correlation between severity of grading of sulcal veins and Mullen score for gross motor outcome also was noted.

Conclusions
Our preliminary data suggests that neonatal SWI (particularly hypointensity/prominence of subependymal veins) may play a role as a biomarker for neurodevelopmental outcome in neonates with HII and hypothermia therapy. Subependymal veins drain basal ganglia and thalami that have been shown to play a role in visual reception and expressive language in other neurological disorders. The positive correlation between prominence of sulcal veins and gross motor score remains unexplained. Further studies including a higher number of patients are needed to corroborate our results.

KEYWORDS: Hypoxia, Outcome, Susceptibility-Weighted Imaging

O-75

Pallidal Index: A Potential Predictor of Motor Outcome in Hypoxic Ischemic Encephalopathy

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Purpose
To determine the value of Pallidal Index (PI) in predicting motor outcome in newborns with hypoxic ischemic encephalopathy (HIE).

Materials and Methods
Infants with clinical diagnosis of HIE who were born at or referred to a tertiary Children's Hospital in 2010 and 2011 were selected for this retrospective study. Bayley scores documented by a pediatrician were retrieved from the patients' charts. Those who expired early, or had no Bayley scores available were excluded. Brain MR imaging (MRI) of the remaining 27 newborns were reviewed. Pallidal index was measured for each scan using axial T1-weighted images. Pallidal index was defined as the ratio of the signal intensity in the medial aspect of the right globus pallidus over the signal intensity of the right frontal subcortical white matter. Measurements of the signal intensity were performed using institutional image viewer, by drawing small regions of interest. Regression analysis was performed to assess correlation between the PI and sum composite scores for motor, language, or cognitive development in cooled and not cooled groups separately. The relationship between the PI and history of anticonvulsant therapy in the newborns also was evaluated.

Results
Twenty-seven MRI scans were reviewed (20 status postcooling; average gestational age: 38.5 weeks; average age at the time of MRI: 6.6 days). The mean PI was 1.63 (SD=0.24). Lower PI was associated with higher Bayley motor score in the cooled group (P value = 0.04). There was no such significant correlation in newborns without cooling. There is no significant correlation between the PI and cognitive or language Bayley scores. The preliminary analysis of our data demonstrates lower PI in babies treated with anticonvulsant therapy.

Conclusions
Pallidal index, although originally introduced to be used in metabolic encephalopathies, correlates with Bayley composite motor score as an index of motor outcome in newborns with HIE. Therefore, PI should be considered as a potential predictor of motor outcome in HIE. In our preliminary analysis, newborns with prior anticonvulsant therapy had lower PI, which is an interesting observation worthy of further investigation in larger number of cases.

KEYWORDS: Encephalopathy, Globus Pallidus, Hypoxia
Pediatric Intracranial Aneurysms: A Spectrum of Underlying Pathological Conditions and Presentations in 15 Patients

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Purpose
Intracranial aneurysms (IA) are rare in the general pediatric population and account for less than 2% of all cerebral aneurysms. Of the over 700 reported cases of pediatric aneurysms, the most common presentation is subarachnoid hemorrhage (80%) and the most common location is the internal carotid artery terminus. The purpose of this study was to describe the spectrum of
underlying pathological conditions and clinical presentations in pediatric patients with intracranial aneurysms.

Materials and Methods
A retrospective review of the author’s prospectively collected pediatric cerebral angiography database from July 2010 to October 2013 was performed. All pediatric patients with cerebral aneurysms (fusiform, saccular, and pseudoaneurysms) were included. Medical records were reviewed for age, gender, past medical history, clinical presentation, and treatment plan.

Results
From July 2010 to October 2013, 117 children underwent diagnostic or therapeutic cerebral angiograms. Of these, 15 children (7 boys and 8 girls), from 15 days to 19 years, had a total of 32 intracranial aneurysms. Clinical presentation was varied: subarachnoid hemorrhage (n = 3), stroke (n = 1), headache (n = 2), post-traumatic (n = 2), feeding artery aneurysm for AVM (n = 1), incidental finding (n = 6). Underlying pathologies: sickle cell disease (n = 6), transcarbamylase deficiency (n = 1), AVM (n = 1), no significant past medical history (n = 7). Two patients underwent coil embolization. Two patients underwent surgical aneurysm clipping. The other eleven patients were managed conservatively with stability of their aneurysms documented by regularly scheduled MRI/MRAs and/or DSA.

Conclusions
Pediatric intracranial aneurysms are rare. Unlike the majority of cases reported in the literature, an increasing number of aneurysms are being detected as incidental findings in a number of underlying disease pathologies.

KEYWORDS: Aneurysm
Osseous Intramedullary Signal Alteration and Enhancement in Sturge-Weber Syndrome: An Early Diagnostic Clue

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Purpose
Sturge-Weber syndrome (SWS) is a sporadic phakomatosis with variable intracranial involvement. The full disease spectrum is typified by a facial nevus flammeus, ipsilateral choroidal angioma, and ipsilateral leptomeningeal angiomatosis of varying severity. Over time, imaging manifestations often evolve toward cerebral hemiatrophy and compensatory hemicalvarial enlargement known as the Dyke-Davidoff-Mason syndrome. However,
recognizable imaging correlates may be lacking early in the disease process and in milder phenotypes. We have observed bone marrow signal changes to be quite prevalent across all SWS disease durations and phenotypes. The purpose of this study is to evaluate the presence and extent of bone marrow signal abnormalities and enhancement in patients with Sturge-Weber syndrome.

Materials and Methods
The Montage brain MR imaging database at a single academic children's hospital was queried for the term "Sturge-Weber" to build a cohort for retrospective analysis. The electronic medical record for each patient was reviewed for the presence of a Sturge-Weber syndrome diagnosis. All relevant clinical information was collected. Images from each SWS patient's brain MR were reviewed by a board certified neuroradiologist. Bone marrow volume, signal, and enhancement patterns were specifically evaluated.

Results
A total of 20 brain MR exams from different SWS patients, with a mean age of 4.8 +/- 5.8 years (range 6 months - 16 years) met inclusion criteria. In all patients exhibiting a port wine stain (18/20), leptomeningeal enhancement, bone marrow T2 prolongation, and/or marrow enhancement was present ipsilaterally. Leptomeningeal enhancement was only present in 50% of all patients. However, 80% (16/20 patients), had unilateral bone marrow abnormalities (T2 prolongation and/or enhancement). In 35% (7/20 patients), unilateral bone marrow abnormalities occurred without accompanying leptomeningeal angiomatosis. The age of these patients were all < five years (6/7 < 2 years).

Conclusions
Bone marrow signal abnormality and enhancement is common ipsilateral to the nevus flammeus in Sturge-Weber syndrome. As this may be the sole brain MR abnormality in some patients, it may reflect mild SWS phenotypes or early disease manifestations prior to visible leptomeningeal angiomatosis. Adjunctive fat saturation techniques should be considered for bone marrow evaluation on brain MR work up in these patients.

KEYWORDS: Angioma, Bone Marrow, Phakomatoses
TBI in children is one of the leading causes of childhood morbidity and mortality. Injuries can be divided by severity into mild, moderate, and severe cases. Mild TBI accounts for approximately 80% to 90% of all TBIs. Although long-term neurocognitive deficits are rare following mild TBI, children with mild TBI are more likely to display post concussive symptoms (PCS) than children with other types of injuries (1). Mild TBI was defined as head injury producing a Glasgow Coma Scale (GCS) of 13-15. Children are awake, may be confused but can communicate. However, studies showed that up to 40% of patients with an initial GCS of 13 had abnormal CT scans and 10% required neurosurgical treatment with outcome similar to moderate TBI. The accepted definition includes patients who have a GCS of 14-15 at initial presentation. In preverbal children a modified scale is used (2, 3). CT is recommended in children younger than 2 years who present altered mental status, palpable skull fracture, scalp hematoma, loss of consciousness (LOC), severe mechanism of injury, or not acting normally. Repeated vomiting,
posttraumatic fit, and bulging tense fontanel are also clinically important to CT (4-7). In patients older than 2 years CT is recommended in patients with altered mental status or signs of basilar skull fracture. CT is also often performed in patients with history of LOC, vomiting, severe mechanism of injury, or severe headaches. CT scanning is the investigation of choice for patients with mild TBI at presentation to detect underlying pathology and the presence of surgically defined lesions that require neurosurgical treatment or hospitalization in the neurosurgical centre. MRI is not performed in all cases of mild TBI, but in selected cases because of neurologic symptoms after 2 days of follow up. Symptoms include subtle and nonspecific clinical signs as dizziness, worsening headaches and seizures. Because these symptoms may be delayed (15 days to 1 month), clinical follow up after discharge from the hospital is done at 3 weeks (or early). In the presence of such symptoms MRI is recommended to look for diffuse axonal injury (DAI). MRI protocol includes susceptibility weighting imaging, diffusion weighting imaging and tensor diffusion imaging (8-10). Spectroscopy is also reported. A group of older patients with frequent concussion injuries (football, ice hockey and soccer players) for several years has emerged in the past years. Structural changes are seen on brain imaging. MRI with advanced techniques is mostly performed in research setting (11).

O-79

Abusive Head Trauma

Silvera, V.
Boston Children's Hospital
Boston, MA

Abstract/Presentation Summary
In young children, traumatic CNS injury is a leading cause of morbidity and mortality. In the United States, the incidence of abusive head trauma in children less than 2 years of age is estimated to be 17/100,000 person–years.1 Classically, infants with abusive head trauma will present withretinal hemorrhages, subdural hematomas and encephalopathy. External signs of trauma are absent in as many as 50% of cases.2The history provided by the caretaker is often not reliable and will typically change over time or may be developmentally incompatible with the child's age. Radiographs, CT and MRI play an important role in the assessment of children with abusive head trauma. Skull radiographs and CT are most sensitive for detecting skull fractures and intracranial hemorrhage, 3 while MRI is sensitive in the detection of hypoxic ischemic injury and white matter contusional tears.4 Hypoxic ischemic injury is often multifocal and in a non-arterial vascular distribution. Subdural hematomas, considered hallmark findings in infants with abusive head trauma, are most commonly located within the interhemispheric fissure and over the cerebral hemispheres.5 The appearance of subdural hematomas in these children is highly variable and may be challenging to interpret in regard to the timing of the subdural hemorrhage. 6 In regard to outcome, 7-30% of children with abusive head injury die, 30-50% suffersignificant cognitive or neurological deficits, and 30% have a chance for full recovery. 7 In fatal cases of abusive head trauma, the cause of death is most commonly increased intracranial pressure related to severe brain edema. In this presentationattention will be focused on head imaging patterns that are most suggestive of abusive head trauma, the temporal evolution of imaging findings, and challenges related to dating of subdural hematomas.
Clinical Management Directions in Mild TBI

Meehan, W.
Boston Children's Hospital
Boston, MA

Abstract/Presentation Summary

Recent studies have shown a 4 fold increase in the incidence of diagnosed concussions sustained by high school athletes, and a 2-3 fold increase in the number of emergency department patients diagnosed with concussion. Approximately 23-30% of all pediatric patients diagnosed with a concussion in the emergency department sustained their injury during sports participation. The CDC estimates that as many as 3.8 million sport-related traumatic brain injuries occur each year, the vast majority of which are concussions. Concussion is caused by a rapid spinning or rotational acceleration of the brain. Biomechanical forces that result in a rotational acceleration of the brain and impart a shear strain on the underlying parenchyma, induce the signs and symptoms of concussion. The leading hypothesis regarding the pathophysiology of concussion suggests that this shear strain results in deformation of the axonal membrane, leading to a massive influx of sodium and calcium, and a corresponding efflux of potassium. An unorganized depolarization of neurons ensues, causing a spreading depression-like phenomenon, with the release of excitatory amino acids such as glutamate. The sodium-potassium pump works to returns sodium to outside of the axonal membrane, a process which requires adenosine tri-phosphate (ATP). Given the large disruption of ionic gradients, large amounts of ATP are required. ATP is derived from glucose, delivered by blood flow to the neurons. For a period of days to weeks after concussion, however, there is decreased blood flow to the brain. Thus, there is an inadequate supply to meet the increased demand for ATP, and this supply-demand mismatch is thought to result in the prolongation of concussion symptoms. Concussion are assessed by using symptom inventories, standardized balance assessments, and neurocognitive evaluations, either computerized or in person with a neuropsychologist. Once it has been established that an athlete has sustained a concussion, and other potential concomitant injuries have been addressed or ruled out, treatment may begin. The foundations of treatment begin with physical and cognitive rest. Most athletes recover quickly from concussions, in a matter of days to weeks. Studies show that well over 90% of collegiate and high school athletes that sustain a sport-related concussion have full resolution of their symptoms and are deemed recovered by medical personnel within a month. Thus, physical and cognitive rest is often the only treatment required for the vast majority of athletes suffering sport-related concussions. If symptoms persist beyond a month, referral to a clinician specializing in the management of concussions should be considered. Such clinicians can offer a thorough assessment for other potential contributing etiologies and therapies for prolonged headaches, sleep disturbance, vestibular dysfunction, mood disorders, and cognitive difficulties. Once recovered, athletes are gradually returned to their sports, starting with light aerobic activity, and progressing in a stepwise fashion through the return-to-play stages outlined by the international consensus on concussion in sport, so long as they remain symptom free.
Abstract/Presentation Summary
The visual pathway begins in the globe, where light makes its initial encounter, and includes sequentially the cornea, aqueous humor, lens, vitreous humor, and retina. It continues with the optic nerve, optic chiasm, optic tract, lateral geniculate nucleus of the thalamus, finally reaching the occipital lobe via the optic radiation. Abnormalities of the globe are frequently diagnosed clinically by ophthalmologists, with imaging playing a secondary though sometimes important and confirmatory role especially in the setting of trauma or a congenital anomaly. Optic nerve abnormality is usually suspected based on the classic clinical findings of visual field defect, dyschromatopsia, and afferent pupillary defect, but requires imaging evaluation for more precise delineation and characterization of the pathology, as well as for search of a potential underlying cause. As an example, MR imaging can confirm the presence of optic neuritis, but in addition may demonstrate white matter lesions in the brain suggesting to the clinician the diagnosis of a demyelinating disease. MR imaging can also distinguish between the more common causes of visual loss related to the optic nerve seen in adults, namely optic neuritis, optic nerve atrophy, and compressive optic neuropathy from a perioptic meningioma. Disturbance of the optic chiasm produces the infamous bitemporal hemianopsia. Here, imaging again plays an important role in assessment for any pituitary or suprasellar lesion. Symptoms pointing to lesions affecting the optic radiation or occipital lobe require imaging evaluation for a parenchymal lesion in the brain. In this presentation, the role of radiology in the evaluation of more common pathologies involving the globe, optic nerve, and optic chiasm is explored, including discussion of important associated findings that should be included in the radiologist's checklist and noted in our reports.
Abstract/Presentation Summary
This presentation will have greater discussion directed to the parotid glands as the most frequently directed salivary imaging request and will emphasize mass lesions and their variable imaging presentations, with limitations as to their benign vs. malignant character. Comments will include solitary/ multiple/ diffuse and cystic lesions and include non-neoplastic entities (congenital) with limited discussion of obstructive salivary disease, with proportionate emphasis on the more common parotid masses or those lesions with characteristics allowing identification such as recurrent pleomorphic adenoma and carcinoma ex pleomorphic adenoma. Implications re character of the parotid capsule and its late encapsulation will be mentioned. Perineural tumor spread emphasizes the need to fully assess a proper field of study and not just the primary space of the involved salivary gland. Only 20% of parotid masses are malignant yet diligence to detect the malignant nature/ extent or to suggest tissue sampling or further follow up studies, or consider a role apparent diffusion coefficient (ADC) mapping of salivary gland tumors may play. Submandibular gland discussion includes mass lesions, benign and malignant, clues to the nature of the mass/ whether the mass arises within or external to the gland. Abutting nodal adenopathy, especially lymphoma or nodal SCCa metastasis, need to be differentiated from a primary SMG neoplasm. Primary SMG malignancy occurs in 45-50% of SMG neoplastic masses (usually Adenoid Cystic Ca (ACCa), mucoepidermoid ca (MEC) or adenoca (AdCa). Masses centered within the SMG invading adjacent tissues suggest malignancy. Main differential from malignant SMG mass includes pleomorphic adenoma (BMT), sialadenitis, SMG mucocele. Sublingual gland lesions, as with SMG masses, require attention because of likelihood for malignancy, recent data having SLG tumors approaching 80% malignancy rate. As with SMG masses, adjacent adenopathy favors mucoepidermoid carcinoma while perineural spread favors adenoid cystic ca. Hematogenous spread (usually lungs) favors ACCa. Main differentials include carcinoma of the FOM (usually clinical diagnosis), venolymphatic malformation and ranula. Dehiscence of the mylohyoid muscle, extension of the SLG into the submandibular space is discussed. Minor salivary gland tumors include lesions arising within the oral cavity/oropharynx, nasopharynx and sinonasal cavity. This presentation will be practical, includes common salivary gland pathologies but also pitfalls in diagnosis by misinterpretation of anatomic landmarks or limitations by the imaging modality chosen.
Monday
1:00PM - 2:30PM
Palais des congres de Montreal, 517a

15 - GENERAL PROGRAMMING: PAIN AS A BRAIN DISEASE: NATURE VERSUS NURTURE

Pain and Brain Structure and Function

Prabhakaran, V.
University of Wisconsin-Madison
Madison, WI

Abstract/Presentation Summary
In the United States, the prevalence of chronic pain has been estimated to be approximately 30% and about 116 million Americans are living with chronic pain (Debono et al., Institute of Medicine). Neuroimaging using fMRI can help elucidate the mechanisms underlying pain (Tracey and Bushnell, 2009) and several studies have shown altered cerebral processing due to either experimentally induced or disease-related pain in different patient groups (fibromyalgia, irritable bowel syndrome, chronic back pain etc.). Functional MRI (fMRI) has helped to identify brain regions underlying the experience of pain and dissected these into anatomically distinct activities of different functional systems (e.g. somatosensory, limbic systems)(Tracey, 2005). This has clinical significance because it identifies distinct targets for therapeutic modulation. fMRI can capture the variability of responses even on a single subject level; for example, inter-individual differences in pain responses can be found in the primary somatosensory, anterior cingulate and prefrontal cortices (Coghill et al., 2003). In this review, I will focus on the brain regions associated with pain processing, modulation of activity in these regions due to manipulations that reduce pain perception, and alterations in functional connectivity due to chronic pain.

fMRI Biomarkers of Pain

Wager, T.
University of Colorado at Boulder
Boulder, CO

Abstract/Presentation Summary
Brain-based biomarkers for pain and distress have the potential to transform the study of affective processes in health and across disorders. Human neuroimaging plays a unique role in this process, by creating a bridge between neurophysiological systems that can be studied mechanistically and mental phenomena. Though neuroimaging data are routinely interpreted as though they were biomarkers, they are not, because they are often poorly defined and their sensitivity and specificity to particular mental phenomena is not characterized. I describe recent
efforts to develop a biomarker for acute somatic pain based on patterns of fMRI activity, which we term the "neurologic pain signature" (NPS). Across studies, the NPS has over 90% sensitivity and specificity for pain on a per-person basis compared with other salient somatic and emotional events. It can be applied to existing and new fMRI datasets, accelerating the development and testing cycle. I demonstrate how the NPS may be used to compare pain treatments at the neurophysiological level and provide a beginning point for deconstructing "pain" as a unitary experience. Finally, I present data suggesting that it may be possible to develop fMRI-based "signatures" for multiple types of affect, providing new markers for study across disorders.

O-86
Structural Abnormalities in Migraines
Filippi, M.
San Raffaele Scientific Institute, Vita-Salute San Raffaele University
Milan

Abstract/Presentation Summary
In the past few years, the application of magnetic resonance imaging (MRI) techniques to study patients with migraine has changed our view of migraine from primarily a vascular disorder to a neurovascular disease and currently to a central nervous system (CNS) disorder. Abnormal function of key brain areas and networks, mainly involved in pain processing, has been shown to occur in the brain of migraineurs. Numerous conventional MRI studies have described an increased risk of harbouring white matter hyperintense lesions in migraineurs, that might be influenced by headache frequency, disease duration and the presence of aura. The application of modern MRI techniques has also revealed diffuse structural abnormalities of the brain gray and white matter. Specifically, the involvement of key brain areas and networks, mainly involved in pain, visual and sensorymotor processing, has been shown to occur in the brain of migraineurs. In addition, the application of morphometric techniques is contributing to identify the structural correlates of some of the clinical deficits that are typically detected in migraineurs in clinical practice. All of this is critical not only to improve the understanding of migraine pathophysiology, but also to characterize better its heterogeneous clinical manifestations, and to develop imaging biomarkers to be applied in treatment trials of new experimental drugs.

Monday
1:00PM - 2:30PM
Palais des congres de Montreal, 520

16 - YOUNG PROFESSIONALS PROGRAMMING: HEALTH CARE REFORM EDUCATION AND UPDATE
O-88
Political Advocacy for the Neuroradiologist
Turski, P. · Tu, R.
University of Wisconsin · Progressive Radiology
Madison, WI · Washington, DC

Abstract/Presentation Summary
The presentations will provide an overview of the opportunities for neuroradiologists to advocate for their specialty through the American Society of Neuroradiology (ASNR), the American College of Radiology (ACR) the American Medical Association as well as local and national organizations. Dr. Turski is past Chair of the ASNR Health Policy Steering Committee which oversees the Quality, Safety and Value Committee, the Economics Committee and the Standards and Guidelines Committee. Dr. Turski will review the activities and personnel associated with each committee. A case example will be presented demonstrating how Dr. Turski became a political advocate for neuroradiology when magnetic resonance angiography was introduced into clinical practice 25 years ago. He will further use this example to explain the relationship of AMA CPT Codes, AMA Relative Value Units, ACR standards and Guidelines, ACR Appropriateness criteria and the coordination between the ASNR Health Policy Committee and the ACR Neuroradiology Commission. Dr. Tu is a radiologist in Washington, DC. He is Clinical Associate Professor of Radiology at The George Washington University in Washington DC, Chairman of Radiology at United Medical Center and Partner of Progressive Radiology, the largest physician owned imaging company in the State of Maryland. Dr. Tu is a native Washingtonian and will share his story how his involvement in local life in the District of Columbia brought insight and access to health policy from the local to national scene. As the sole radiologist to have served on the DC Board of Medicine during his tenure, ACR Chapter President, hospital Chairman, Chair of the ACR Medicaid Network and ASNR Advisor to CPT his dedication to public service Dr. Tu will show how he did it.

O-89
1:40PM - 2:20PM

Healthcare Reform Impact on Neuroradiology

Bello, J.
Montefiore Medical Center
Bronx, NY

Abstract/Presentation Summary
This presentation will attempt to decipher the "alphabet soup" that comprises the undercurrent within the stormy sea of Healthcare Reform. The underpinnings of Healthcare Reform will be addressed from a recent historical perspective. Contributing components of the reimbursement cycle will be defined, including the Current Procedural Terminology (CPT) and Relative Value Update Committee (RUC) processes. Their relative importance and relationship to CMS will be described. Radiology's position in today's challenging and changing climate of healthcare reform will be analyzed; potential future roles for Radiology in alternative delivery models will be explored. Neuroradiology's current status in organized medicine will be discussed, including ASNR's involvement in both the AMA and ACR. A summary of recent legislative challenges will be presented and ongoing advocacy efforts will be reviewed. Strategies for protecting our profession will be suggested, including the need to integrate radiology and stewardship into the
undergraduate medical curriculum at an early stage, and to include healthcare policy and economics within our graduate medical education curriculum. Emphasis will be placed on the importance of being or becoming involved.

Discussion

Monday
1:00PM - 2:30PM
Palais des congres de Montreal, 524

17 - PARALLEL PAPERS: Adult Brain: Structural and Functional Imaging
O-90
1:00PM - 1:07PM

Music and the Brain: fMRI Activation Patterns of Classical and Rap Music

Y. Safriel

\(^{1}\)Radiology Associates of Clearwater/University of South Florida, Belleair Beach, Florida

Purpose
Music therapy has been used successfully in rehabilitation by health care professionals. Athletes and performers also use music to prepare for events. While the effects of music and music therapy have been published, the activation pattern, connectivity and mechanism of action is not completely understood. As part of a pilot study evaluating the effect of different types of music on patients and performance athletes, we compared the activation pattern of two markedly different types of music.

Materials and Methods
Review Board approval was obtained. Volunteers between the age of 25 and 49 were recruited. Eight subjects were scanned, two females and six males. BOLD acquisition was obtained with the subjects listening to two separate paradigms each comprising 5 cycles of 30 seconds of active/rest (green/red on attached figure respectively). The first paradigm was classical music (Violin Concerto #5 in A, WA Mozart, Berlin Philharmonic, Deutsch Gramophone) and the second paradigm was rap music (Low, Flo Rida, Mail on Sunday, Atlantic and Poe Boy). The rest state was 30 seconds of silence. Prior to BOLD scanning, 3D volumetric acquisition and GRE field map of the head was obtained. BOLD functional MRI (fMRI) was performed on a Siemens 3 T Trio using standard parameters that also are used for presurgical evaluation. Images were analyzed using the in-line workstation (Leonardo, Siemens, Germany) with a visually supervised measurement routine.

Results
There were striking differences in activation for both 'music' (active) and 'silence' (rest) between
the classical and rap paradigms. Rap music showed strong activation in the auditory cortex symmetrically bilaterally. Classical music showed activation in similar areas but of markedly lesser magnitude. The silent state was similar for both paradigms and significantly less than the active state.

Conclusions

Functional MRI shows striking differences between classical and rap music. This information may have impact on music therapy and the type of music played to patients during MRI, amongst other implications. Future study directions include defining the connectivity related to various types of music and evaluation of variations of measurements between different pieces in the same music type.

KEYWORDS: FMRI, Functional Connectivity MR, Functional Networks

Identification of the hand motor cortex: comparison of structural imaging with functional MR imaging and corticospinal tractography
Purpose
Identification of the central sulcus for localizing primary motor cortex is crucial in presurgical planning for brain lesions in proximity; however, localization of this region based on morphologic features is not always straightforward. Normal anatomical variations, mass effect from space-occupying lesions, and congenital malformations such as cortical dysplasias can create uncertainty. In addition, reorganization can occur with chronic injuries and slowly progressing pathology. The purpose of this study was to compare the accuracies of different methods for identification of primary motor cortex based on structural MRI as compared to functional MR imaging (fMRI) and diffusion tensor imaging (DTI) fiber tracking of the corticospinal tract (CST) in the involved and contralateral hemisphere of patients with brain lesions.

Materials and Methods
Fifty-five patients (22 men and 33 women; mean age: 54.5 years) with brain lesions and prior MRI with motor fMRI were identified for this HIPAA-compliant retrospective study. At least one motor task for each fMRI was available in 109 hemispheres. Diffusion tensor imaging fiber tracking of the CST was available in 86 hemispheres. Three different methods were used to define the central sulcus on 3D MPRAGE T1-weighted sequences for structural analysis: (1) following the typical course of the superior frontal and precentral sulci (the axial method), (2) identification of the typical shape of the motor hand area (the precentral knob), and (3) difference of cortical thickness in precentral gyrus. One radiologist with 10 years of experience applied each method in all hemispheres and a confidence rating was assigned to each method, using a 5-point scale. Concordance between structural analysis and fMRI and DTI fiber tracking was assessed by two neuroradiologists with 13 and seven years of experience after training.

Results
All three structural anatomical localization methods could be applied to all hemispheres, except for two failures using the axial method secondary to anatomical variation. On fMRI studies, task-related activation localized central sulcus with high confidence in all but six hemispheres. Tracking of CST identified the central sulcus in all 86 hemispheres, concordant with fMRI. Central sulcus identification based on cortical thickness was the most accurate method, with the highest confidence rating (mean score: 4.99) in 100% of the patients. Precentral knob morphology also permitted the recognition of the central sulcus in all of the patients, but confidence rating (mean score: 4.7) was lower. The axial method was least accurate (mean score: 4.35).

Conclusions
The difference in cortical thickness across the central sulcus is a reliable anatomical landmark for identification of the precentral gyrus as compared to localization with fMRI and DTI fiber tracking; however, cases of decreased confidence or failure also occur with fMRI and DTI fiber tracking and thus structural assessment remains complimentary to these techniques. In addition, localization of specific motor functions is not sufficiently accurate based on anatomical landmarks and requires fMRI, especially when anatomical landmarks are distorted or...
reorganization may have occurred. Functional MRI and DTI fiber tracking improves the confidence and efficiency of presurgical planning in patients with brain lesions.

KEYWORDS: Diffusion Tensor Image, FMRI, Glioma

O-92

1:14PM - 1:21PM

The Effect of Hyperbaric Oxygen Treatment on Resting State Networks

M Allen1, J Davidson2, J Davidson2, M Benzaquen2, B Ances1, T Benzinger3, J Rutlin1, MBrier4, E Leuthardt1, J Shimony1

1Washington University, Saint Louis, MO, 2St Luke's Hospital, Chesterfield, MO, 3Mallinckrodt Institute of Radiology/Washington University, Saint Louis, MO, 4Washington University in St. Louis School of Medicine, Saint Louis, MO

Purpose

Hyperbaric oxygen (HBO) treatment is an established method to improve wound healing in the extremities by stimulating angiogenesis. A similar effect in the brain has not been well established. Resting-state functional magnetic resonance imaging (rsfMRI) has been used to reliably identify and study resting state networks (RSN) in the brain. The purpose of this project was to evaluate if HBO treatment can help patients with chronic cerebral small vessel disease (CSVD) by measuring changes in connectivity of RSN.

Materials and Methods

Twenty patients >50 years of age with chronic cerebrovascular disease were recruited from the community. Patients were scanned using rsfMRI before and approximately four weeks after they were treated with hyperbaric oxygen therapy. Subjects were treated in Sechrist Monoplace Hyperbaric Chambers at a pressure of two atmospheres absolute for 45 minutes using 100% oxygen. Subjects were given 10 treatments over a span of two weeks (5 treatments per week). Twenty age-matched controls and 17 young adult healthy controls were selected from other ongoing studies at our institute. Resting-state fMRI preprocessing was performed using standard methods. Thirty-six regions of interest associated with the following RSN were selected for analysis: Default Mode (DMN), Dorsal Attention (DAN), Control (CON), Salience (SAL), and Somatomotor (SMN). The correlation matrix between all regions was calculated and transformed using the Fisher z-transform to obtain normal distributions. The internetwork and intranetwork connectivity for these five RSN was measured and compared across groups.

Results

The figure demonstrates the changes in the different intranetwork connectivity across the groups. The intranetwork connectivity of all five RSN in the young control group was highest of all and decreased in the elderly normal controls in all networks, except for the SMN network, which increased slightly. In every network, the connectivity decreased in the elderly patients with CSVD. The connectivity in this group of patients shows improvement after HBO therapy in each of the five networks.

Conclusions

Resting-state networks can be used to monitor treatment of disease in the brain, and the current study provides preliminary evidence that HBO treatment can be used to improve RSN connectivity in patients with CSVD.
RESTING STATE NETWORKS (rs-fcMRI) in HIV ASSOCIATED NEUROCOGNITIVE DISORDER (HAND) AND CORRELATION WITH BLOOD BRAIN BARRIER DISRUPTION AND MR SPECTROSCOPY

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Purpose
Resting-state functional connectivity could be a sensitive marker for neurocognitive impairment in HIV-associated neurocognitive disorder in the era of highly active antiretroviral therapy and may provide an understanding to the association of the accelerated aging in HIV.

Materials and Methods
We used resting state fMRI study to measure the intermodal and intranodal connectivity among five functional brain networks in 30 HIV-infected participants who are on highly active antiretroviral therapy and seven age- and sex-matched healthy volunteers. We compared the results with the blood-brain barrier integrity and neuronal integrity measures by MRS and plasma and CSF viral load.
Results
The HIV-infected patients demonstrated decreased rs-fcMRI intra network correlations in the salience networks (SN), default mode networks (DMN), control networks (CN) and dorsal attention networks (DAN) while sensorimotor network (SMN) showed no significant change. Internodal correlation demonstrated reduced correlation between DMN-DAN as well as DMN-SAL while there appears to be a trend in increase between the CN-SAL and CN-SMN. Correlative studies with plasma and CSF viral load as well as CD-4 count did not show any correlation with rs-fcMRI results. There is a trend towards positive correlation with disrupted blood-brain barrier and neuronal loss on spectroscopy.

Conclusions
HIV-associated neurocognitive disorder could be a causative factor in decrease in the rs-fcMRI and appear identical to the age-associated cognitive decline. Reduced neuronal integrity and blood-brain barrier disruption could be contributory/comorbid factors for affection of the resting state networks.

KEYWORDS: Highly Active Antiretroviral, HIV, Neurocognition

O-94
1:28PM - 1:35PM

Diffusion Tensor Imaging Detects Early Microstructural Hypothalamic Changes Associated with Cognitive Dysfunction in Obese Subjects

J Puig1, G Blasco1, J Daunis-i-Estadella2, X Molina3, R Rodriguez4, M Serrano4, G Xifra4, W Ricart4, F Fernandez-Aranda5, S Pedraza1, J Fernandez-Real4
1Girona Biomedical Research Institute (IDIBGI), Hospital Dr Josep Trueta, Girona, Spain, 2University of Girona, Girona, Spain, 3Biomedical Research Institute (IDIBGI), (IDI), Hospital Universitari de Girona, Girona, Spain, 4IDIBGI, Hospital University Dr Josep Trueta, CIBERobn, Girona, Spain, 5Hospital Universitari de Bellvitge, CIBERobn Hospital de Llobregat, Barcelona, Spain

Purpose
Despite progress in understanding the neurobiology of energy homeostasis, little is known regarding how brain systems that promote weight stability are altered in obesity. Growing evidence implicates hypothalamic inflammation in the pathogenesis of diet-induced obesity and cognitive dysfunction in rodent models. Few studies have addressed the association between obesity and hypothalamic damage in humans and its relevance. We sought to evaluate obesity-associated hypothalamic damage by diffusion tensor imaging (DTI) together with its impact on cognitive function.

Materials and Methods
We prospectively studied 24 consecutive middle-aged obese subjects (13 women; 49.8±8.1 years; BMI 43.9 ± 0.92 Kg/m2) and 20 healthy volunteers (10 women; 48.8±9.5 years; BMI 24.3 ± 0.79 Kg/m2). All patients underwent 1.5 T MRI (Intera, Philips Healthcare, Best, the Netherlands) including axial FLAIR and DTI sequences. Diffusion-sensitized gradients were applied along 15 noncollinear directions with a b-value of 1000 s/mm2. Diffusion tensor images were coregistered, and a neuroradiologist blinded to all clinical information placed free-hand regions of interest in the right and left sides of the hypothalamus using dedicated software (Olea
Sphere V.2.0, Olea Medical, La Ciotat, France). Primary ($\lambda_1$), secondary ($\lambda_2$), and tertiary ($\lambda_3$) eigenvalues, FA, and mean diffusivity (MD) were calculated. Cognitive function was evaluated with neuropsychological tests. Receiver operator characteristic curves were used to calculate the DTI-metrics cutoffs to predict obesity-associated hypothalamic damage.

Results
Mean $\lambda_1$ values for the hypothalamus were significantly lower in obese subjects (P<0.001). The mean hypothalamic $\lambda_1$ cutoff point that best discriminated obese and control subjects was 1.072, yielding 75% sensitivity, 87.5% specificity, 83.3% PPV, and 80.7% NPV for hypothalamic damage (AUC, 0.854; 95% CI 0.742-0.96) (Figure). No significant differences were found for $\lambda_2$, $\lambda_3$, FA, or MD (Table). Patients with hypothalamic $\lambda_1<1.072$ had significantly increased BMI and blood inflammatory markers. Loss of hypothalamus gray matter defined as $\lambda_1<1.072$ significantly correlated with cognitive impairment. Combined BMI and alanine aminotransferase was the strongest predictor of obesity-associated hypothalamic damage (AUC=0.89).

Conclusions
Our preliminary data indicate that $\lambda_1$ could be a useful DTI-metric for assessing hypothalamic damage in obese individuals. Further studies are needed to validate the quantification of DTI-metrics as a noninvasive tool for detecting obesity-induced damage in the hypothalamus.

KEYWORDS: Cognitive Deficit, Diffusion Tensor Image, Hypothalamus

<table>
<thead>
<tr>
<th></th>
<th>Obese (n=24)</th>
<th>Control (n=20)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (male/female)</td>
<td>11/13</td>
<td>10/10</td>
<td>0.783</td>
</tr>
<tr>
<td>Age (years)</td>
<td>49.875(8.158)</td>
<td>48.85(9.511)</td>
<td>0.706</td>
</tr>
<tr>
<td>BMI (kg/m$^2$)</td>
<td>43.987(4.548)</td>
<td>24.305(3.548)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>115.896(37.612)</td>
<td>84.35(10.261)</td>
<td>0.001</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>142.625(20.334)</td>
<td>120.9(11.947)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td>190.75(46.731)</td>
<td>202.9(30.953)</td>
<td>0.309</td>
</tr>
<tr>
<td>HDL–cholesterol (mg/dl)</td>
<td>46.875(11.078)</td>
<td>63.35(15.618)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Triglyceride (mg/dl)log transformation</td>
<td>4.61(0.532)</td>
<td>4.203(0.454)</td>
<td>0.009</td>
</tr>
<tr>
<td>HOMA-IR (mean ± SD)</td>
<td>4.838(3.149)</td>
<td>0.97(0.906)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ultrasensitive CRP (mg/dl)</td>
<td>0.877 (0.843)</td>
<td>0.137(0.152)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Primary eigenvalue</td>
<td>1.014(0.984 – 1.040)</td>
<td>1.112(1.046 – 1.162)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Secondary eigenvalue</td>
<td>0.673(0.611 – 0.728)</td>
<td>0.767(0.665 – 0.812)</td>
<td>0.105</td>
</tr>
<tr>
<td>Tertiary eigenvalue</td>
<td>0.395(0.334 – 0.433)</td>
<td>0.440(0.351 – 0.535)</td>
<td>0.096</td>
</tr>
<tr>
<td>Fractional anisotropy</td>
<td>0.393(0.369 – 0.444)</td>
<td>0.410(0.380 – 0.440)</td>
<td>0.427</td>
</tr>
<tr>
<td>Mean diffusivity</td>
<td>0.755(0.724 – 0.817)</td>
<td>0.802(0.727 – 0.843)</td>
<td>0.337</td>
</tr>
</tbody>
</table>
Figure. FLAIR images (a) and diffusion tensor images (b) were coregistered and a free-hand region of interest placed on the hypothalamus. c, Primary eigenvalues (λ₁) for the hypothalamus were lower in the control group (P<0.001). We calculated the λ₁ cutoff to predict hypothalamic damage with receiver operator curve.

O-95 1:35PM - 1:42PM

Diffusion Tensor Tractography of Pyramidal Tract in Brainstem: A Study on Optimal Reduction Factor in Parallel Imaging

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Purpose
Single-shot echo planar imaging (EPI) has inherent drawbacks including low signal-to-noise ratio (SNR) and susceptibility artifact. Susceptibility artifact in EPI is remarkable particularly at the pons-sphenoid interface causing severe image distortion of the pons. This makes the use of diffusion tensor tractography (DTT) based on EPI limited at the pons level. However, parallel imaging applied to EPI can mitigate aforementioned drawbacks owing to the reduction of phase encoding steps. In parallel imaging, reduction (R) factor indicates a ratio of original phase
encoding steps to reduced phase encoding steps. Therefore, parallel imaging for DTT through the pons needs an optimal R to achieve both higher SNR and less image distortion. The purpose of this study is to find optimal R factor for DTT through the pons.

Materials and Methods
We measured SNR, image distortion and the number of the corticospinal tract fiber at different values of R. This study was conducted with ten healthy volunteers (9 male, 1 female; median age, 30 years, range 27 - 43 years). Diffusion tensor imaging was performed at 3 T based on single-shot EPI with following parameters: diffusion gradient direction = 15, b value = 1000 s/mm², voxel size = 2 x 2 x 2 mm³ and was repeated with R = 1, 2, 3, 4, 5. First, SNR was calculated using signal intensity measured on b = 0 image and noise value measured on noise map. Second, image distortion was evaluated by measuring anteroposterior diameter of the pons on b = 0 image. Lastly, the number of the corticospinal tract fiber was calculated. Diffusion tensor tractography was conducted for right and left pyramidal tracts passing through the pons in 10 subjects (total 20 tracts). Signal to noise ratio, image distortion and the fiber number of the tract were compared between different R using Friedman test. P value less than 0.05 was considered to be statistically significant.

Results
Each of SNR, image distortion and fiber number of the tracts was significantly different between different R. Maximal SNR was achieved at R factor 2 in nine out of 10 subjects and at R factor 3 in only one subject (p < 0.01). Image distortion was decreased continuously with the increase in R factor. The least image distortion was achieved at R factor 5 in nine out of 10 subjects (p < 0.01). The fiber number of the corticospinal tracts through pons was maximal at R factor 3 in 11 out of 20 tracts, followed by R factor 4 (6 tracts) and R factor 2 (2 tracts) (p < 0.01).

Conclusions
For DTT of corticospinal fiber tracking at brainstem, R factor 3 is considered optimal, balancing between SNR and image distortion. Our results reflect that DTT is influenced by a combination of SNR and image distortion which vary differently depending on R factors. Further technical improvement in parallel imaging such as better coil design and less reconstruction artifact may allow higher R factor useful in DTT in the future.

KEYWORDS: Corticospinal Tract, Diffusion Tensor Image, Parallel Imaging

O-96

Relationship between white matter integrity and serum cortisol levels in drug-naive major depressive disorder patients: a diffusion tensor imaging study using tract-based spatial statistics

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Purpose
In major depressive disorder (MDD) patients, the frontal-subcortical circuits and frontal-limbic circuits are proposed as important pathogenic elements. A higher daytime cortisol level due to a hyperactive hypothalamic-pituitary-adrenal axis also have been reported in MDD. Our aim was to evaluate the relationship between the white matter (WM) integrity and serum cortisol levels during the first depressive episode in drug-naïve MDD patients using a tract-based spatial statistics (TBSS) method.

Materials and Methods
Twenty-nine drug-naïve MDD patients with first depressive episode and 47 age- and gender-matched healthy subjects (HS) underwent diffusion tensor imaging (DTI) scans, and the analysis was conducted using TBSS. Morning blood samples were extracted from all MDD patients and HS for cortisol measurement.

Results
The serum cortisol levels were significantly higher in the MDD patients than in the HS. Compared with the HS, the MDD patients had significantly reduced FA values (p<0.05, FWE-corrected) in the inferior fronto-occipital fasciculus (IFOF), uncinate fasciculus (UF), and anterior thalamic radiation (ATR) (Table). The FA values of the IFOF, ATR, and UF had significantly negative correlations with the serum cortisol levels in the MDD patients (p<0.05; FWE-corrected). There were no regions that showed a positive correlation between FA and cortisol levels.

Conclusions
In early stage of the MDD patients, the FA values of the IFOF, UF and ATR were decreased significantly compared with HS, and also showed significant inverse correlations with the cortisol levels. Since the IFOF, UF and ATR are essential elements for the frontal-subcortical circuits and frontal-limbic circuits, high levels of cortisol in MDD might injure the microstructures in these specific WM circuits.

KEYWORDS: Diffusion Tensor Image, White Matter Tracts

Table. Results of image analyses

<table>
<thead>
<tr>
<th>Anatomical regions</th>
<th>Cluster size</th>
<th>p-value (FWE-corrected)</th>
<th>MNI coordinates (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA values</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between-groups comparison(HS&gt;MDD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.corticospinal tract</td>
<td>53</td>
<td>0.049</td>
<td>69 105 114</td>
</tr>
<tr>
<td>R.SCR</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>L.IFOF</td>
<td>283</td>
<td>0.039</td>
<td>114 147 72</td>
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<tr>
<td>L.UF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L.external capsule</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>L.corticospinal tract</td>
<td>1221</td>
<td>0.036</td>
<td>111 104 116</td>
</tr>
<tr>
<td>L.ATR</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Anatomical regions | Cluster size | p-value (FWE-corrected) | MNI coordinates (mm) 
--- | --- | --- | ---
Negative correlation to cortisol levels in MDD patients
R.IFOF | 96 | 0.047 | 56 113 73
R.external capsule | | | |
L.ATR | 706 | 0.045 | 111 169 88
L.UF | | | |
L.IFOF | 1036 | 0.031 | 107 144 100
L.cingulum | | | |
L.ACR | 3921 | 0.031 | 65 161 78
R.ATR | | | |

R= right, L= left, MNI= Montreal Neurologic Institute, SCR= superior corona radiation, IFOF= inferior fronto-occipital fasciculus, UF= uncinate fasciculus, ATR= anterior thalamic radiation, ACR= anterior corona radiation

O-97

White and Gray Matter Segmentation of the Human Brain Stem Using Diffusion Tensor Imaging

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Purpose
In this study, we tested the reproducibility of manually subdividing the brainstem based on diffusion tensor MRI (DTI) into gray and white matter based neuroanatomical regions.

Materials and Methods
Using DTI and T1- and T2-weighted MRI scans from 20 participants (age range = 3 to 20) we manually delineated 20 gray and white matter regions of interest (ROIs) per hemisphere. For T1 images, we used an SPGR sequence on a GE scanner. For DTI images, we used a b value of 1000 with 30 directions, slice thickness of 2.5 mm and field view was 24. Regions of interest included inferior, middle and superior cerebellar peduncles, medial lemniscus, corticospinal tract, crus cerebri, decussation of the middle and superior cerebellar peduncles, pontocerebellar fibers, cranial nerves V and VII/VIII, red nucleus, substantia nigra, inferior olive, mammillary bodies, superior and inferior colliculi, central tegmental tract, rubrothalamic and dentatorubral tracts (see Figure 1). Three neuroanatomically trained operators manually labeled all ROIs.

Using intraclass correlation coefficients (ICCs), we evaluated intra- and inter-rater reliability.

Results
Across all ROIs, the average ICCs for intra- and inter-rater reliablity ranged from approximately
0.75 (dentatorubral and rubrothalamic tracts) to 0.95 (decussation of the pontocerebellar fibers). Larger ROIs demonstrated higher ICC values than smaller ROIs.

Conclusions
Our findings suggest that gray and matter areas can be manually parcelated with high reproducibility using DTI and high-resolution T1-weighted images. Future work will focus on utilizing this information to develop an automated atlas-based method for quantitative analysis of brainstem structures.

KEYWORDS: Anatomy, Brainstem, White Matter Tracts

Figure 1
Axial view of ROIs in the brainstem, progressing from superior to inferior (left to right). Top row shows diffusion encoded color images of DTI scans and bottom row shows T1 weighted scans. ROIs: inferior (red), middle (purple) and superior (pink) cerebellar peduncles, medial lemniscus (green), corticospinal tract (burnt orange), crus cerebri (light blue), decussation of the middle and superior cerebellar peduncles (dark purple), pontocerebellar fibers (teal), cranial nerve V (dark blue), red nucleus (red), substantia nigra (yellow), inferior olive (green), and inferior colliculus (brown).

(Filename: TCT_O-97_ASNRBrainstem.jpg)

O-98

Transient hypothyroidism: An arterial spin labeling magnetic resonance study

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Purpose
Thyroid dysfunction is a contributor to the depression. We used arterial spin labeling (ASL) to investigate changes in the regional cerebral blood flow (rCBF) distribution in patients with transient post-thyroidectomy hypothyroidism.

Materials and Methods
Our study included 24 patients with transient hypothyroidism and 40 healthy control subjects. We acquired scans with ASL on a 3 T MR system. On the day of the MR studies we quantified the severity of depression using the 21-question Beck Depression Index (BDI) and the 17-item Hamilton Depression Scale (HAM-D). We used voxel-based analysis to compare the absolute rCBF value of the patients and control subjects. We also performed region-of-interest (ROI) analysis of the whole brain, white and gray matter, cerebellum, bilateral caudate nuclei, amygdala, hippocampus, lentiform nucleus, and thalamus to examine the correlation between the rCBF and depression severity (BDI score, HAM-D score). After thyroid hormone replacement therapy (HRT) we again obtained ASL images and the BDI and HAM-D scores. Based on these scores the patients were categorized as unchanged and improved. To confirm the reversal of rCBF diminution after thyroid HRT we used group comparisons between control subjects and patients showing improvement and between the controls and patients with no change. We also performed ROI analysis to investigate the correlation between the rCBF and the severity of depression after thyroid HRT.

Results
The rCBF in the posterior circulation was lower in patients with hypothyroidism than in the controls (p<0.05). After thyroid HRT the rCBF was enhanced in patients showing improvement. In patients with no change the area with significantly low rCBF remained unchanged. There was a significant correlation between the BDI score and the rCBF in the whole brain, white and gray matter, the left amygdala, bilateral hippocampi, and right thalamus (correlation coefficient: -0.57 to -0.51, p=0.01 to 0.04). In patients manifesting no change the rCBF of the whole brain, white and gray matter, and the left amygdala showed a significant decrease as the HAM-D score increased (correlation coefficient: -0.47 to -0.44, p=0.02 to 0.04).

Conclusions
On ASL images there was a significant rCBF decrease in the posterior circulation of patients with transient hypothyroidism after thyroidectomy, a phenomenon that may help to explain their depression. In some but not all patients we observed recovery of the rCBF after thyroid HRT. Our findings suggest that a lack in the improvement of depression after thyroid hormone replacement may reflect a persistent decrease in the rCBF.

KEYWORDS: ASL, Cerebral Blood Flow, Thyroid
The rCBF in the posterior circulation was lower in patients with hypothyroidism than in the controls (p<0.05).
Regional cerebral blood flow in depressive disorders: Arterial spin labeling magnetic resonance study

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Purpose
Findings in the limited number of studies that addressed changes in cerebral blood flow (CBF) in depressed individuals are inconsistent. They suggest a complex neuropathophysiology in patients with depressive disorder that may be related to differences in disease development and treatment responses. We used arterial spin labeling (ASL) magnetic resonance imaging (MRI) to investigate CBF changes in patients with refractory and nonrefractory depressive disorders (RDD, NDD) and healthy subjects.

Materials and Methods
Our study included 68 participants, 40 were the healthy controls and 28 suffered from depression. They underwent imaging on a 3 T MRI system between February 2012 and September 2013. ASL- and echo-planar images were subtracted and averaged to yield perfusion-weighted images. On the day of the MR studies we quantified the severity of depression using the 21-question Beck Depression Index (BDI) and the 17-item Hamilton Depression Scale (HAM-D). After treatment with antidepressants we again acquired ASL images and recorded the BDI and HAM-D scores. Based on these scores the patients were categorized into an RDD group (n=16) and an NDD group (n=12). Then we performed voxel-based comparison of the regional CBF (rCBF) among the patients and controls. To reduce possible interindividual variability in rCBF we normalized all CBF voxel data by dividing each participant's voxel data by his/her global mean CBF value for the cerebellum. We also performed region-of-interest (ROI) analysis of the gray and white matter and of the bilateral caudate nucleus, amygdala, hippocampus, lentiform nucleus, and thalamus. To reduce the possible interindividual variability in rCBF we normalized all CBF ROI data by dividing each participant's ROI data by his/her global mean CBF value for the cerebellum. We defined this as the normalized CBF (nCBF). Lastly we investigated the correlation between the nCBF in patients with RDD and NDD and the severity of depression (BDI- and HAM-D score) before and after antidepressant treatment.

Results
In patients with NDD, perfusion in the left frontal and parietal lobe and the caudate nucleus was lower than in the control subjects. In patients with RDD, perfusion in the bilateral temporal lobes was significantly lower than in the controls (p<0.05). Before antidepressant treatment, there was a significant inverse correlation between the BDI score and the nCBF value of the bilateral amygdalae and lentiform nuclei in patients with RDD (correlation coefficient: -0.61 to -0.49, p=0.01 to 0.04). After treatment, there was a significant correlation between the HAM-D score and the nCBF value of the right lentiform nucleus in patients with NDD (correlation coefficient: 0.58, p=0.04). In the control subjects, there was no significant correlation between the BDI score and the rCBF in all ROI examined.
Conclusions
Our study revealed that the rCBF distribution is different in patients with RDD and NDD. An understanding of differences in the neurophysiologic blood flow patterns in RDD and NDD may help to select appropriate treatments for particular patient subgroups.

KEYWORDS: ASL, MR Imaging Perfusion, Psychiatry

O-100

Symmetric T1 hyperintensity in globus pallidi in a patient with posterior reversible encephalopathy syndrome.

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¹Dr. Balabhai Nanavati Hospital, Mumbai, Maharashtra, India, ²Dr. R.N.Cooper Hospital, Mumbai, Maharashtra, India

Purpose
We present a case, where an MR imaging (MRI) scan of brain performed on an eclamptic patient for evaluation of seizures, within 24 hours of treatment with magnesium sulphate revealed a symmetric hyperintense signal in the basal ganglia on T1-weighted images in addition to features of posterior reversible encephalopathy syndrome (PRES). Other conditions which could have a similar appearance of the basal ganglia were ruled out with appropriate tests. We also report MR spectroscopy (MRS) findings in the basal ganglia of the same patient. We have followed up this patient at one-month interval and have documented gradual decrease in the T1 signal in the basal ganglia, with disappearance of the signal on a scan performed at six months. MR imaging scans also were performed on two other patients who also were administered magnesium sulphate. These scans showed similar signal intensity changes. We postulate it to be secondary to deposition of magnesium in the brain parenchyma. It has to be determined whether deposition of magnesium in the brain parenchyma could have implications in the use of magnesium sulphate in pregnant patients.

Materials and Methods
Our index patient was a 28-year-old female, primigravida with 29 weeks gestation and with no significant prior history presenting to our hospital with two episodes of generalized tonic clonic convulsions. The blood pressure was elevated (180/120 mm Hg). Other findings were unremarkable. The patient was treated with anticonvulsants and injections as per Pritchard's regimen. Magnesium sulfate was administered for 24 hours as 4 grams intravenous and 10 grams loading dose followed by 5 grams intramuscularly 4 hourly [total dose: 14+ (5x6) = 44gms]. The seizures responded to treatment and the blood pressure normalized. However, patient persisted to be drowsy. Neurological examination did not reveal any focal deficit. On the second day postictus, the patient underwent an MRI scan of brain using T1 fluid attenuation inversion recovery (FLAIR), fast spin echo (FSE) T1 and T2. For T1 FLAIR, a repetition time (TR) of 1500 ms, echo time (TE) of 7.5 ms, inversion time (IR) of 750 ms, matrix of 256 x 192 were used with two number of excitations (NEX). For SE T1 sequence, TE of 400 ms, TR of 21 ms and a matrix of 320 x 192 were used with 2 NEX. T2-weighted images were obtained using TE of 4200 ms, TR of 80 ms and matrix of 320 x 224 with 3 NEX. Slice thickness of 3 to 5 mm and field of view of 24 cm were used. Single voxel spectroscopy was performed using 2 x 2 x 2 cm
sized voxel and a short TE (30 ms). Liver and renal function tests and serum levels of copper, manganese and magnesium were assessed. Follow-up MR scans using axial T1 FLAIR and T2-weighted images were performed at week one on index patient with further follow up at one month and six monthly intervals. Two other pregnant patients who also had convulsions and were administered magnesium sulphate as part of the treatment protocol were scanned within 24 hours of the first episode, with follow-up scans at one and six monthly intervals.

Results
The scan in the index patient revealed more or less symmetric, hyperintensities on T2-weighted sequences in bilateral posterior parietal cortex and subcortical white matter consistent with a diagnosis of PRES. There was no venous sinus thrombosis. Also seen was a symmetric hyperintense signal in the globus pallidi on T1-weighted imaging. The globus pallidi appeared normal on T2-weighted images. On single voxel MR spectroscopy study, there was reduction in the height of mI peak and mI/Cr ratio. No abnormal peak could be detected. Liver and renal function tests were normal. Serum levels of copper and manganese too were within the normal range. Serum magnesium levels were found to be elevated. Follow-up MR scans conducted after a week on the index patient, revealed resolution of the lesions in bilateral parietal parenchyma which were considered to represent PRES. However, the signal changes seen on T1-weighted imaging in the globus pallidi were persistent. It was, thus, hypothesized that the T1 hyperintensity seen in the globus pallidi could be secondary to magnesium deposition following intramuscular magnesium sulfate injections for control of blood pressure. Further follow-up MRI in the index patient at one month interval revealed reduction in the T1 signal intensity by about 50 % with normal appearance at six months. The serum magnesium levels at six months were within normal range. The two subsequent patients were scanned within 24 hours of injection. T1 hyperintense signal was seen in both these patients, which decreased on follow-up MRI performed at one and six months. Serum magnesium levels were elevated at the time of the first MR scan and within normal range at six months in both patients. Neurological examination of these patients also was normal.

Conclusions
Although, magnesium has been used for almost a century in several clinical conditions, this is the first report raising possibility of deposition of magnesium in the brain, when administered in pharmacological dosages. It appears as a symmetric high signal on T1-weighted MR scan. The intensity is likely to be dependent on the dosage of administered drug and time to scan since the injection. Hence, magnesium deposition must be considered in the differential diagnosis of bilateral symmetric T1 hyperintensity in the globus pallidi in the given clinical setting.

KEYWORDS: Globus Pallidus

O-101
2:17PM - 2:24PM

Relationship Between Lactate Dehydrogenase and the Development of PRES in Cancer Patients Receiving Systemic Chemotherapy

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1University of Arkansas for Medical Sciences, Little Rock, AR
Purpose
Posterior reversible encephalopathy syndrome (PRES) is a neurotoxic process that occurs in the setting of hypertension, infection, transplantation, pregnancy, autoimmune disease, and cancer. Although the pathophysiology of PRES remains unclear, an underlying state of immune dysregulation and endothelial dysfunction has been proposed. The purpose of this investigation was to examine alterations of serum lactate dehydrogenase (LDH), a marker of endothelial dysfunction, relative to the development PRES.

Materials and Methods
A retrospective database of 88 PRES patients was compiled via an IRB-approved electronic medical record search for those treated for PRES at our institution from 2007-2012. Clinical diagnosis of PRES was confirmed by review of brain MR exams by two subspecialty certified neuroradiologists. Clinical features at presentation and initial blood pressure were recorded. Blood pressure was classified according to American Heart Association criteria. Serum LDH values were collected at three time points: prior to, at the time of, and following PRES diagnosis. Student's T-test was used to analyze the normal distribution of serum LDH measurement at the three measured time points.

Results
Twenty patients (23%) developed PRES while undergoing chemotherapeutic treatment for malignancy. Within this subset, serum LDH values were available during the course of treatment in 12 patients (9 female; mean age 57.8 years(range 33-75 years). Among the subset of 20 chemotherapy-related PRES patients, five (25%) were normotensive, seven (35%) hypertensive, and eight (40%) exhibited extreme hypertension. Normal blood pressure at presentation was less commonly encountered in the nonchemotherapy group (9%). Fourteen (70%) of chemotherapy-related PRES patients presented with seizure. Additional or alternative presentations included: altered mental status (6), headache (4), and vision changes (7). Lactate dehydrogenase levels at the time of PRES diagnosis were higher than those before and after (p=0.0263), with a mean difference of 114.8 IU/L. Mean time intervals between LDH measurement prior to and following PRES diagnosis were 44.8 days and 51.4 days respectively. Mean elapsed time between last chemotherapy administration (mean 3.5 chemotherapeutic agents/patient) and PRES onset was 11.1 days.

Conclusions
Serum LDH, a marker of endothelial dysfunction, shows statistically significant elevation at the onset of PRES toxicity in cancer patients receiving chemotherapy. Our findings support a systemic process characterized by endothelial injury/dysfunction as a factor, if not the prime event, in the pathophysiology of PRES.

KEYWORDS: Chemotherapy, Hypertension, Posterior Reversible Encephalopathy

O-102

Initial assessment of MRI/PET in patients with neurofibromatosis type 1

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Purpose
In NF1 patients, plexiform neuroribromas (PNFs) and optic pathway gliomas (OPGs) are commonly imaged to assess their progression/degneration and progression respectively. Clinical examination, imaging, and even biopsies often are inconclusive in these assessments. PET/CT has limited soft tissue contrast and exposes patients to high radiation which is important in children and young adults who require multiple studies. Whole body FDG PET/MRI is a novel metabolic–anatomical imaging technique that overcomes these limitations but is limited by time and field of view constraints and its utility in this setting has not been described. Our purpose is to assess PET/MRI sensitivity for detection of PNFs and OPGs, its sensitivity for FDG avid lesions localization and compare its results with those of conventional MRI studies.

Materials and Methods
Using whole body PET/MRI we evaluated 11 NF1 patients with (n=4) or without (n=7) focal pain. Whole body MR sequences included coronal STIR, T1 VIBE pre and postcontrast with 4-6 stations covered depending on patient size (n=11). Coronal STIR and axial T2 thin sections through the optic pathways were acquired additionally in patients with OPGs (n=3). Patients received a standard IV dose of FDG one hour prior to the exam. Total imaging time was approximately 35 minutes (range: 25-45 min). Fused MR/PET images were analyzed and maximum standardized uptake value (SUVmax) was recorded for all lesions. We also correlated all MR images with conventional MR images obtained previously.

Results
We studied a total of 11 patients (2 males, 9 females; mean age: 23.3±18.1, median age: 17 years), of which four had recently developed local pain. Of the asymptomatic ones, whole body MR images showed all lesions when compared to dedicated MR images obtained previously and were enough to assess location and extension but not intrinsic mass characteristics. The PET portion of the study showed no uptake of FDG in any lesions. In symptomatic patients, the whole body MR images also identified all lesions when compared to previous MRI studies. PET study showed one tumor with FDG uptake (maxSUV>4) and also areas of uptake not in the tumors (n=3) but rather in muscles adjacent to them suggesting that the pain did not originate from progressive and/or degenerating tumors.

Conclusions
Whole body MR images obtained as part of MR PET studies were sufficient to identify all mass lesions when compared to conventional dedicated MR studies. Masses in asymptomatic patients did not show FDG uptake but in three of the four symptomatic patients MR PET showed areas of high uptake not in the masses but in muscles adjacent to them suggesting that the cause of pain in them was not the tumors.

KEYWORDS: MR Imaging/PET, Neurofibromatosis, PET

Monday
3:00PM - 4:30PM
Palais des congrès de Montreal, 517bc

18 - PARALLEL PAPERS: Head and Neck: New Techniques and Orbits
O-103

3:00PM - 3:07PM

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Purpose
In the head and neck, cross-sectional imaging provides only one index of biological activity, i.e., morphologic evaluation, which is nonspecific. Most current advances in MR imaging (MRI) allow exploring physiologic alterations that can be used as imaging biomarkers. Radial-VIBE with GRASP assesses for structural dynamic contrast-enhanced (DCE) permeability. Our hypothesis is that the permeability patterns of every normal anatomical structure in the neck should be distinct. The purpose of this study therefore is to evaluate the role of Radial-VIBE with GRASP to establish the unique permeability characteristics of the different normal anatomical structures of the neck.

Materials and Methods
This retrospective HIPPA-compliant study evaluated 10 patients who underwent clinically indicated MRI of the neck at 1.5 T. Along with standard MRI sequences, dynamic Radial-VIBE sequence with GRASP was performed during administration of 0.01 mmol/kg of gadolinium-based contrast at 3 mL/second. The following acquisition parameters were used: spatial resolution=1.0x1.0x2.0 mm; 800 spokes; flip angle=12°; TR=4.57 ms; TE=2.06 ms; matrix=256x256; bandwidth=400 Hz/px; field of view=256 mm2; acquisition time=4'43". Signal-time curves (Figure 1) were generated along with the following parameters: Ktrans (transfer constant, aka permeability), VE (volume of extravascular-extracellular space), VP (blood plasma volume), KEP (rate constant), wash-in, wash-out, AUC (area under the curve), peak maximum enhancement (MPeak) and time to maximum enhancement (MTime). Normal structures of the neck such as the jugular vein, sternocleidomastoid muscle (SCM), lymph node (LN), thyroid gland, and vocalis muscle (vocalis) were evaluated.

Results
Mixed model analysis of variance (ANOVA) was used to compare normal structures of the neck in terms of each imaging measure. All statistical tests were conducted at the two-sided 5% significance level using SAS 9.3 (SAS Institute, Cary, N.C.). As outlined in Table 1, VP and wash-in demonstrated statistically significant (p<0.05) differences in all measured structures of the neck. Most of the remaining permeability parameters also demonstrated significant differences among the different anatomical structures of the neck.

Conclusions
The results from this proof-of-principle study are consistent with the hypothesis that each normal structure of the neck has a unique permeability pattern. The GRASP technique is a new viable method for assessing permeability patterns in the head and neck.

KEYWORDS: Head And Neck, Permeability MR Imaging

**Table 1:** p-Values from the ANOVA analysis, comparing regions in terms of each DCE measure.
Molecular MR Imaging of Myeloperoxidase Activity is a Potential Imaging Biomarker for Head and Neck Cancer

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Purpose
Head and neck squamous cell carcinomas (HNSCC) can be associated with an intense inflammatory response. Myeloperoxidase (MPO) is a highly oxidative inflammatory enzyme abundantly secreted by macrophages and neutrophils. In this study we evaluated whether MPO-
Gd, an activatable MR molecular imaging agent highly specific and sensitive to MPO activity, would be superior in detecting tumor extent compared to a conventional gadolinium contrast agent (DTPA-Gd) in a murine model of HNSCC.

Materials and Methods

Head and neck squamous cell carcinoma was induced in ten 8-week C57Bl/6 mice with 4-nitroquinoline-N-oxide (100 ug/ml) dissolved in drinking water for four months. Five age-matched C57Bl/6 mice on normal water were used as control. After another eight to 10 weeks, the mice were screened for tumor using bioluminescence imaging (BLI) of MPO activity (with luminol). When BLI imaging was positive, MR imaging (MRI) was performed with DTPA-Gd and MPO-Gd. The mice then were sacrificed for histopathological analysis of the tongue samples, with anti-MPO antibody and anti-cytokeratin 14 antibody to validate the imaging findings.

Results

Nine out of 10 mice developed tumor, three mice died before imaging was performed, and six mice were imaged. The luminol BLI signal (total flux) in the head and neck region of the tumor group was higher than that in the control group (tumor: 40,011±5,179 p/s; control: 16,326±2,179 p/s; p=0.0018), confirming the development of inflammation. On MRI, lesions were detected within the tongue. The enhancing volume detected by MPO-Gd was higher than that by DTPA-Gd (MPO-Gd: 0.0232 cm3; DTPA: 0.0097 cm3; p=0.013). Furthermore, MPO-Gd imaging detected areas that were absent with DTPA-Gd imaging (Figure 1), confirmed histopathologically to represent early tumor (Figure 2).

Conclusions

Molecular MR imaging targeting MPO activity is superior at detecting early HNSCC and identifying tumor extent than Gd-DTPA.

KEYWORDS: Head And Neck, MR Imaging, Squamous Cell Carcinoma
Impact of Model-Based Iterative Reconstruction on image quality of contrast enhanced Neck CT

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Purpose
To compare adaptive statistical iterative reconstruction (ASiR30) and model-based iterative reconstruction (MBIR) algorithms for the assessment of image quality of contrast-enhanced neck CT.

Materials and Methods
The imaging data of 64 consecutive patients undergoing contrast-enhanced neck CT with a noise index of 23.4 were reconstructed retrospectively by ASiR30 as well as MBIR. Objective image quality was assessed by comparing signal to noise ratio (SNR), contrast to noise ratio (CNR) and background noise (BN) at two different levels; at the levels of mandible (level I) and superior mediastinum (level II). Two experienced blinded reviewers subjectively graded the image quality and overall image quality on a scale of 1 to 5 grading system, (Grade 5 = excellent image quality without artifacts and grade 1 = nondiagnostic image quality with significant artifacts). The subjective image quality assessment was performed at four different levels, including the level of nasopharynx, oropharynx, true vocal cords (VC) and sterno-calvicular (SC) junction.

Interobserver agreement was assessed with Cohen's kappa analysis. Thyroid shield was placed over the lower neck for all patients as a part of radiation safety exercise in our institution.

Results
Compared with ASiR30, MBIR significantly improved SNR [(mean ± SD) 12 ± 4.3 versus 16 ± 7.2, p<0.001], CNR (6.8 ± 2.4 versus 7.6 ± 2.6, p<0.001) at the level I and (3.9 ± 3.4 versus 6.9 ± 8.1, p<0.001), (3.7 ± 1.6 versus 4.9 ± 2.0, p<0.001) at the level II, respectively. Model-based iterative reconstruction also significantly decrease BN at the level I (7.8 ± 9.2 versus 6.3 ± 9.2, p<0.016), although there was no significant difference at the level II (34 ± 31 versus 32 ± 33, p=0.61). Model-based iterative reconstruction scored significantly higher over ASiR30 by both reviewers, at the level of nasopharynx (4.8 ± 0.3 versus 4.2 ± 0.3, p<0.001), oropharynx (3.7 ± 0.6 versus 3.1 ± 0.6, p<0.001) and overall image quality (3.9 ± 0.3 versus 3.7 ± 0.3, p<0.001).

Model-based iterative reconstruction scored significantly lower at the level of VC (3.7 ± 0.5 versus 4.0 ± 0.4, p<0.001) and SC junction (3.4 ± 0.5 versus 3.8 ± 0.2, p<0.001), due to artifacts related to thyroid shield specific for MBIR. Interobserver agreement was relatively low at all levels (k = 0.04, 0.31, 0.17, 0.05, and 0.02 for MBIR and 0.02, 0.30, 0.02, 0.00, and 0.06 for ASiR30 at the level of nasopharynx, oropharynx, VC, SC, and overall image quality respectively) reflecting the bias in ratings between the two reviewers.

Conclusions
Model-based iterative reconstruction offers improved subjective and objective image quality as evident by higher SNR and CNR and lower BN within the same data set for contrast-enhanced neck CT. This raises a great potential of MBIR to reduce radiation dose while maintaining the image quality. Only minor downside was prominent artifact related to thyroid shield on MBIR.
Further studies are necessary to assess how much radiation dose saving can be achieved with application of newer model-based iterative reconstruction algorithm.

KEYWORDS: Head And Neck, Image Quality, Iterative Reconstruction

O-106

Radiologic Findings in Patients with Persistent Hemifacial Spasm After Microvascular Surgical Decompression

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Purpose
To identify common anatomical locations of persistent unaddressed vascular compression of the facial nerve in patients with a history of a failed microvascular decompression.

Materials and Methods
Fifteen patients with persistent hemifacial spasm following a previous microvascular decompression were included in this retrospective study. The patients were evaluated clinically by a neurosurgeon specializing in cranial nerve disorders and had findings consistent with persistent hemifacial spasm. All patients underwent thin section steady-state free precession MR images. Blinded to the surgical results, a single neuroradiologist reviewed the imaging to identify: presence of a vessel contacting the facial nerve, whether the contacting vessel was an artery, vein or both, which artery was responsible, which segment of the nerve was involved, and whether this point of contact was medial or lateral to the existing pledget. If the patient underwent a repeat microvascular surgical decompression, the imaging findings were compared to the operative findings.

Results
In 11 of the 15 patients persistent arterial compression was identified; one of these patients also had venous contact with the facial nerve. Eleven patients underwent repeat microvascular decompression. Of these 11 patients 10 had imaging evidence of persistent vascular compression of the facial nerve. The PICA was the sole culprit vessel in three patients, the AICA was the sole culprit vessel in six patients, and both the AICA and PICA contacted to the facial nerve in one patient. Compression of the adherent segment (along the undersurface of the pons) was identified in six patients (60%), the root detachment point in one patient (10%), and the transition zone in three patients (30%). The point of contact was medial to the pledget in eight patients (80%) and was lateral to the pledget in two patients (20%). These findings were confirmed at surgery. One patient without imaging evidence of arterial compression underwent repeat surgical decompression, and small arterioles were noted intra-operatively compressing the facial nerve. Long term outcome data are being acquired. Four patients were not offered repeat decompression. Three of these patients had no evidence of persistent vascular compression and one patient had arterial contact of the cisternal segment of the facial nerve, lateral to the existing pledget.

Conclusions
In patients with persistent hemifacial spasm despite microvascular decompression, the
unaddressed vascular compression when present is typically medial to the previously placed pledget. In the majority of patients in this small series, the compression occurred at the adherent segment that extends along the undersurface of the pons. Special attention should be paid to the proximal portions of the seventh nerve, particularly the portions medial to the existing pledget, in patients with persistent hemifacial spasm to identify residual compression.

KEYWORDS: Cranial Nerves, Facial Nerve

O-107

Ultrasound Diagnosis of Intra-Thyroid Parathyroid Adenoma: The Importance of Identification of the Dominant Polar Vessel

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Purpose

Intrathyroid parathyroid adenomas (ITPA) are uncommon but do occur. When clinical and laboratory findings of hyperparathyroid function are present, imaging localization of the parathyroid adenoma (PA) may remain elusive particularly if the adenoma is intrathyroid. The purpose of this study is to evaluate the impact of a dominant polar vessel (DPV) in the ultrasound (US) localization of an ITPA. While the DVP has been recognized previously as a characteristic of a parathyroid adenoma, the significance of this sign in localizing a parathyroid adenoma has not been established.

Materials and Methods

The appearance of ITPAs localized on US were reviewed retrospectively and where possible were compared to the CT and sestamibi findings. Inclusion criteria were the preoperative US suspicion of ITPA and FNA/cytologic/pathologic documentation of a parathyroid adenoma. The following US features were recorded: size, margins, echotexture, echogenicity, comet tail artifact, calcification and vascular flow were assessed. Power Doppler was performed to identify a dominant polar vessel (DPV) that partially encircled the nodule and/or extended into the nodule. FNA was performed based on the US suspicion of an ITPA.

Results

Intrathyroid parathyroid adenomas were diagnosed by US in 25 patients, four men and 21 women based on the presence of a DPV and absence of localization of an alternate site of parathyroid adenoma by US, CT, and sestamibi scans. The characteristics of the ITPAs diagnosed by US were nonspecific in size, echotexture, and echogenicity. Each ITPA had a well defined margin. Calcification and comet tail artifact due to crystalline colloid were absent in all of the ITPAs. A DPV on power Doppler US was present in 22 of 25 (88%) suspected ITPAs. Correlation between the presence of a DPV and ITPA was statistically significant (p-value < 0.0001 by Fisher's exact test). Accuracy of the test was 0.89 (58/65; 95% exact CI: 0.79, 0.96). Sensitivity of the test was 0.88 (22/25 with DVP; 95% exact CI: 0.69, 0.97). Specificity was 0.90 (36/40 without DVP; 95% exact CI: 0.76, 0.97). Thus, the demonstration of DPV is a valid indicator for the presence of an ITPA and the absence of a DLV is highly specific for absence of
an ITPA. Of 25 ITPAs localized by US, eight of 21 (38%) were detected by 4D CT scan and four of 24 (17%) were detected by sestamibi scan. FNA and/or surgical resection/surgical pathology documented that lesion localized by US was a parathyroid adenoma. Surgical resection/surgical pathology suggested that 17 of 24 (71%) were true ITPAs, and seven of 24 (29%) were closely adjacent to the margin of the thyroid gland and possibly extrathyroid.

Conclusions
In a patient undergoing pre-operative evaluation for primary hyperparathyroidism and absence of imaging localization of a parathyroid adenoma, the DPV is a distinguishing US characteristic that can raise the suspicion for, and facilitate the diagnosis, of an ITPA.

KEYWORDS: Parathyroid, Thyroid, Ultrasonography

O-108


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Purpose
Cross-sectional imaging is limited in evaluation of pathologic lymphadenopathy. Positron emission tomography-computed tomography (PET-CT) has proven to be helpful. However, there are certain limitations. Neck dissection therefore remains the gold standard. Radial-VIBE in combination with the new GRASP technique can be used for dynamic contrast-enhanced (DCE) structural assessment. Our hypothesis is that normal lymph nodes will demonstrate difference DCE parameters when compared with pathologic lymphadenopathy. The purpose of this study is therefore to evaluate the role of Radial-VIBE with GRASP to distinguish metastatic lymphadenopathy from normal lymph nodes in primary head and neck cancers.

Materials and Methods
In this HIPAA-approved retrospective study, 27 lymph nodes from 10 patients were evaluated. Of the 27 lymph nodes, there were nine pathologically proven metastatic and 18 normal lymph nodes. All patients were imaged on 1.5 T system utilizing standard MRI protocols and DCE-MRI with Radial-VIBE and GRASP. The Radial-VIBE sequence was acquired during administration of 0.01 mmol/kg of gadolinium-based contrast at 3 mL/second using: spatial resolution=1.0 x 1.0 x 2.0 mm; 800 spokes; flip angle=12°; TR=4.57 ms; TE=2.06 ms; matrix=256 x 256; bandwidth=400 Hz/px; field of view=256 mm2; acquisition time=4'43". Signal-time curves were generated from ROIs along with K-trans (transfer constant, permeability coefficient), VE (volume of extravascular-extracellular space), VP (blood plasma volume), KEP (rate constant), wash-in, wash-out, AUC (area under the curve), peak maximum enhancement, and time to maximum enhancement.

Results
Statistical analysis was performed using mixed model analysis of variance (ANOVA) for each imaging measure. The lack of statistical independence among observations from the same patient
was accounted for by assuming data to be correlated only when acquired from the same subject.
All statistical tests were conducted at the two-sided 5% significance level using SAS 9.3 (SAS Institute, Cary, N.C.). The mean, standard deviation, and median values are listed in Table 1, and p-values are listed in Table 2. Most of the measured parameters demonstrated significant (p < 0.05) difference with exception of VE and Ktrans. VE demonstrated a statistical trend with p=0.075.

Conclusions
Our pilot study demonstrates significant difference in permeability parameters of pathologic lymphadenopathy when compared with normal lymph nodes using Radial VIBE with GRASP technique.

KEYWORDS: Lymph Node Metastasis, Permeability MR Imaging

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High-resolution Flat-panel CT in the Post-operative Evaluation of Cochlear Implants.

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Purpose
Clinical outcomes following cochlear implantation vary considerably in the degree and quality of hearing recovery. Cochlear implant (CI) location, insertion depth, scalar localization, and relationship to the facial nerve are important factors for CI outcomes. This study investigates the utility of flat-panel computed tomography (FPCT) in the postoperative evaluation of patients with CI.

Materials and Methods
All patients gave written informed consent to participate in this IRB approved study. Fifteen patients with 19 previously placed CIs (18 Med-El standard 31.5-mm arrays, 1 Med-El medium 24-mm array) underwent postoperative FPCT (DynaCT, Siemens, Erlangen, Germany) evaluation on a flat-panel angiography system (Axiom Artis Zee, Siemens) using commercially available software (Syngo DynaCT, Siemens). A collimated 20-second FPCT of the head was performed: 109 kV, small focus, 200-degree rotation angle, and 0.4-degree/frame angulation step. Postprocessing was performed on a commercially available workstation (Leonardo; Siemens). Secondary reconstructions were created using the following parameters: manually generated VOI to include only the electrode array, voxel size 0.07 mm - 0.08 mm, 512 x 512 matrix, Hounsfield units (HU) and edge enhancement (EE) kernel types, and very smooth, normal, auto, and sharp image characteristics. Images were analyzed for the ability to identify distinct electrode contacts, CI insertion point, relationship to the facial nerve, and scalar localization. The four different types of image characteristics and two different kernel types used in the creation of secondary reconstructions were compared to identify the optimal reconstruction parameters for CI visualization.

Results
Flat-panel CT could depict the insertion site, CI course, relationship to the facial nerve, and all 228 individual electrode contacts. Scalar localization could be inferred based on the relationship to the cochlear walls, yet discrete visualization of the CI and adjacent osseous spiral lamina throughout CI course was not possible. The HU kernel type and sharp image characteristic provided the highest quality combination for CI visualization.

Conclusions
Flat-panel CT is a promising imaging tool for the evaluation of patients with CIs and produces high-resolution images that identify the CI insertion point, all individual electrode contacts, and the relationship to the facial nerve.

KEYWORDS: Facial Nerve, Flat-Detector Cone-Beam CT, Hearing Loss
C-Arm CT Imaging of the Temporal Bone: Image Quality and 3D Radiation Dose Distribution

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Purpose
In recent years there have been substantial developments in the field of C-Arm-based CT acquisitions (CACT), especially when focusing on small volume, high contrast targets. The relatively small area and osseous anatomy of the temporal bone make this structure an ideal candidate for CACT imaging. The purpose of this study was to compare the image quality and the relative radiation dose to the ocular lens between multidetector CT (MDCT) and CACT using a cadaveric model and an anthropomorphic head phantom.

Materials and Methods
Five cadaveric heads were scanned on a C-Arm biplane system with CACT capability, and on a clinical 64-slice MDCT. A small field of view high resolution scan mode was used for CACT using a micro focal spot, 6.5 cm by 11 cm coverage and 0.154 mm detector pitch. The center of the field of view was the right temporal bone in all acquisitions. For MDCT scans, a standard clinical temporal bone protocol was used with a 0.531 pitch, noise index 6.7, acquisition slice thickness 2.5 mm, and axial bone reconstructions of 0.625 mm. Image quality was qualitatively...
evaluated by a panel of experienced neuroradiologists. Dose measurements were performed using thermoluminescent dosimeters (TLDs). The dose to the lens was estimated by placing TLD chips under the eyelids of intact whole cadaver heads. Volumetric dose measurements were taken using an anthropomorphic head phantom to compare the different dose distributions of each modality qualitatively. All TLD measurements were repeated three times and averaged. A total of 35 measurement locations were used to create the volumetric dose maps for the phantom study.

Results

Image quality between the MDCT and CACT were judged to be equivalent for clinical evaluation (Figure). The radiation dose to the lens was 6.9 times lower in CACT. The volumetric dose distribution for MDCT showed a relatively uniform dose distribution compared to an asymmetric dose distribution for CACT. In the region of the orbits, the dose was higher for MDCT than for CACT, which is consistent with the cadaveric result. For CACT, the dose was highest over the right temporal bone with a large gradient that decreased markedly away from the temporal bone.

Conclusions

Due to the geometry of the scan range and collimation of the CACT system, a substantial dose reduction was observed for CACT over MDCT for the ocular lens. Future applications of this imaging technique include the potential usability of flat-panel-based C-Arm systems for cochlear implant staging, delivery under fluoroscopic guidance, as well as postdelivery assessment of surgical position.

KEYWORDS: Flat-Panel Angiographic CT, Radiation Dosage, Temporal Bone
Optic nerve elevation in children: causes, imaging appearance and clinical significance.

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Purpose
To define the spectrum of disorders manifested clinically as optic disk elevation; to define reliable MR imaging features of true papilledema; and to evaluate the prognostic value of restricted diffusion within the optic disks.

Materials and Methods
MR imaging (MRI) of the brain and orbits in 127 patients referred for papilledema were reviewed by two neuroradiologists blinded to the clinical history. In addition to routine MR brain imaging with and without gadolinium, thin section T2 and post-gadolinium T1 images in axial and coronal planes with fat suppression and diffusion imaging were obtained. The subjects' ages ranged from six months to 15 years. Comparison was performed with orbital MRIs of 46 patients.
imaged for reasons other than suspected papilledema. All imaging was performed on 1.5 or 3 T MRI scanners.

Results
Evaluation of MRI examinations reveals that 68% of patients referred for papilledema had positive imaging findings of true papilledema; 8% of patients had an imaging diagnosis of pseudopapilledema; and 24% had a normal imaging exam. The spectrum of imaging findings of true papilledema in the orbits includes: protrusion (inversion), restricted diffusion, and enhancement of the optic nerve heads, and enlargement of the optic nerve sheath greater than 8 mm. The spectrum of underlying pathologies includes, in decreasing order of prevalence: hydrocephalus, predominantly due to brain tumors; pseudotumor cerebri; venous sinus thrombosis, intracranial hemorrhage, vascular anomalies; and miscellaneous causes including local orbital pathology such as optic neuritis, trauma, and inflammatory disorders. Patients with papilledema were categorized into three groups depending on their visual outcome (normal, subnormal and abnormal). A comparison between these groups was made using a chi-square test for association, and pairwise comparisons were conducted with a two-sample t-test. Our findings indicate that restricted diffusion of the optic nerve heads was seen in 73.7% of patients with clinical papilledema. Visual outcomes were subnormal or normal in 86.8% of our patients with papilledema. However, there was no statistically significant association between visual outcome and prevalence of diffusion restriction.

Conclusions
A significant number of pediatric patients referred for papilledema had positive MRI findings. The largest subset of patients with positive imaging findings was due to hydrocephalus, predominantly as a result of tumors or other causes of increased intracranial pressure. However, there was no statistically significant association between visual outcome and prevalence of restricted diffusion within the optic disks.

KEYWORDS: Optic Nerve, Orbits, Pseudotumor Cerebrii

O-112

Superior Oblique Muscle Size Variations in Congenital Superior Oblique Muscle Palsy

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Purpose
Congenital superior oblique palsy (CSOP) is the most common congenital cranial nerve palsy and cause of strabismus. Recent animals and human studies have provided strong candidate genes involved in the development of the superior oblique muscle (SO) and/or its cranial nerve, indicating that this condition may be due to primary muscle hypoplasia or primary misdevelopment of the nerve/nucleus. We aimed to demonstrate structural MR imaging (MRI) of the SO, 4th cranial nerve (CN4) and its nucleus, and to correlate the imaging phenotype with candidate genes responsible for the structural development of each component. Data from the initial analysis of SO muscle is presented and will be supplemented with subsequent data from cranial nerve and nucleus imaging as well as correlations with genetic tests.
Materials and Methods
Clinically confirmed patients with unilateral CSOP were recruited from a tertiary referral Ophthalmological institution underwent 3 T MRI of the brain and orbits using a standardized imaging protocol. Maximal cross-sectional areas of the SO (MaxA) were outlined and calculated on ITKSNAP (PICSL, Pennsylvania) by an experienced neuroradiologist blinded to the diagnosis. The data were tabulated and the following parameters calculated: mean MaxA for controls and the nonaffected side of patients, mean MaxA affected side of patients, mean difference in MaxA in patients (affect versus nonaffected) and controls.

Results
Twenty-two subjects were recruited consisting of 11 patients and 11 aged-matched controls. In all 11 patients, there was a measurable difference in MaxA between the affected and asymptomatic side. Mean MaxA of controls and the nonaffected side of patients: 24.98±3.88(19.94-33.37)mm², mean MaxA of affected side of patients: 19.38±5.51(5.29-25.23)mm², mean difference in MaxA in patients (affect versus nonaffected): 8.03±7.66(2.85-24.41)mm², and controls: 0.54±0.33(0-0.81)mm².

Conclusions
A wide variation in maximal cross-sectional area of the affected SO is demonstrated in patients with CSOP which overlaps with normal control SO areas. There is a measurable difference in cross-sectional area of the SO between the affected and nonaffected SO in CSOP patients and between the affected side in CSOP SO areas and control SO areas. Correlations with the presence of CN4 and its nucleus as well as with genotypic will provide insight into the pathophysiological mechanism of CSOP.

KEYWORDS: Congenital

O-113

Distinguishing Recurrent Thyroid Cancer from Normal Thyroid Tissue Using Multiphasic Multidetector CT-Enhancing Characteristics

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Purpose
Normal thyroid tissue frequently persists in the thyroid bed following total thyroidectomy and distinguishing this tissue from recurrent disease on follow-up CT images is a diagnostic challenge. We performed multiphase multidetector dynamic CT studies (4D-MDCT) to assess the contrast patterns of recurrent disease and normal thyroid tissue and determine a way to differentiate between these two.

Materials and Methods
Twenty-four patients with 29 nodules of pathologically proven recurrent thyroid carcinoma underwent 4D-MDCT imaging of the neck prior to surgical resection or biopsy. We selected 17 random patients undergoing 4D-MDCT for parathyroid disease without evidence of thyroid cancer to serve as case controls for thyroid enhancing characteristics. Our 4D-MDCT protocol included 4 phases: baseline noncontrast, 25 seconds (arterial phase), 55 seconds (venous phase) and 85 seconds (delayed phase) after injection. Regions of interest (ROIs) were placed over
lesions by identifying the lesion on the most conspicuous phase, defining the lesion with a freehand ROI, and copying this ROI over to the other phases without size variation. Statistical analysis is by Student's T-test.

Results
Thyroid cancer recurrences had baseline Hounsfield densities of 40 +/- 16 versus normal thyroid tissue with 100 +/- 21 (mean +/- standard deviation). Arterial phase was 115 +/- 43 versus 208 +/- 29, venous phase was 106 +/- 26 versus 163 +/- 30 and delayed phase was 99 +/- 27 versus 147 +/- 25. Simple T-test comparisons showed all these differences to be highly statistically significant (p < 0.01). It is clear that normal thyroid tissue has a higher density than recurrent disease at baseline and all phases of enhancement, and that these differences are greatest at baseline and during the arterial phase.

Conclusions
Normal thyroid tissue can be differentiated from recurrent thyroid cancer by means of a distinctly different enhancement pattern. These data serve as justification for future prospective human studies.

KEYWORDS: CT, Neoplasm, Thyroid
classical ocular and intracranial manifestations of these syndromes using ocular imaging like optical coherence tomography (OCT), fundus autofluorescence (FA), and orbital imaging by ultrasonography which complement cranial imaging with computed tomography (CT) and MR imaging (MRI) are described.

Materials and Methods
Patients with congenital ocular syndromes were identified via a retrospective text search program using relevant keywords. Additional clues to the diagnosis were sought on clinical examination, ocular and fundus photographs, ocular and orbital USG, and brain imaging studies. Pertinent images of each modality were analyzed for diagnostic clues characteristic of a particular syndrome. The confirmation of the genetic diagnosis was accessed from the genetics database.

Results
Optical coherence tomography in Bardet-Biedl and Joubert syndromes reveal characteristic findings of absent or rarefied cone outer segment tips line, and vitreoretinal interface abnormalities. Defects or absence of all retinal layers are seen in morning glory syndrome (MGS), CHARGE (chorioretinal colobomata), and Aicardi syndrome (chorioretinal lacunae). Enlarged optic cups with nerve fiber layer thinning are characteristic of Sturge Weber syndrome (SWS). Retinal capillary hemangioblastomas in von Hippel Lindau (VHL) disease, diffuse choroidal hemangioma in SWS, and retinal hamartomas in tuberous sclerosis are noted on OCT, USG and CT/MRI. Characteristic CT and MRI findings are noted in trilateral retinoblastoma and optic pathway gliomas in neurofibromatosis 1, in addition to the molar-tooth sign in Joubert syndrome, hemangioblastomas in VHL, leptomeningeal angiomatosis in SWS, and trans-sphenoidal basal encephalocele in MGS.

Conclusions
Ocular imaging by OCT and FA can help determine retinal morphological alterations such as thickening, atrophy or excavations which can help explain defective vision in these patients. Abnormal findings will prompt further testing by complementary investigative tools like USG, CT and MRI which provide an extended view into the orbit and cranium, which offer diagnostic clues about nonocular lesions in these syndromes. Such comprehensive imaging not only aids in planning the best approach to diagnosis and management but also serves to prognosticate these disorders.

KEYWORDS: Childhood, CNS, MR Imaging
Venous sampling for Cushing’s Disease: Comparison of Internal Jugular Vein (IJV) and Inferior Petrosal Sinus (IPS) Sampling

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1The Johns Hopkins University School of Medicine, Baltimore, MD

Purpose
To compare the accuracy of venous sampling from the internal jugular vein (IJV) with sampling from the inferior petrosal sinus in the setting of Cushing's disease (CD).

Materials and Methods
Twenty consecutive patients who were referred for venous sampling for suspected Cushing's disease underwent a modified venous sampling technique using a coaxial catheter system. Simultaneous baseline venous sampling was performed at five sites: the inferior petrosal sinuses, internal jugular veins and right femoral vein. Venous sampling was repeated after the administration of either corticotrophin releasing hormone (CRH) or desmopressin (DDAVP). The blood samples were analyzed for adrenocorticotropic hormone (ACTH) levels.

Results
Review of the venograms demonstrated appropriate catheter position in 17 of 20 cases. There were no complications associated with the procedures. When measured in the IPS, 17 of 17 cases had ratios diagnostic of CD. When the ratio was measured in the IJV, 9 of 17 (53%) cases had ratios diagnostic of CD. In 14 of 17 cases the IPS ratio lateralized. Of the 13 patients who have undergone surgery, nine had pathology consistent with an adenoma. One additional patient had a clinical cure despite normal tissue in the pathological specimen for a 77% cure rate. In only four cases was there lateralization when IJ ACTH levels were evaluated. In one case this was associated with aberrant drainage of the IPSS. There were not enough cases in the DDAVP group to compare outcomes between the stimulating agents.

Conclusions
Sampling of the IJV is not useful for the evaluation of Cushing's disease, with the exception of rare instances of aberrant IPS drainage.

KEYWORDS: Pituitary Adenoma

Retrospective Analysis of Correlation between Computed Tomography (CT) Density and Functional Status of the Thyroid Gland

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Purpose
It has long been known that there is a significant correlation between thyroid CT density and the
iodine concentration of the tissue (1), and has been suggested that CT density may have the potential to reflect thyroid functional status (1, 2). However, the relationship of CT density and thyroid function has not been studied fully. The purpose of this study is to determine the correlation between the CT density (Hounsfield units, HU) of the thyroid gland and its functional status measured by serum thyroid-stimulating hormone (TSH) levels.

Materials and Methods
In this retrospective study, the medical records of patients who had a cervical spine CT examination for a reason not related to thyroid pathologies between June 2012 and August 2013 were reviewed to identify subjects who also had a thyroid functional test (TSH) within three months of the CT scan. A total of 157 patients met the inclusion criteria and were included. The TSH levels were retrieved from the medical record system and the thyroid CT densities (Hounsfield units) were determined on axial images of the noncontrast CT scan using a soft tissue window. For each patient, the CT densities of two regions of interest (ROIs) of at least 20 mm² were measured for each lobe of the thyroid gland and the average of the four measurements was used as the CT density of the corresponding thyroid. The sternocleidomastoid muscles were used as internal controls. The CT densities of both right and left sternocleidomastoid muscles were determined and the mean muscle densities were calculated in the same manner. In this study, 0.4–4.0 µIU/mL was considered as the normal range for serum TSH levels. The subjects were divided into three groups based on the TSH levels (Low TSH < 0.4 µIU/mL, Normal TSH 0.4 – 4.0 µIU/mL and High TSH > 4.0 µIU/mL) for statistical analyses. In correlation analysis, the patients were divided into two groups, those with TSH < 3.0 µIU/mL and those >= 3.0 µIU/mL.

Results
There were 77 female and 80 male patients, with ages ranging from 20 to 112 years and an average age of 60.7 years. The mean thyroid CT densities for the Low, Normal and High TSH groups were 83.1 ± 16.5 HU (n = 51), 97.4 ± 16.7 HU (n = 78) and 83.0 ± 21.5 HU (n = 28), respectively. Both Low and High TSH groups demonstrated significantly decreased thyroid CT densities when compared to the normal group (P < 0.0001, for both groups). In contrast, the mean densities of the sternocleidomastoid muscles for the same groups were 54.1 ± 9.0 HU (n = 51), 55.5 ± 10.8 HU (n = 78) and 52.6 ± 8.1 HU (n = 28), respectively, with P values of 0.47 and 0.20 for the Low and High TSH groups, respectively, when compared with the Normal TSH group. This result suggested that there was no significant difference in the CT densities of the muscles between the normal and abnormal TSH groups. In addition, correlation analysis demonstrated a weak positive correlation between the thyroid CT densities and TSH levels (r = 0.42; P < 0.00001, n = 125) for subjects with a TSH level < 3.0 µIU/mL and a moderate negative correlation (r = -0.64; P < 0.0001, n = 30) for those with a TSH level >= 3.0 µIU/mL.

Conclusions
The CT density of the thyroid gland is correlated to its functional status as measured by the serum TSH levels. Patients with both abnormally increased and decreased TSH levels demonstrated significantly decreased CT densities, a relationship not observed in the muscle tissue. There is a weak positive correlation between the thyroid CT density and the TSH levels for subjects with TSH levels < 3.0 µIU/mL and a moderate negative correlation for patients with TSH levels >= 3.0 µIU/mL. Therefore, the CT density of thyroid may be an indicator of the thyroid function status, and when CT density of the thyroid gland is below 80 HU on a routine noncontrast cervical spine CT, it may be warranted to recommend a thyroid function test.
Added Value of Dynamic-susceptibility contrast (DSC) MRI and Susceptibility Weighted Imaging in Differential Diagnosis of Solitary Brain Masses

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Purpose
Susceptibility-weighted imaging (SWI) and dynamic susceptibility contrast (DSC) perfusion images are used routinely for characterization of brain lesions. The purpose of this study was to determine the added value of these for differentiating solitary intra-axial brain lesions (tumoral versus nontumoral; differentiating tumor types) by combined assessment of intralesional susceptibility artifacts (ILSA) and the relative cerebral blood volume rCBV.

Materials and Methods
Thirty-five patients with solitary intra-axial brain lesions, without previous surgery, were reviewed retrospectively. Independent reviews were performed by two neuroradiologists blinded to the histopathology results using conventional MR images alone and with adjunctive SWI and DSC perfusion MR imaging (MRI). The solitary lesions were assessed with presence of intralesional susceptibility artifacts (ILSA) (0, 1+, 2+, 3+) and rCBV (hypoperfusion/moderate perfusion/high perfusion) and the imaging diagnosis were compared with specific histopathologic types of lesions. Clinical diagnosis/response to treatment on follow up was considered in case histopathology was not available as in infective lesions.

Results
Two observers diagnosed lesional pathology accurately in 18 (51.4%) of 35 lesions after reviewing the conventional images alone and 26 (74.2%) of 35 lesions after reviewing the adjunctive SWI and DSC perfusion MRI. Intralesional susceptibility signal were seen in 10 (100%) of 10 glioblastoma multiformes (GBMs) usually 3+, in one (25%) of five anaplastic astrocytomas, in two (40%) of five metastatic tumors, two (40%) of five anaplastic oligodendrogliomas and 1(25%) of five tuberculoma. No susceptibility signal was seen in three of the lymphomas, one toxoplasmosis and low grade gliomas. There was a significant difference in ILSA being more prominent in GBM (3+) than other lesions. On DSC perfusion MRI high rCBV was in all of the GBMs (solid portions) and metastasis (100%), moderately high perfusion in lymphomas (100%) and low perfusion in anaplastic astrocytomas (grade II-III), anaplastic oligodendrogliomas, low grade glioma and tuberculomas. A combination of high (3+) intralesional susceptibility artifacts (ILSA) and high perfusion significantly adds to the correct diagnosis of glioblastomas over metastasis. No ILSA seen was in moderately perfused lymphomas. Solitary enhancing circumscribed lesions showing low perfusion with no/low ILSA
favor tuberculoma over infiltrative/low grade gliomas (infiltrative, nonenhancing with low perfusion and no ILSA). Diagnosis of tumefactive demyelination versus low to indeterminate grade glioma can be challenging even with perfusion MRI and SWI.

Conclusions
The use of DSC MRI and SWI together significantly improves the diagnostic accuracy for the differential diagnosis of solitary brain lesions compared with the use of conventional MR imaging alone.

KEYWORDS: MR Imaging Perfusion, Neoplasm, Susceptibility-Weighted Imaging

Assessment of Recurrent Glioblastoma Multiforme Response to Treatment with Bevacizumab: a Diffusional Kurtosis Imaging Study

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Purpose
Bevacizumab has been used increasingly in treating recurrent glioblastoma multiforme (GBM). However, only a fraction of patients respond to the treatment, and effective assessment of treatment response remains difficult. Standard postcontrast T1 and FLAIR images can either exhibit 'pseudoresponse' or 'pseudoprogression' (1, 2). Recently, diffusion-weighted imaging (DWI) was shown to predict or correlate with tumor response to Bevacizumab treatment (3-6). In this study, we investigate whether diffusional kurtosis imaging (DKI) (7) can effectively evaluate recurrent GBM response to Bevacizumab treatment. We hypothesized that volumetric analysis of DKI-derived diffusion parameters may help stratify patients into "responders" and "nonresponders".

Materials and Methods
Patients: Ten patients (56.7 ± 9.2 years, 6 females) diagnosed with recurrent GBM were included in this study. All patients previously underwent postoperative therapy, including radiation combined with chemotherapy (Temozolomide) or radiation alone. Bevacizumab was given every two weeks. One patient was later excluded from the study due to Bevacizumab induced thrombocytopenia. The remaining nine patients were classified into two groups based on a threshold of 90 days progression free survival (PFS): responders (n = 5) with PFS mean of 234 days (range: 90-255 days) and nonresponders (n = 4) with PFS mean of 35 days (range: 28-56 days). MR imaging (MRI): Baseline (1-3 days before treatment) and posttreatment (28 days after treatment) MRI scans were obtained from each patient. MR imaging scans were performed on a Siemens 3 T scanner and included standard postcontrast T1, FLAIR, and DKI with b = 0, 1000, and 2000 s/mm² along 30 encoding directions. Diffusional kurtosis images were used to estimate diffusion and diffusional kurtosis tensors (8), from which parametric maps of mean diffusivity (MD), fractional anisotropy (FA), and mean kurtosis (MK) were generated. Image Analysis: Diffusion maps and FLAIR images were first coregistered to T1-weighted images to ensure the same anatomical space for all images. Regions-of-interest (ROIs) were defined by FLAIR hyperintensity excluding necrosis. Z-scores of each image voxel in the ROI were computed to
quantify the changes in MD, FA, and MK with respect to normal appearing white matter (NAWM) (6). Region of interest image voxels then were classified into "significant increase", "increase", "significant decrease", and "decrease" based on a 95% confidence interval of z-scores (Figure 1). These statistically quantified changes were compared between the responder and nonresponder groups using the two-samples t-test (one-tailed, unequal variances assumed) with a significance level p = 0.05.

Results
In post-treatment MK maps (28 days after treatment), responders showed a significantly smaller ratio of significantly decreased MK volume to decreased MK volume than nonresponders (ratio: 1.4 ± 0.8 versus 5.8 ± 3.8, p = 0.048). This indicates that responders had a smaller portion of significantly decreased MK volume than nonresponders (Figure 1). MD, FA, and volume of abnormal FLAIR signal showed no significant changes.

Conclusions
Our preliminary results demonstrated that post-treatment (28 days after treatment) volumetric changes in MK may help stratify patients into responders and nonresponders (mean PFS: 234 versus 35 days). This suggests that DKI may be useful for early assessment of recurrent GBM response to Bevacizumab treatment.

KEYWORDS: Diffusion Kurtosis Imaging, Glioblastoma, MR Imaging
T1-Rho Imaging of Brain Tumors: A Novel Method to Predict Histology of Intracranial Masses

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Purpose
T1-Rho (T1ρ) is an inherent tissue contrast in MR imaging (MRI) that has shown sensitivity to macromolecules (proteins). Our aim in this study is to investigate whether the T1ρ sequence may provide a useful biomarker for differentiation of intracranial masses.

Materials and Methods
Eight subjects (1 male and 7 females, aged 27-72 years) with newly diagnosed intracranial masses (3 glioblastoma, 2 metastatic melanoma, 1 metastatic rectal cancer, 1 hemangiopericytoma, and 1 hemangioblastoma) were imaged at 3.0 T utilizing a novel 3D whole brain fluid suppressed turbo spin echo T1ρ–weighted sequence along with standard intracranial mass MRI sequences such as T1, T1 postcontrast, and FLAIR sequences. All subjects were scanned with spin-lock (SL) times of 0, 20, 40, 60, 80, and 100 msec at 500 Hz. After image acquisition, two regions of interest were defined by a neuroradiologist for each patient: one in the tumor nidus and one in the surrounding peritumoral T2 hyperintensity, and also in ipsilateral and contralateral normal-appearing white matter. Quantitative T1ρ and T2 values were obtained for each of these regions of interest.

Results
Figure 1A shows a scatterplot comparing T1ρ values (A) of tumor nidus versus tumor edema in eight patients with intracranial masses (Yellow diamonds = metastatic lesions, Green circles = glioblastoma, Red square = anaplastic hemangiopericytoma, Blue triangle = hemangioblastoma). Metastatic lesions demonstrate lower T1ρ values compared to both low and high-grade primary intracranial masses (Figure 1). Within the peritumoral T2 hyperintensity, the high grade primary tumors (glioblastoma) are of lower T1ρ value than the low grade neoplasm. Figure 1B shows a T1 postcontrast MRI image of glioblastoma in left frontal lobe and Figure 1C shows the corresponding T1ρ map of glioblastoma.

Conclusions
Though these data were collected in a small group of patients, they suggest that further research into T1ρ characteristics of various intracranial masses holds potential and value in aiding diagnosis, treatment planning, and prognostication before final pathology results may be available.

KEYWORDS: Contrast, Grading Scale, Neoplasm
Diagnostic Performance Of Magnetic Resonance Imaging In The Diagnosis Of Intracranial Tumors - Comparison With Pathology Results

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Purpose
A correct diagnosis of intracranial tumors on magnetic resonance imaging (MRI) implies an accurate distinction of tumor characteristics, specifically its location (intra versus extra-axial), its nature (benign versus malignant), and its origin (primary versus secondary). We analyzed the diagnostic performance of MR imaging (MRI) in our center in pathology proven intracranial tumors.

Materials and Methods
Patients with brain tumors were searched in MRI and pathology databases between January 1, 2010, and April 1, 2010. One hundred sixty-four consecutive patients constituted our study population (81 males, 83 females, minimum age 3 years old, maximum age 87 years old). The MRI reports were performed by board-certified neuroradiologists and retrospectively analyzed regarding the diagnostic impression and compared with the pathology reports. Agreement on intra/extra-axial location, benign/malignant, primary/secondary, and diagnostic impression of tumor histology were analyzed. Performance diagnostic tests, including sensitivity, specificity, positive predictive value, and accuracy were calculated.

Results
Sensitivity and specificity were calculated as follow: 90.5% and 94% for the diagnosis of intra/extra-axial location; 80.5% and 92.6% for benign/malignant tumor; and 73.5% and 76.5% for primary/secondary tumor. The accuracy of the diagnostic impression compared with tumor histology was 57%. There was a total of 10% false negatives for tumor diagnosis. Overall diagnostic accuracy was highest for the diagnosis of extra-axial versus intra-axial lesions (96%). Positive predictive value was highest for intra/extra-axial location (95%) and for benign/malignant tumor (94%), and significantly lower in distinguishing primary from secondary tumors (74%).

Conclusions
MR imaging is reliable in the diagnosis and characterization of intracranial tumors. Higher sensitivity, specificity and positive predictive values were found for the differentiation of intra-axial versus extra-axial lesions, and of benign versus malignant lesions.

KEYWORDS: MR Imaging Brain, Neoplasm, Quality Control

Imaging Genomic Mapping of Tumor Volume MRI phenotypes in Glioblastoma Multiforme and Correlation with the Survival and Treatment Response
Purpose
The search for the effective therapy for glioblastoma (GBM) continues despite the recent discoveries of new molecular targets and pathways. MR imaging (MRI) is a noninvasive diagnostic modality previously validated to be able to perform robust radiogenomic (imaging genomic) screens for uncovering potential novel molecular targets/determinants (1, 2). Thus, we seek to provide comprehensive image genomic analysis in GBM using quantitative MRI enhancing volume and large scale gene and microRNA expression profiles and correlating with survival.

Materials and Methods
Based on The Cancer Genome Atlas (TCGA), discovery and validation sets with gene, microRNA and quantitative MR imaging data were created. Top concordant genes and microRNAs correlated with high CE volumes obtained from the contrast-enhanced MRI (downloaded from the Cancer Imaging Archive); both sets were further characterized by Kaplan Meier survival statistics, microRNA-gene-imaging correlation analysis, and GBM molecular subtype-specific distribution.

Results
The top upregulated and downregulated gene in both the discovery and validation sets was identified in those patients with high CE volume. Patients with high CE volume demonstrated gene and microRNA signatures associated with angiogenesis. These patients also had poor survival.

Conclusions
Here, we present our imaging screening method for molecular cancer subtypes and genomic correlates of contrast enhancing tumor volume. Our findings also have potential therapeutic significance since successful molecular targeting of those genes, microRNA and pathways involved in the growth of high contrast enhancing tumor volumes will improve therapy and patient survival in GBM.

KEYWORDS: Contrast Enhancement, Glioblastoma, Imaging Genomics
Materials and Methods
Using The Cancer Genome Atlas (TCGA), we identified 99 treatment naive GBM patients for whom both gene and miRNA expression profiles including the 1p/19q deletion status, and pretreatment MR neuroimaging from The Cancer Imaging Archive (TCIA) were available. The VASARI feature set and 3D Slicer software 3.6 (http://www.slicer.org) were used for image analysis and image review was done in consensus by two neuroradiologists. Fluid attenuated inversion recovery (FLAIR) was used for segmentation of the edema and postcontrast T1-weighted imaging (T1WI) for segmentation of enhancement (defined as tumor) and necrosis. Imaging parameters then were correlated with 1p/19q deletion status and gene expression profiles. Complex biomarker signatures based on profiling and survival were created.

Results
A specific imaging biomarker signature using multiple imaging parameters predicted the presence of 1p/19q codeletion in patients with GBM. These also were associated with overall and progressive-free survival.

Conclusions
Imaging genomic signatures can be expected to promote a more robust personalized approach to patient care and accelerate drug development and clinical trials. An imaging biomarker signature was created using both qualitative and quantitative imaging parameters that predicted 1p/19 deletion status and expression.

KEYWORDS: Glioblastoma, Imaging Biomarker, Imaging Genomics

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Pitfalls of Inoperative Magnetic Resonance Imaging (IoMRI) of Pediatric Brain Tumors: Results of a Four-Years' Experience

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Purpose
To review causes of false positive, false negative, misread inoperative MR images (IoMRI) obtained during surgery of pediatric brain tumors.

Materials and Methods
We retrospectively reviewed the inoperative MR images obtained during the surgery of pediatric brain tumors performed between October 2009 and 2013 at the Montreal Children's Hospital. All of the patients underwent inoperative MRI during and/or at the surgery. Inoperative MRI was obtained on 3 T magnet with an 8-channel inoperative head coil. Images were analyzed at the time of acquisition by a senior pediatric neuroradiologist and the operating neurosurgeon in consensus. Correlation with first postoperative MRI follow-up findings was performed in terms of evaluation of degree of resection, immediate complications and limitations.

Results
Among all of the pediatric neurosurgical procedures done at the Montreal Children's Hospital between 2009 and 2013, 176 benefit from IoMRI, 126 (108 patients) were indicated for intracranial tumor and 50 (45 patients) for epilepsy surgery. Eighteen patients were excluded due to nonavailable follow-up examination. Mean age was 8.9 years. Among the 90 patients included
(53 male, 37 female), a total of 108 surgeries was performed for supratentorial (70), infratentorial (35) and extra-axial (3) mass lesion. Based on IoMRI results, gross total resection (GT) was achieved in 57/108 surgeries, subtotal resection (ST) in 33/108 cases, including cases with further resection and no residual (ST-GT) or residual (ST-EXT) tumor at end of surgery. Eighteen surgeries initially were planned partial or biopsies (PP). On the follow-up MRI obtained with a mean postoperative interval of 104 days, 52/57 GT were confirmed with no residual or recurrence seen; 4/33 ST did not have residual corresponding to false positive cases. Overall, accuracy of the IoMRI findings was 90%. Out of the 57 cases with GT resection assessed on IoMRI, five showed tumoral tissue on the first postoperative follow-up MRI. In all of these cases, the resected tumor was of high grade malignancy (glioblastoma multiformis, supratentorial anaplastic ependymoma, metastasis of rhabdomyosarcoma, undifferentiated medulloblastoma). Rapid local recurrence of these malignant lesions could explain the discrepancy between inoperative and follow-up MRIs. In the four false-positive cases with misread IoMRI, several causes were identified, including venous enhancement, surgical bed enhancement as well as blood by product deposits in the surgical cavity. In addition to assessing degree of tumor resection, IoMRI revealed unexpected complications of potential clinical significance on patient's outcome including acute ischemic arterial infarct, active bleed in the surgical bed as well as vascular injury.

Conclusions
Inoperative MRI is a valuable tool to help neurosurgeons achieve gross total resection of pediatric brain tumors. Reading IoMRI is still a challenge to radiologists. We illustrate and explicit causes of potential errors and difficulties of MR interpretation including unexpected complications.

KEYWORDS: MR Imaging, Neuronavigation, Pediatric Brain Tumors
CT In The Diagnosis Of Intracranial Tumors: Is The Diagnostic Performance of The Attending Neuroradiologists Better Than The Resident’s?

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Purpose
Computed tomography (CT) is usually the first exam performed for the diagnosis of intracranial tumors, many times in the emergency setting, and frequently by the resident on call. Accurate distinction between intra- and extra-axial, benign or malignant and primary versus secondary lesions is important to reach a correct diagnostic impression and follow-up approach. We hypothesized that experienced certified board neuroradiologists would be able to better analyze CT images and obtain correct diagnosis of intracranial tumors when compared to neuroradiology residents.

Materials and Methods
Patients with brain tumors were searched in CT and pathology databases between January 2010 and April 2010. Reports of 86 CT in 86 patients (36 male and 50 female, minimum age 3 years, maximum age 85 years) with pathology proven intracranial tumors were analyzed retrospectively, and diagnostic impressions were compared to the final pathology reports. The diagnostic performance of the neuroradiology residents and attending neuroradiologists in the diagnosis of intracranial tumors were compared. Agreement on intra-/extra-axial location, benign/malignant, primary/secondary tumor, and diagnostic impression of tumor histology were analyzed separately for reports performed by residents and attending neuroradiologists. Sensitivity, specificity, positive predictive value, and accuracy were calculated for these parameters.

Results
Sensitivity, specificity and positive predictive value for neuroradiology residents on CT were respectively 75%, 100% and 100% for intra-/extra-axial location of tumor, 60%, 67% and 78% for benign/malignant tumor and 50%, 82% and 33% for primary/secondary tumor. For attending neuroradiologists the sensitivity, specificity and positive predictive value were significantly higher and calculated in 80%, 100% and 100% for intra-/extra-axial location of tumor, 71%, 100% and 100% for benign/malignant tumor and 66%, 97% and 66% for primary/secondary tumor, respectively (p<0.05). There also were significant differences between residents and attending neuroradiologists concerning the accuracy of the diagnostic impression for tumor histology, with 37% and 66%, respectively (p<0.05).

Conclusions
There were significant differences between residents and attending neuroradiologists in the interpretation of CT scans of intracranial tumors. Attending neuroradiologists had consistently higher scores in every parameter analyzed. Our study highlights the importance of routine supervision and validation of the resident reports, especially in the emergency setting.

KEYWORDS: Neoplasm, Report Content, Resident Training
Comparison of cerebral blood volume and plasma volume in untreated intracranial lesions.

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Purpose
Cerebral blood volume (CBV) and plasma volume (Vp) permit the noninvasive assessment of the microvasculature of brain tumors. Cerebral blood volume and Vp should represent related vascular spaces, differentiated by hematocrit, and thus theoretically should be directly related. However, the acquisition of the two parameters utilizes not only significantly different MR imaging (MRI) approaches, but significantly different modeling assumptions. Our purpose was to examine the equivalence of CBV and Vp, and the potential for using these parameters to distinguish different types of intracranial lesions.

Materials and Methods
In this retrospective study patients were scanned with a standard clinical protocol that included both dynamic contrast enhancement (DCE) and dynamic susceptibility contrast (DSC) imaging after the gadolinium contrast agent injection (gadobenate dimeglumine, 0.1 mmol/kg). Our study population included 27 histologically proven untreated newly diagnosed brain tumor patients: Glioblastoma multiformis (GBM) WHO grade IV (n=6), Meningiomas (n=7), and Metastasis (n=14: four from breast cancer, three from gastrointestinal cancer, three from urogenital cancer, three from nonsmall cell lung cancer and one from melanoma). Regions of interest (ROIs) were delineated manually avoiding hemorrhage and necrosis. The lesion shape guided the shape of the ROI to minimize confounding factors. The ROIs size varied between 0.2-0.3cm² and multiple ROIs were drawn in some lesion, based on the lesion size. A total of 86 ROIs [GBM (n=34), meningiomas (n=33), and metastasis (n=19)] were drawn. The ROIs were propagated to DSC-MR images to calculate the CBV in same region. Rational regional CBV (rrCBV) were calculated based on the contralateral white-matter CBV. The hematocrit (HCT) effect was eliminated in our calculations. In metastatic lesions we assessed the rrCBV and Vp correlation in all metastatic lesions and also in lesions with same type of primary tumors separately. Statistical analyses were performed with Pearson and Spearman correlations.

Results
rrCBV and Vp correlation was improved in meningioma (Pearson correlation=0.859, Spearman correlation coefficient=0.641, P <0.01), followed by GBM (Pearson correlation=0.546, Spearman correlation coefficient=0.649, P <0.01). This relation was not significant in metastatic lesions even in patients with the same type of primary tumor. The pattern remained the same even after eliminating the HCT effect.

Conclusions
rrCBV and Vp correlate well in meningioma and moderately well in GBM. Metastatic lesions did not show adequate correlation. This difference in correlation suggests that Vp and rrCBV represent more significantly different vascular processes than their definitions would initially suggest. Furthermore, in cases of an unknown diagnosis, examining the relationship between rrCBV and Vp may help differentiate between metastases and GBMs, while rrCBV and Vp range have a huge overlap in these two pathologies.
Comprehensive Motion-Corrected Neuroimaging Protocol

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Purpose
Motion artifacts degrade roughly one third of MR imaging (MRI) studies and render approximately one study per day nondiagnostic, therefore patient motion persists to be a considerable problem in MRI studies of the brain. In the U.S., the estimated economic impact has been estimated recently to amount to $150-200k/year/MR scanner. Despite attempts to correct for motion with specific MRI acquisition methods that allow for retrospective corrections (e.g., PROPELLER/BLADE) or adaptive approaches (e.g., PACE, PROMO), one major limitation is the lack of a comprehensive solution that applies to all MR pulse sequences. Here, we present an approach that allows one to perform motion correction for a complete suite of brain MR sequences, without an accompanying scan time penalty.

Materials and Methods
A comprehensive neuroimaging protocol was augmented by the ability to adapt to patient head position changes in real time for each pulse sequence. Specifically, the protocol implemented on a GE 3 T (750w) comprised: 3D T1w BRAVO, PDw/T2w FSE, T1 FLAIR, T2 FLAIR, 3D TOF COW, 3D PCASL, 3D SWAN, high-resolution T2w FSE and DWI. The pulse sequences were updated with patient head position information at a rate of 60 times per second using a MR-compatible, in-bore optical tracking system (HobbitView, Atherton, CA) that was independent of the MR acquisition process. All experiments were IRB approved and informed consent was obtained. Eight volunteers performed prespecified motion maneuvers mimicking patterns commonly encountered on routine brain scans: (i) sustained motion for the entire exam; (ii) rapid abrupt motion; (iii) coughing; (iv) "falling asleep"/nodding; (v) no motion.

Results
In all subjects, motion caused substantial artifacts that rendered all sequences diagnostically inadequate. Some sequences (e.g., FSE) were more prone to motion than others (e.g., BRAVO, EPI). Our adaptive motion correction technique was able to fix motion artifacts in all subjects and all sequences. Most importantly, all studies could be rendered diagnostically adequate by application of this technique. A few residual artifacts remained on certain sequences that are more prone to motion than others, but this did not impact the radiologists' ability to make a diagnosis. High-resolution T2-weighted FSE often suffers from ringing/ghosting artifacts even in cooperative subjects who try to hold still. Thus, there is a diminishing return from going to higher resolution. However, pristine image quality could be achieved when motion correction was turned on indicating that these artifacts are due to motion and emphasizing that even in cooperative subjects motion correction is beneficial. Since the pose tracking focuses on one landmark, all scans are perfectly registered to each other. An added benefit of this registration step is that it even allows the patient to leave the scanner in between exams as long as the tracking marker on the forebrain is not removed or its position altered; this is potentially of value.
in many settings, such as delayed postcontrast studies and scenarios where the patient has to be recalled for further sequences.

Conclusions
Currently available motion correction methods, which are pulse sequence specific, may result in inadequate correction of diagnostically important "money shot" sequences, and consequently missed diagnoses. Optical motion correction allows tracking motion independent of the MR acquisition process, and can be applied to virtually any pulse sequence. Therefore, our method provides a comprehensive solution for every pulse sequence. The speed and precision of the presented optical method allows one to adaptively correct for motion. In this study, this led to a change from 100% technically inadequate studies to 100% diagnostic studies.

KEYWORDS: Motion Correction, MR Imaging
Postcontrast T1 FLAIR versus T1 Fast Spin Echo: Which is the better choice for intracranial lesion evaluation?

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Purpose
Loss of cerebrospinal fluid (CSF) and tissue contrast on 3 T MR imaging (MRI) scanners is a widely known limitation of 3 T MRI. Inversion recovery is used to adjust for this loss but its efficacy postcontrast has not been investigated extensively. Previous studies have evaluated differences in conspicuity of spinal cord lesions on 3 T versus 1.5 T MR imaging in gadolinium-enhanced T1-weighted fast spin echo (FSE) and T1-weighted FLAIR, finding that use of FLAIR may yield increased conspicuity of lesions. The purpose of this study is to determine whether a similar conclusion can be made in the evaluation of intracranial lesions.

Materials and Methods
After the iv administration of gadolinium, T1 FSE and T1 FLAIR sequences were obtained in 30 consecutive patients. Three experienced radiologists were asked to evaluate and compare the conspicuity of abnormal enhancing intracranial lesions between the two sequences. Of the 30 patients, 19 had abnormal enhancing lesions and thus were evaluated. A 5-point number scale was used to score the overall conspicuity of lesions found in each MRI study, with lower numbers representing increased conspicuity of lesions on FLAIR and higher numbers representing increased conspicuity of lesions on FSE.

Results
An increase in conspicuity was consistently seen on T1-weighted FLAIR in comparison to T1-weighted FSE. Utilizing chi-square analysis, the difference in conspicuity between the studies was found to be statistically significant (mean: 2.02, p<0.0001).

Conclusions
In postgadolinium T1 3T MR imaging, T1-weighted FLAIR increases the visualization enhancing brain lesions when compared to T-1 weighted fast spin echo and is therefore recommended as the preferred sequence in routine MR imaging.

KEYWORDS: Fast Spin-Echo, FLAIR, Fluid-Attenuated Inversion Recovery
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3:00PM - 4:30PM
Palais des congres de Montreal, 517a

20 - SCENARIO PLANNING AND THE ASNR
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Scenario Planning: Principles, Theory and Practice

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Scenario Planning: The SCARD Experience

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Relevance to ASNR

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Univ of California, San Francisco Med Ctr
San Francisco, CA

Discussion

Monday
3:00PM - 4:38PM
Palais des congres de Montreal, 520
Brain CT and the Detection of Subdural Hematomas in Trauma: Do coronal and sagittal reformations improve sensitivity?

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Purpose
Current standard of care employs emergent noncontrast brain computed tomography (CT) in the axial plane only as the initial imaging evaluation for acute head trauma. At our institution, orthogonal images (coronal and sagittal) have been included routinely. Our goal was to determine if the addition of orthogonal imaging planes (coronal and sagittal) improves the sensitivity for detection of subdural hematoma (SDH) compared with standard axial brain CT. We assumed a null hypothesis of no difference in sensitivity. We also hypothesized that the reading times for the multiplanar CT would not be significantly longer.

Materials and Methods
In this retrospective single institution study, 200 consecutive patients receiving noncontrast brain CT for an indication of trauma met inclusion criteria. By design, equal numbers of patients were assigned to each group: 100 SDHs and 100 controls (negative exams). All patients were anonymized and randomly divided into five sets of 40 (each with 20 SDH, 20 control). Each patient's scan was presented twice, once with axial images only and once with axial, coronal, and sagittal images. Four readers (two CAQ-certified neuroradiologists, a neuroradiology fellow, and one radiology resident) were blinded to the purpose of the study and asked to provide their diagnostic impressions. There were 10 sessions per reader (5 axial, 5 reconstructed). The scan order was randomized for each session, so that no two sessions were identical. Final impressions and average reading times were recorded. Detection rates of SDHs (using the final report as the standard of reference) were compared between axial and reconstructed reading sessions.

Results
Gender distribution was equal between the SDH and control groups (both: 58 male; 42 female). The SDH cohort was significantly older (average 50.6 versus 39.6, p = 0.0002). To date, a total of 16 reading sessions have been completed: eight reconstructed and eight axial only. On average, reading time spent per scan was not significantly different between groups (142s axial; 157s reconstructed, p=0.54). For axial images only (320 readings), 18.8% of SDHs were not identified (30 of 160) compared to 8.1% (13 of 160) with reconstructed images (p = 0.008) (Figure 1).

Conclusions
There was a significantly increased detection rate of SDH with the addition of orthogonal reconstructions, without a significant increase in reading times. Further work will include an assessment of the clinical significance of "missed" SDHs through patient chart review. Increased SDH detection rates in the setting of trauma may reduce patient morbidity and mortality.

KEYWORDS: CT, Subdural Hemorrhage, Traumatic Brain Injury
Average time spent per patient: Axial - 142 sec, Reconstructed - 157 sec

P value = 0.008
Repeated Head CT in the Neurosurgical ICU: Feasibility of SAFIRE based Ultra-low dose CT for Surveillance

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¹Mount Sinai Hospital, New York, NY

Purpose
Patients in the neurosurgical intensive care unit (NICU) undergo multiple head CT scans, resulting in high cumulative radiation exposures. Our aim was to assess the acceptability of a dedicated, special purpose SAFIRE iterative reconstruction-based ultra-low dose CT (ULDCT) protocol for NICU surveillance head CT exams, by quantitatively and qualitatively comparing image quality to routine studies on the same patients performed with our standard of care SAFIRE LDCT and legacy FBP SDCT protocols.

Materials and Methods
A retrospective analysis was performed of 54 head CT exams - ULDCT (n=22), LDCT (n=12) and SDCT (n=20) in 22 NICU patients. SDCT were reconstructed using FBP on a Somatom Sensation 64 (Siemens, Erlangen, Germany). LDCT and ULDCT exams were obtained on a Siemens AS+128 scanner with commercially available SAFIRE. Qualitative and quantitative parameters including image quality and dose were evaluated.

Results
SAFIRE ULDCT represented a 68% lower CTDIvol compared to FBP SDCT techniques in the same patients while maintaining similar quality and SNR levels. SAFIRE LDCT offered higher image quality than FBP SDCT (p< 0.05) with no differences in SNR at 24 % lower CTDIvol. Compared to LDCT, ULDCT had significantly lower SNR (p=0.001) but demonstrated clinically satisfactory measures of image quality.

Conclusions
In this cohort of NICU patients, dedicated ULDCT for surveillance head CT imaging leads to a significant dose reduction while maintaining adequate image quality.

KEYWORDS: CT, Dose Reduction, Iterative Reconstruction

<table>
<thead>
<tr>
<th></th>
<th>ULDCT (n=22)</th>
<th>LDCT (n=12)</th>
<th>SDCT (n= 20)</th>
<th>SDDCT-ULDCT (%)</th>
<th>SDCT-LDCT (%)</th>
<th>LDCT-ULDCT (%)</th>
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<tr>
<td>CT dose index volume – CTDIvol (mGy)</td>
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<tr>
<td>Max</td>
<td>20.46</td>
<td>54.71</td>
<td>60.69</td>
<td>40.23 (56)</td>
<td>5.99 (10)</td>
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<td>Min</td>
<td>11.77</td>
<td>26.79</td>
<td>33.80</td>
<td>22.03 (65)</td>
<td>7.01 (20)</td>
<td>15.03 (56)</td>
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<td>Mean</td>
<td>15.55</td>
<td>36.47</td>
<td>48.38</td>
<td>32.83 (68)</td>
<td>11.92 (24)</td>
<td>20.91 (57)</td>
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<td>Dose length product –DLP (mGy·cm)</td>
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<td>Max</td>
<td>375.00</td>
<td>958.00</td>
<td>1128.20</td>
<td>753.20 (67)</td>
<td>170.20 (15)</td>
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<td>Min</td>
<td>188.00</td>
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<td>574.65</td>
<td>386.65 (67)</td>
<td>103.65 (18)</td>
<td>283.00 (61)</td>
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<td></td>
<td>Mean</td>
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<tr>
<td>Effective Dose- ED (mSv)</td>
<td>273.39</td>
<td>668.58</td>
<td>843.30</td>
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<td>(67)</td>
<td>174.82</td>
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<td>Difference ED</td>
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<tr>
<td>Max</td>
<td>0.86</td>
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<td>2.59</td>
<td>1.73</td>
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<tr>
<td>Min</td>
<td>0.43</td>
<td>1.08</td>
<td>1.32</td>
<td>0.89</td>
<td>(67)</td>
<td>0.24</td>
</tr>
<tr>
<td>Mean</td>
<td>0.62</td>
<td>1.53</td>
<td>1.93</td>
<td>1.31</td>
<td>(68)</td>
<td>0.4</td>
</tr>
</tbody>
</table>

**SDCT (1/25/13)**

**LDCT (1/26/13)**

**ULDCT**

ED = 2.23 mSv  
CTDlvol = 47.83 mGy  
DLP = 971 mGy*cm

ED = 1.56 mSv  
CTDlvol = 36.3 mGy  
DLP = 678 mGy*cm

(Filename: TCT_O-134_ASNR.jpg)

O-135
Utility of CT Perfusion in the setting of a false-negative CTA for brain death due to a decompressive craniectomy or major skull fracture

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Purpose
CT angiogram (CTA) is the most commonly used ancillary test in the determination of brain death. However it can be falsely positive (that is negative for brain death) in patients with a decompressive craniectomy or major skull fractures. This is due to the reduction in intracerebral pressure allowing sufficient filling of the intracranial vessels. False negative CTAs can lead to unnecessary delay in diagnosis with implications on organ transplantation as well as use of limited resources on brain dead patients. We explore the utility of CT perfusion (CTP) in these situations.

Materials and Methods
Between January 2013 and August 2013, CTP was performed in five patients with decompressive craniectomy or major skull fracture with clinically and radiologically suspected brain death but negative CTA results. All these patients had adequate opacification of cortical segments of the middle cerebral arteries and internal cerebral veins and thus scored four on the four-point CTA scale. Regions of interest (ROIs) were drawn in bilateral cerebral parenchyma and in deep gray nuclei to assess cerebral blood volume (CBV) and cerebral blood flow (CBF). Mean CBV and CBF were calculated. Values for CBF x CBV were used to assess level of perfusion, with levels below a threshold of 19.72 being regarded as tissue infarction, and thus brain death.

Results
All the patients showed CBV x CBF values less than 19.72 indicating tissue infarction despite presence of adequate filling of intracranial vessels on CTA.

Conclusions
Computed tomography angiography may be inadequate and falsely negative for the diagnosis of brain death in patients with decompressive craniectomy or major skull fracture. Computed tomography perfusion should be considered in the guidelines as a valid ancillary test in order to reach conclusive diagnosis early in the management of these patients.

KEYWORDS: Brain Death, Craniectomy, CT Perfusion

Subject NCCT findings
1 diffuse hypodensity, loss of gray white differentiation, large tentorial hematoma, right frontotemporal
2 diffuse hypodensity, loss of gray white differentiation, right frontotemporal craniectomy
3 loss of gray white differentiation, subdural hemorrhage
4 diffuse hypodensity, loss of gray white differentiation, large displaced fracture left skull base
5 loss of gray white differentiation, left hemicraniectomy
Aging effect in the alterations of frontoparietal network after mild traumatic brain injury

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Purpose
Poor attention and memory impairment are symptoms frequently complained after mild traumatic brain injury (mTBI). However, behavioral performance usually was normal in these patients. Frontoparietal network (FPN) is an intrinsic brain network involved in tasks of numerous executive cognitive processes such as attention, motor inhibition and working memory and is constantly observed in the resting-state functional MR imaging (rs-fMRI) studies. Alterations of the FPN after mTBI have been reported in several studies. This study aims to evaluate the influence of age on frontoparietal network connectivity after mTBI.

Materials and Methods
Research ethics committee approval and patient written informed consent were obtained. We collected two groups of mTBI patients (age > 50 years and age < 30 years). The older group contains 13 patients (51~68 years; average 57.7 years) and the younger group contains 13 patients (21~29 years; average 24.7 years). Thirteen age- and gender-matched normal controls (NC) for the older group (51~68 years; average 60.1 years) and 13 age- and gender-matched normal controls for the younger group (21~29 years; average 26.1 years) were recruited. All patients received resting-state fMRIs within two weeks after mTBI on a GE Discovery MR750 3 T MRI scanner. Data preprocessing using SPM8 (www.fil.ion.ucl.ac.uk/spm) included slice timing correction, head motion correction, spatial normalization to the MNI template, and spatial smoothing. Group independent component analysis (ICA) was performed using GIFT (http://icatb.sourceforge.net). For each group, the preprocessed images from all subjects were concatenated and reduced by two-step principal component analysis, followed by independent
component estimation with the Infomax algorithm. The group ICA analysis on each group was run 20 times using the ICASSO function to ensure stability and reliability of the 20 estimated components. A set of average group components were created and back-reconstructed into single-subject space. The individual subjects' components were scaled to spatial z-score maps by subtracting the global mean from each voxel and dividing by the global standard deviation and then entered into a one-sample t test (p < 0.01, corrected for multiple comparisons with false discovery rate criterion; cluster threshold = 10 voxels). Two-sample t test were performed to assess group differences between carriers and noncarriers results (p < 0.001 uncorrected; cluster threshold = 10 voxels).

Results
One-sample t test results showed bilateral FPN connectivity in the younger and older groups. The lateralized FPN component included the brain regions in the ipsilateral intraparietal sulcus, inferior parietal lobe, and dorsal premotor cortex, as well as some minor brain regions in the contralateral dorsal premotor and inferior parietal cortex, which were consistent with previous reports. Figure 1 shows two-sample t test results of bilateral FPN connectivity compared between the mTBI patients and the normal controls. In the younger group, increased FPN connectivity was found both in the RFPN and LFPN relative to the normal control. In the older group, there also was increase in bilateral FPN connectivity relative to the normal control. However, the older group showed greater extent of increase in FPN connectivity than the younger group.

Conclusions
This study found that bilateral FPN connectivity was increased in both the younger and older adults after mTBI. However, greater extent of increase in FPN connectivity was found in the older group than the younger group.

KEYWORDS: Aging, Functional Connectivity, Mild TBI
Diffusion Tensor Imaging for Outcome Prediction in Complicated and Uncomplicated Mild Traumatic Brain Injury
Purpose
There is growing recognition that current classification schemes for mild traumatic brain injury (MTBI) based solely on Glasgow Coma Scale and duration of post-traumatic amnesia and loss of consciousness are very limited, with small mean effect sizes in long-term impairment obscuring differences among diverse subgroups of MTBI patients with very different prognoses. Diffusion tensor imaging (DTI) is a promising technique for identification of microstructural white matter damage after traumatic brain injury. Although group differences in DTI parameters between MTBI patients and controls have been demonstrated, we sought to explore the practical use of acute or subacute DTI data for outcome prediction in the individual patient after controlling for demographic, clinical, and CT and conventional MRI predictors.

Materials and Methods
We evaluated DTI at 3 T for evidence of white matter injury in 37 adult MTBI patients at the semi-acute stage (10.9±3.6 days) after injury, employing both whole-brain voxelwise analysis and a complementary region-of-interest (ROI) approach. Because whole-brain voxelwise approaches may have limited sensitivity due to the heterogeneity of spatial distribution of white matter injury in MTBI, while the ROI approach may be limited by failure to interrogate less common areas of white matter injury, we employed both of these methods as complementary approaches in the current study.

Results
Complicated MTBI, defined as presence of any acute traumatic intracranial lesion and/or depressed skull fracture on day-of-admission CT or semi-acute 3 T MRI, was associated with significantly reduced fractional anisotropy (FA) in the internal and external capsules, uncinate fasciculi, genu of corpus callosum, and corona radiata compared to 50 control subjects. In contrast, we found no significant group differences in FA between uncomplicated MTBI and control subjects, using either whole-brain voxelwise or ROI methods. To determine the clinical relevance of DTI findings to outcome, we assessed for correlations between 3- and 6-month outcome measures and DTI, CT and MRI findings and demographic, socioeconomic and clinical predictors. MR imaging features, including DTI parameters, surpassed other variables for prediction of 3- and 6-month outcome. The best predictors of 3-month Extended Glasgow Outcome Scale (GOS-E) were DTI evidence of one or more ROIs with severely reduced FA (univariate odds ratio 8.0 per unit decrease in 3-month GOS-E, p=0.008) and MRI evidence for contusion (univariate odds ratio 12.6, p=0.02). The only statistically significant predictor of 6-month GOS-E was combined conventional MRI and DTI evidence of any traumatic intracranial lesion (odds ratio 4.8, p=0.03).

Conclusions
We employed both whole-brain voxelwise and ROI analyses as complementary approaches to show that microstructural white matter injury severity does vary, on a group level, according to
the presence of more familiar macroscopic pathoanatomical lesions on CT and conventional
MRI. In addition, this is the first study to compare DTI features in individual MTBI patients to
conventional MRI, CT, clinical, demographic and socioeconomic features for the prediction of 3-
and 6-month outcome in individual patients. We show that conventional MRI and DTI are
useful, complementary imaging biomarkers for prediction of 3- and 6-month outcome in MTBI.

KEYWORDS: Diffusion Tensor Image, Traumatic Brain Injury

![All MTBI vs. controls](Filename: TCT_O-137_ASNR_Abstract_Submitted2013Dec13.jpg)

**O-138**

**Resting State Networks of Traumatic Brain Injury**

L Lin¹, M Brier¹, S Chleboun², A Snyder¹, C MacDonald¹, J Shimony³
Purpose
Patients with traumatic brain injury (TBI) often have difficulty with cognition, sensory processing, communication, and mood. It is thought that the axonal injury and consequent disruption of functional networks contributes to the cognitive dysfunction. Previous studies of functional connectivity in TBI patients has been mainly in the acute phase of injury, and focused on the default mode network (DMN). The purpose of this study was to look at changes in several resting state networks (RSN) in patients with chronic (1-7 years from injury) TBI using resting state functional MRI (rsfMRI).

Materials and Methods
Eighteen chronic TBI patients (13 moderate and 5 severe by GOSE criteria) ranging from 1-7 years since initial injury and 16 age-matched controls were enrolled. Subjects were scanned in a 3 T Allegra MRI scanner (Siemens, Erlagen, Germany) while awake with eyes open and not performing any tasks. Following previously described protocols, we acquired rsfMRI [TE = 25 ms, 90º flip, (4 mm) 3 voxels, 438 frames], high resolution MPRAGE and T2-weighted fast spin echo scans. Preprocessing included compensation for asynchronous slice timing, retrospective correction for head motion and atlas transformation ((3 mm) three voxels). Thirty-six regions of interest (ROIs) representing five resting state networks were used to extract the time course of the blood oxygen level dependent (BOLD) signal from the rsfMRI. A Pearson correlation coefficient (r) was computed between the time course of each ROI with all other ROIs and normalized with the Fisher's z-transformation. The resulting z-values were averaged within each of the five resting state networks.

Results
As seen in the figure, the within network correlations decreased in both TBI groups, with the decrease more noticeable in the severe TBI group. The differences between control and severe groups are significant in every network except for the sensory-motor network (SMN) (Figure 1), while the differences between control and moderate groups are significant in the dorsal attention (DAN) and control networks (CON) (Figure 2). Differences seen in the DMN and salience network (SAL) are significant between control and severe groups, but are not significant between the control and moderate groups.

Conclusions
Intranetwork correlations, on average, are decreased in moderate and severe TBI patients as compared to controls. Although each TBI is different the current results suggest that moderate and severe injury cause more global dysfunction in neural networks.

KEYWORDS: Resting-State FMRI, TBI, Traumatic Brain Injury
FDG-PET Precuneus hypometabolism in Veterans with history of Traumatic Brain Injury (TBI)

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¹Stanford University/Palo Alto WRIISC, Menlo Park, CA, ²Stanford University, Palo Alto, CA, ³VA Palo Alto Health Care System, Palo Alto, CA, ⁴Palo Alto Veterans Affairs Hospital, Palo Alto, CA

Purpose
To investigate whether traumatic brain injury (TBI) severity is associated with Alzheimer disease (AD)-like metabolic decline independent of age in a cohort of mid-life veterans. There is increasing evidence suggesting that a history of TBI is increasing the risk for dementia and may hasten its onset. However, it is unclear to what extent there is a specific link between TBI and AD.

Materials and Methods
A convenience sample of mid-life veterans was selected from our study center. Diagnosis of TBI severity and post-traumatic stress disorder (PTSD) was established using alteration of consciousness (AOC), loss of consciousness (LOC), post-traumatic amnesia (PTA) and clinician-administered PTSD scale (CAPS). All patients underwent FDG imaging within one week of the examination. Fluorodeoxyglucose scans were spatially normalized to the MNI FDG template in SPM8 and smoothed with at 6mm kernel. Scans then were entered into a multiple regression analysis with TBI severity as variable of interest and age as nuisance variable. T maps exploring
negative correlations between TBI severity and metabolic decline were initially thresholded at \( p < .001 \) (uncorrected) followed by a volume-of-interest (VOI) analysis (30 mm sphere).

Results
The sample consisted of 57 veterans (7 females), mean age of 46.8 years (median: 45.1), 31 mild TBI, 5 moderate TBI and 43 with PTSD. Glucose metabolism decreased significantly with increasing TBI severity in the right precuneus and left angular gyrus. Volume-of-interest analyses with FWE multiple comparison correction at \( p < .05 \) confirmed the robustness of the effect.

Conclusions
Traumatic brain injury severity is associated with AD-like metabolic decline within the precuneus and angular gyrus, independent of age.

KEYWORDS: PET/CT, TBI, Traumatic Brain Injury

O-140

Longitudinal Assessment of Executive Working Memory with fMRI in Athletes Participating in Contact Sports, Baseline and Post-Concussion Evaluation

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\(^1\)University of Florida, Gainesville, FL

Purpose
To develop a rapidly performable objective functional MR imaging (fMRI) paradigm to assess executive decision making and memory in the evaluation of concussion following sports-related injury. There are an estimated 1.6-3.8 million sports-related concussions each year in the United States. Postconcussive symptoms include lowered cognitive function and resolution of this is used as a clinical indicator of recovery. Cognitive function usually is assessed by standardized neuropsychometric tests compared with baseline results or against established population-specific normative data. Limitations of these tests include subjective components related to the player's responses, especially at time of baseline testing and a potentially high false positive rate (40%) as suggested by other investigators. There has been increased assessment of functional abnormalities in symptomatic athletes utilizing fMRI, however most of these studies compare fMRI findings to the results of normative group data. To further refine this testing, a cohort of players engaged in competitive contact sports underwent baseline and postconcussion imaging.

Materials and Methods
Prior to the beginning of the scheduled season baseline MR and fMRI imaging was obtained on players participating in contact sports as part of an IRB-approved research protocol. MR imaging was performed on a 3 T Toshiba Titan scanner and included high resolution volumetric T1, a blood sensitive sequence, FLAIR, and diffusion tensor imaging (DTI). Functional MRI testing consisted of a six minute BOLD contrast scan using an n-Back test paradigm with alternating 0-Back and 2-Back tests of working memory function. Total scan time was 25 minutes. Following a sports related concussion diagnosed by team physicians, the players underwent repeat imaging using the same protocol 1-3 days postinjury. Analysis of fMRI BOLD data was performed with FSL fMRI Expert Analysis Tool (FEAT) and group maps created to compare baseline and postconcussion regions of activation.
Results
Sixty-six players enrolled in the study and underwent baseline imaging per protocol. During the season there were four practice- or play-related concussions, all of which had follow-up imaging. Baseline memory test results for the group of players that subsequently had a concussion demonstrated a correct performance rate on the baseline 0-Back and 2-Back tests of 100% and 100% respectively. Correct group performance rate on the postconcussion 0-Back and 2-Back tests was 98% and 93% respectively. Functional MRI group analysis maps demonstrated a decrease in activation in the dorsal lateral prefrontal cortex (DLPC) following concussion which was most significant on the right.

Conclusions
An fMRI task of executive working memory can be performed in addition to routine sequences following mTBI to provide activation information. Although there was not a significant change in performance on n-Back testing, there were definite changes in the pattern of cortical activation. Following mTBI there was decreased activation in the DLPC, especially on the right in our cohort. This correlates well with the work of other investigators that have used control populations as their comparison group. These findings further confirm that there are different physiological responses to memory following injury and suggests this testing paradigm may be of utility in the diagnosis of mTBI.

KEYWORDS: FMRI, Memory, Traumatic Brain Injury

O-142

White Matter Integrity Changes and Head Impact Exposure in a Season of High School Varsity Football

E Davenport1, C Whitlow1, J Urban1, M Espeland1, Y Jung1, D Rosenbaum1, G Gioia2, A Powers1, J Stitzel1, J Maldjian1

1Wake Forest University School of Medicine, Winston-Salem, NC, 2Children's National Medical Center, Rockville, MD

Purpose
The purpose of this study is to determine if the cumulative effects of head impacts from a season of high school football produce magnetic resonance imaging (MRI) measurable changes in the brain in the absence of clinically diagnosed concussion.

Materials and Methods
Twenty-seven players from a local high school football team (mean age=17.2; age range=16-18) were instrumented with the head impact telemetry system (HITs) during all practices and games. All players received pre and postseason MR imaging (MRI). Diffusion tensor imaging (DTI) images were acquired using a 2D single-shot EPI sequence (TR=10500 msec; TE=99 msec; FA=90 degrees; spatial resolution= 2.2x2.2 mm; slice thickness = 3 mm; 54 slices; 10 b = 0 volumes; 15 diffusion directions with b = 1000/2000 each). Immediate postconcussion assessment and cognitive testing (ImPACT) also was conducted. The biomechanical metric computed from the HITS data for this study was the risk weighted cumulative exposure (RWE). This metric represents the collected risk of concussion over the course of the season. Total impacts and risk weighted cumulative exposure (RWE), including linear (RWELinear),
rotational (RWERotational), and combined components (RWECP) were computed for each subject. Fractional, linear, planar and spherical anisotropies (FA, CL, CP, CS, respectively), as well as mean diffusivity (MD), were used to determine total number of abnormal white matter voxels (defined as 2 standard deviations above or below the group mean). Delta (post minus preseason) ImPACT scores for each individual were computed and compared to the DTI measures using the Spearman's rank correlation coefficient. None of the players analyzed experienced clinical concussion (N = 25).

Results
Regression analysis revealed a statistically significant linear relationship between RWECP and FA. Secondary analyses demonstrated additional statistically significant linear associations between RWE (RWECP and RWELinear) and all DTI measures. There also was a strong correlation between DTI measures and change in verbal memory subscore of the ImPACT.

Conclusions
We demonstrate that a single season of football can produce brain MRI changes in the absence of clinical concussion. Similar brain MRI changes have been previously associated with mild traumatic brain injury.

KEYWORDS: Concussion, Diffusion Tensor Image, DTI

(Filename: TCT_O-142_asnr2014_dtigraph.jpg)

O-143 4:03PM - 4:10PM

Interhemispheric Connectivity Changes Associated with a Season of High School Football

F Mokhtari1, E Davenport2, J Urban2, N Bahrami2, C Whitlow2, A Powers2, J Stitzel2, J Maldjian2

1Wake Forest University, Winston Salem, NC, 2Wake Forest University School of Medicine, Winston Salem, NC
Purpose
The goal of this study is to determine if cumulative head impacts over a season of high school football has an effect on brain network connectivity.

Materials and Methods
Thirty high school football players without history of prior concussion (age: 14-18, gender: male) participated in the study. None of the players included in the study experienced clinical concussion during the season. For each subject, biomechanical data were acquired using the head impact telemetry (HIT) system during practices and games using helmet-embedded sensors. Six minutes of resting-state fMRI pre and postseason were obtained using a Siemens Trio 3 T scanner in each subject. The biomechanical metric utilized to capture each player's head impact exposure was the risk weighted cumulative exposure (RWECP) (1). This metric is defined as the combined risk of concussion calculated from the peak resultant linear and rotational acceleration for each impact. FMRI data preprocessing was performed using SPM8. For each subject, fMRI data were motion corrected, normalized to MNI space and band-pass filtered at 0.01 - 0.1 Hz. The 6 rigid-body motion parameters, as well as parameters for the white matter signal, global mean signal, and cerebrospinal fluid signal were regressed from the time series. Interhemispheric connectivity was calculated between regions of the AAL atlas including 54 regions in each hemisphere using a correlation metric. For each subject, connectivity differences between post and preseason for each ROI were computed. In order to investigate the relationship between RWECP versus prepost difference in functional connectivity a multiple linear regression analysis was performed. Body mass index (BMI), time between scans, and participant age were included in the model as confounders. Significance was determined using a bootstrap analysis with 1000 resamplings.

Results
Eight interhemispheric connectivities out of 54 connectivities were identified as significant (p < 0.05). The likelihood of identifying eight significant connectivities at an alpha of 0.05 among 54 tests is less than 1%. Table 1 shows the results obtained using univariate and multivariate linear regression analysis and the bootstrapping multiple linear regression analysis for RWECP versus prepost season difference of interhemispheric connectivity.

Conclusions
These results indicate changes (predominantly decreases) in the interhemispheric connectivity between frontal lobe, thalamic and cerebellar structures in nonconcussed subjects during a single season of football. This is in accordance with several studies which have shown significant changes in frontal lobe and cerebellum interhemispheric connectivities associated with mTBI (2, 3).

KEYWORDS: Concussion, FMRI, Functional Connectivity
Mild Neck Compression Alters Intracranial Venous Sinus Volume: Implications for a Novel Neuroprotective Effect in Concussion

J Leach¹, G Myer¹, D Smith¹

¹Cincinnati Children’s Hospital Medical Center, Cincinnati, OH

Purpose
Recent animal models indicate that internal jugular vein compression may mitigate traumatic axonal injury by potentially reducing intracranial Slosh effect by increasing intracranial blood volume and altering intracranial compliance (1). Additional recent population studies have documented a decrease in reported concussions in athletes at higher altitudes, potentially related to altitude-related changes in cerebral volume (2). Understanding how jugular venous compression may alter venous volume in humans is necessary to see if this approach can be applied as a potential neuroprotective mechanism. The purpose of the current study was to investigate the effect of mild neck compression on the volume of the intracranial dural sinuses in normal subjects.

Materials and Methods
Four normal subjects (ages: 28-38, M:2, F:2) participated in the study cohort. A pneumatically operated band compression device was used to provide transient mild neck compression during the procedure. Previous internal safety studies of the maneuver have documented safety and adequacy of venous compression by US evaluation. Intracranial 2D TOF MRV (coronal plane, 1.6 mm ST, inferior sat pulse) was performed at baseline (NC) and with jugular compression (C) in each subject. Semi-automated segmentation of flow signal within the transverse (TS), sigmoid (SS), straight sinus (StS), and superior sagittal sinus (SSS) was performed using BrainLab iPlan 3.0. Volumes of the venous segments were analyzed in each subject with and without jugular venous compression.

Results
Jugular compression was tolerated well in all subjects with no reported discomfort or symptoms. Volumes of the SS and StS, as well as total dural sinus (TDS) volume increased in all subjects (mean change: + 4.2%, + 25.65%, + 6.3% respectively) with neck compression; SSS volume

<table>
<thead>
<tr>
<th>Interhemispheric connectivities</th>
<th>T-stat and P-value without bootstrapping</th>
<th>P-value with bootstrapping</th>
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<tr>
<td></td>
<td>Univariate Model</td>
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<td>Cerebelum8</td>
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</table>

Results
increased in two and TS volume increased in four. As a group, mean dural sinus volume increased in all segments with a significant increase in TDS (p=0.25), SS (p=0.006), and StS (p=0.0498) volume (Figure).

Conclusions
Jugular venous compression results in increased total dural sinus volume in normal subjects in the MR environment. Significant segmental increases were noted in the sigmoid and straight sinuses. Future research is warranted to determine if mild jugular compression alters intracranial compliance in humans and if reductions in brain damage in response to concussion might be achieved with this maneuver as previously noted in animal studies.

KEYWORDS: TBI, Venous Anatomy, Venous Drainage
Role of MR Neurography in the Management of Entrapment Neuropathies

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Purpose
Magnetic resonance neurography (MRN) is a noninvasive high-resolution magnetic resonance imaging technique increasingly used in the evaluation of the peripheral nerves. The ability of MRN to alter the management of patients with peripheral neuropathy requires further investigation. Our goal was to assess the impact of MRN on the treatment plan in patients with suspected upper and lower extremity entrapment neuropathy.

Materials and Methods
We retrospectively identified 17 patients with suspected upper and lower extremity entrapment neuropathy (10 ulnar; 7 peroneal) that had undergone MRN on 3 T MR scanner with a dedicated extremity coil. Anonymized clinical exam and electrophysiological data were presented to a neurosurgeon who had not been involved in the care of these patients. The neurosurgeon completed a questionnaire on each patient twice, before and after receiving access to the MRN imaging data. The information collected included the following: degree of confidence of a peripheral nerve abnormality (1: low, 2: moderate, 3: high), specific nerve involved, degree of confidence of need for surgery (1: low, 2: moderate, 3: high), timing of surgery (1: immediate, 2: not sure and follow up in 3 months, 3: surgery not needed), approach to surgery (site and length of incision), confidence in approach to surgery (1: low, 2: moderate, 3: high) and estimated length of surgery (1: < 2 hours, 2: 2-4 hours, 3: 4-6 hours, 4: 6-8 hours, 5: >8 hours). Change in evaluation of these parameters before and after access to MRN data was calculated using Wilcoxon signed-rank test. Results were considered significant when p < 0.05.

Results
Before obtaining access to the MRN data the neurosurgeon made the diagnosis of neuropathy in 15 out of 17 peripheral neuropathy subjects. After review of the MRN data there was no significant change in the level of confidence of the neuropathy diagnosis (p = 0.18). The surgeon became significantly more confident about the need for surgery in seven (41.2%) patients (p = 0.003). Furthermore in 11 (64.7%) patients there was a change in timing of surgery recommendation [no surgery to immediate surgery (5.9%), follow up to immediate surgery (29.4%), follow up to no surgery (11.8%), and immediate surgery to follow up (11.8%)]. In eight (47.1%) patients there was a statistically significant increase in confidence level of the surgical approach (p = 0.04). The length of incision was increased in five (29.4%) patients and in one patient the proposed site of incision changed from the lumbar spine to the lateral knee following MRN, as the initial diagnosis of radiculopathy was changed to peroneal nerve entrapment syndrome.

Conclusions
MR neurography is an excellent technique with established technical effectiveness and high diagnostic accuracy. MR neurography has great potential in helping with patient management decisions, such as surgical versus nonsurgical treatment of neuropathies and surgical planning, which may positively affect patient outcome.
Purpose
There is increasing awareness of the long-term effects of cognitive impairment following mild traumatic brain injury (mTBI) in athletics, particularly those who participate in contact sports. We used resting-state functional MR imaging (fMRI) to assess for imaging correlates to the effects of mTBI.

Materials and Methods
College students, eight of whom participate in contact sports and 14 of whom participate in noncontact sports, were imaged on a 3 T scanner with a whole-brain 2D multislice single-shot gradient echo blood oxygenation level-dependent (BOLD) sequence (TE 30 ms, TR 3000 s, 44 axial acquisitions per TR). One hundred sixty brain volumes were acquired. Motion-corrected data were analyzed for statistical significance using SPM 8 and CONN. Eighteen seed regions of interest (ROIs) for computing resting-state networks were chosen based on a literature review of BOLD functional connectivity following head trauma as well as from morphologic analysis of cortical differences in mTBI subjects. Second-level analyses of between-subjects contrasts using the ROIs were performed to generate group functional connectivity maps. The resultant maps were thresholded by cluster area size and then corrected for multiple comparisons at a false discovery rate of p < 0.05.

Results
Using the bilateral dorsolateral prefrontal cortices (DLPC, BA 46) as seeds, connectivity map corresponding to the dorsal attention network (green) was noted in the two groups, with decreased connectivity (blue) predominantly seen in the angular gyri bilaterally in the contact sports group relative to the noncontact sports group (Figure 1a). The left inferior parietal lobule seed generated connectivity map corresponding to a combination of the dorsal attention network as well as the default mode network, with increased connectivity (red) predominantly seen in the left middle temporal gyrus and decreased connectivity seen in the DLPC bilaterally as well as the right premotor cortex in the contact sports group relative to the noncontact sports group (Figure 1b). The bilateral secondary visual cortices seed (BA 18) generated connectivity map corresponding predominantly to the visual system, with decreased connectivity predominantly in the right supramarginal gyrus noted in the contact sports group relative to the noncontact sports group.

Conclusions
Statistically significant changes in functional connectivity are demonstrable between contact and noncontact sport athletes, with the changes primarily affecting working memory and attentional processes. The findings correspond to clinical anecdotes of cognitive impairment in those suffering from mTBI and may help target future therapies.
Spinal injury, ischemic-anoxic brain injury and its correlation between abusive head trauma versus accidental trauma.

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Purpose
The purpose of this study is 1. to compare the relative incidence of spinal ligamentous and soft tissue abnormalities on spinal magnetic resonance imaging (MRI) among three groups of children aged < 48 months: 1) those with abusive head trauma (AHT), 2) those with accidental trauma, and 3) those with nontraumatic conditions. 2. to correlate the incidence of ischemic-anoxic brain injury with ligamentous injury amongst these cohorts.

Materials and Methods
This comparative study included 183 children who underwent spine MRI: 67 with AHT, 46 with accidental trauma and a clinical suspicion of spinal injury, and 70 with nontraumatic conditions. Clinical and radiographic findings were collected in all cases and were analyzed retrospectively to identify MRI evidence of traumatic spinal injuries. The incidence of spinal injuries among the three groups was compared. The incidence of spinal ligamentous injuries were calculated for those with and without radiographic evidence of hypoxic-ischemic encephalopathy. All
comparisons were performed using Fisher's exact test with \( p < 0.05 \) considered statistically significant.

Results
Injuries to the cervical spine ligamentous injuries (predominantly the nuchal, atlanto-occipital and atlanto-axial ligaments) were present in 78% of the AHT group, 46% of the accidental trauma group, and 1% of the nontrauma group; all of these differences were statistically significant. Among the AHT group, ligamentous injuries were correlated statistically with evidence of brain ischemia.

Conclusions
Injury to the cervical spinal posterior ligamentous complex is common in AHT and even more prevalent than in clinically symptomatic traumatic cases. The high correlation between the radiographic findings of occipitocervical ligamentous injuries and ischemic-anoxic brain injury is consistent with an interpretation that transient upper occipitocervical spinal cord injury in AHT leads to disordered breathing and results in hypoxic-ischemic encephalopathy. We recommend imaging the entire spine in AHT to properly identify and classify these injuries.

KEYWORDS: Abusive Head Trauma, Atlantoaxial, Spinal Trauma

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Palais des congres de Montreal, 524

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Rate of Agreement for Manual and Automated Techniques for Determination of New T2 Lesions in Children with Multiple Sclerosis and Acute Demyelination

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Purpose
Determination of new lesions on serial magnetic resonance imaging (MRI) is important in multiple sclerosis (MS) diagnosis, and new T2 lesions serve as a surrogate outcome for relapses in clinical trials. Absence of new lesions confirms a monophasic illness in children with an acute demyelinating syndrome (ADS). The objective of this study was to evaluate inter-rater variability in new T2 lesion determination based on a manual lesion identification method (1) and an automated probabilistic segmentation technique (2, 3).

Materials and Methods
Scans were acquired according to a standard protocol at onset, 3, 6, and 12 months and annually as part of a national prospective study of children with ADS. New T2 lesions were identified manually independently by three experts (2 pediatric neuroradiologists, 1 imaging scientist) using an optimized standard scoring tool (1). T1-weighted pre and postcontrast, PD-weighted,
T2-weighted, and FLAIR sequences were used. Readers were blinded to clinical information. Automated new T2 lesion segmentation was performed on the same cohort using an optimized, computer-assisted method in which a voxelwise Bayesian and lesion-level random forest classification (2, 3) is performed on T1-weighted pre and postcontrast, T2-weighted, PD-weighted, and FLAIR sequences of reference, follow up and difference images. Active scans were defined as having ≥1 new T2 lesion. New T2 lesion counts were categorized into 0, 1, 2 and ≥3 lesions. Rate of agreement was assessed for scan activity and new T2 lesion count.

Results
From 19 children included (10 MS, 9 monophasic ADS), 130 scans were analyzed; 12 scans not meeting predetermined quality specifications were excluded. A mean of 101 new lesions was identified on all scans [expert readers (delineated as R1, R2 and R3): R1=87, R2=90, R3=106]; automated method (delineated as A1): A1=122]. Mean rate of agreement on scan activity between the automated method and expert readers was 87% (R1-A1=91%, R2-A1=83%, R3-A1=88%), compared to 91% between readers. Mean agreement on lesion count of the automated method with expert readers was 82% (R1-A1=85%, R2-A1=77%, R3-A1=84%) compared to 85% between readers; when zero counts were removed, the mean was 53% (R1-A1=61%, R2-A1=39%, R3-A1=59%), compared to 61% between readers.

Conclusions
Agreement is high between manual and automated methods for new T2 lesion determination. Overall, the automated method is more sensitive than the manual readers and identifies a higher number of lesions. The automated method can feasibly aid in the determination of new T2 lesions for diagnosis and monitoring as well as in pediatric MS clinical trials. Discrepancies on agreement between manual and automated methods currently are being arbitrated independently by an expert reader who was not involved in previous aspects of the work; a comparison of sensitivity and specificity of the manual and automated methods will be presented.

KEYWORDS: Demyelination, Multiple Sclerosis, Pediatric Brain
lexicon. We recently developed a standardized MRI scoring tool for pediatric CNS demyelination (5). We expand on this work and propose an evidence-based MRI acquisition protocol and lexicon for structured reporting in children with acute demyelination and MS.

Materials and Methods
The proposed MRI protocol and structured reporting method is based on findings from the Canadian Pediatric Demyelinating Disease Program, a national prospective cohort study of children less than 16 years of age with an incident attack of CNS demyelination in which standardized clinical and MRI data are acquired at onset, 3, 6, and 12 months after onset and annually for eight years. The MRI acquisition protocol entails a set of scans that have been optimized by a group of MS imaging experts for use at the 23 sites in the prospective study. The lexicon is derived from a standardized semiquantitative scoring tool that was developed to score scans acquired in the prospective study. Parameters included in the tool were identified based on a literature review and expert input. A panel of neurologists and radiologists with expertise in demyelination and MS met to refine the definition of each parameter, and those parameters with good inter-rater agreement (κ ≥ 0.6), deemed important in predicting MS diagnosis, and visualized on routine clinical imaging were retained in the final lexicon. The structured reporting template is proposed based on the network's experience with the standardized acquisition protocol and lexicon used in the prospective study.

Results
The recommended minimum brain MRI protocol includes: precontrast 3D T1-weighted SPGR, postcontrast axial T1-weighted SPGR, axial T2-weighted FSE or TSE, sagittal and axial FLAIR, and axial diffusion-weighted imaging (DWI). Focused imaging of the optic nerves and spinal cord should be performed as clinically indicated for optic neuritis or transverse myelitis. With the assistance of MRI-compatible movie goggles and headphones, children tolerate lying still for the duration of the protocol. Unique aspects to imaging children (e.g., artifact from dental hardware) are considered. The lexicon consists of 16 parameters: 15 are binary (yes/no) variables, and one is a count (i.e., number of T2 lesions; counts greater than 15 are grouped as “>15”). Parameters include descriptions of lesion location (e.g., periventricular, brainstem, corpus callosum) and features (e.g., T1-hypointense, diffusion restricted, contrast enhancing). A textual and pictographic atlas for each parameter has been defined. A template for structured reporting is proposed that includes a description of lesions on a single scan (i.e., the lexicon), description of lesion changes on serial scans (e.g., new T2 or contrast-enhancing lesions, lesion resolution or stability, changes in brain volume), and statements on whether the scan meets published predictive and diagnostic criteria for MS.

Conclusions
An evidence-based algorithm for standardized MRI acquisition and reporting in pediatric central nervous system (CNS) demyelination is proposed, providing a framework that will permit revisions and refinements to enhance its applicability and implementation across centers. A standard acquisition protocol and lexicon provides necessary groundwork for implementation of structured reporting in diagnostic radiology, and will facilitate aggregation of data to achieve adequate sample sizes in clinical trials of pediatric MS involving surrogate MRI endpoints.

KEYWORDS: Demyelination, Multiple Sclerosis, Structured Report
Magnetic Resonance Spectroscopic Imaging in Pediatric CNS Inflammatory Demyelination: Assessing the Risk of Relapse

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Purpose
The long-term prognosis of children presenting with acute inflammatory demyelination is highly variable, and difficult to predict. In this study, it was investigated whether brain metabolite levels, as measured by proton magnetic resonance spectroscopic imaging (MRSI), show differences between subjects with monophasic disease and good recovery, versus those with recurrent illness.

Materials and Methods
Fifteen consecutive children presenting with acute central nervous system (CNS) inflammatory demyelination prospectively underwent MRSI (TR/TE: 2300/280ms, 3-4 axial slices, thickness: 15 mm, gap: 2.5 mm, matrix 32x32, nominal voxel size:0.8 cm³) and clinical MR imaging (MRI) at 1.5 T between 1995 and 2006. Clinical follow-up data were used to classify the subjects as either monophasic or polyphasic, according to current consensus criteria. The metabolic ratios Cho/Cr, NAA/Cr and NAA/Cho were compared between groups from voxels in the white matter lesions and contralateral normal appearing white matter (NAWM). Pair-wise ANOVA corrected for multiple comparisons was applied to assess statistical significance.

Results
Eight children (3 male, mean age 8.9 ± 4.5, range 3-17 years) were classified in the polyphasic group and seven children (3 male, mean age 8.7 ± 4.7, range 2-16 years) in the monophasic group. Only in the polyphasic group, both NAA/Cr and NAA/Cho ratios were significantly lower in the demyelinating lesions compared to the NAWM (see Table 1). In the polyphasic group, Cho/Cr showed a trend of elevation compared to the NAWM (P=0.06), unlike in the monophasic group, in which Cho/Cr was similar to the NAWM. MRSI in a case of monophasic ADEM in a 16-year-old girl with multifocal FLAIR hyperintense lesions is shown in Figure 1. The lesions are primarily characterized by moderately diminished NAA levels, with Cho and Cr levels similar to those in NAWM.

Conclusions
Central nervous system inflammatory demyelinating lesions in children with subsequent relapse show greater abnormalities on MRSI compared to children with monophasic disease. MR spectroscopic imaging may be useful, either alone or in combination with other clinical and imaging data, in predicting the risk of relapse and long term prognosis.

KEYWORDS: Acute Disseminated Encephalomyelitis, ADEM, MR Spectroscopy

<table>
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<tr>
<th></th>
<th>WM lesion</th>
<th>NAWM</th>
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<tr>
<td><strong>polyphasic</strong></td>
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<tr>
<td>Cho/Cr</td>
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<tr>
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<tr>
<td>NAA/Cho</td>
<td>0.83 ± 0.36</td>
<td>1.64 ± 0.23</td>
<td>0.00**</td>
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<td><strong>monophasic</strong></td>
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**Pediatric Autoimmune Encephalitis: Antibody Markers and MRI Abnormalities**

C Pluto\(^1\), J Rusin\(^1\), L Ruess\(^1\)

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**Purpose**

Autoimmune encephalitis (AE) can pose a diagnostic dilemma to both clinician and radiologist.
Common clinical features have been described in children with probable AE whether positive or negative for antibody markers. Although variable MR imaging (MRI) findings have been described in the adult population, pediatric MRI descriptions have been sparse. Our purpose was to analyze the clinical and MRI findings of AE in a pediatric population in order to improve the diagnostic algorithm for AE at our institution as well as to further describe MRI findings of AE in the pediatric age group.

Materials and Methods
An IRB approved this retrospective review of clinical and radiology records to identify suspected and confirmed cases of AE at a large pediatric hospital over the past four years based on clinical, laboratory, and treatment response criteria. Clinical information was recorded. Neuroimaging studies were reviewed and the findings in these patients were characterized and compared.

Results
Of 553 patients with a diagnosis of encephalopathy, 17 patients with MR images met the clinical inclusion criteria for AE (encephalopathy with neuropsychiatric symptoms, seizures, movement disorders and/or cognitive dysfunction; and either laboratory evidence of central nervous system (CNS) inflammation, a history of other autoimmune disorder and/or a positive response to immunotherapy). There were 10 (59%) females and seven males. Median age was 10 (range 4-17). Nine (53%) patients had positive antibody markers (in CSF or serum): four NMDA, two GAD-65, two TPO, one GAD-65 and TPO. Marker positive patients had MRI abnormalities primarily within limbic structures including anterior medial temporal lobes (7, 78%); hippocampus, amygdala and uncini (6, 67%); and gyrus rectus (2, 22%). Insular cortex involvement (7/17, 41%) included marker positive (4/9, 44%) and negative (3/8, 38%) patients. Marker negative patients also had temporal lobe lesions (4/8, 50%) however none involved the anterior medial temporal cortex. Only marker negative patients had nontemporal lobe cerebral cortex lesions (parietal 4; occipital 5). Increased T2 signal in sulci also was seen only in marker negative patients (3/8, 38%). Enhancement was seen in 7/17 (41%): 3/9 (33%) marker positive and 4/8 (50%) marker negative patients. Atrophy affected 8/17 (47%): 4/9 (44%) marker positive and 4/8 (50%) marker negative patients. Nine patients had either normal CTA or MRA, and three of these had confirmatory negative catheter cerebral angiograms.

Conclusions
Pediatric patients with suspected and confirmed AE have a narrow spectrum of MRI abnormalities. Limbic structures including the anterior medial temporal lobes are involved more typically in patients with positive antibody markers. However, MRI still may be helpful to suggest the diagnosis of AE, even when antibody markers are negative.

KEYWORDS: Autoimmune, Encephalitis, Encephalopathy

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Rapid MRI Protocol for Pediatric Patients with Traumatic Head Injury

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Purpose
Traumatic brain injury results in over 500,000 pediatric ER visits yearly. After initial evaluation with noncontrast head CT, we utilized a rapid sequence MR imaging (MRI) protocol to monitor evolution of traumatic injury without use of ionizing radiation. We offer a report of our protocol.

Materials and Methods
Rapid MR imaging of the brain was established initially at our institution for monitoring of hydrocephalus in children with ventricular diversion catheters in order to reduce lifetime ionizing radiation exposure. After proven success with high quality diagnostic imaging without the need for sedation, we quickly realized the potential for other applications. As a major regional Level 1 trauma center, the monitoring of traumatic brain injury was an ideal application of our rapid MRI protocol and may become a possible substitution for initial trauma screening in certain patients. Our rapid MR imaging sequences include echo planar imaging (EPI), single shot, and ultra fast half fourier imaging techniques, with additional optional sequences as tolerated.

Results
Rapid MR imaging of the brain was established initially at our institution for monitoring of hydrocephalus in children with ventricular diversion catheters in order to reduce lifetime ionizing radiation exposure. After proven success with high quality diagnostic imaging without the need for sedation, we quickly realized the potential for other applications. As a major regional Level 1 trauma center, the monitoring of traumatic brain injury was an ideal application of our rapid MRI protocol and may become a possible substitution for initial trauma screening in certain patients. Our rapid MR imaging sequences include echo planar imaging (EPI), single shot, and ultra fast half fourier imaging techniques, with additional optional sequences as tolerated.

Conclusions
Our rapid sequence MRI protocol has been optimized to not only follow patients with chronic hydrocephalus, but also to be used to monitor traumatic brain injury without the use of ionizing radiation and sedation.

KEYWORDS: Pediatric Brain, Radiation Dose Reduction, Traumatic Brain Injury

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Purpose

The pathophysiology of pediatric sports-related concussion (SRC) is not well understood. Therefore, functional MRI was employed in an effort to identify alterations in brain activity in concussed children by comparing the fMRI BOLD responses between acute SRC patients and matched controls. Historically, fMRI studies have shown disrupted frontal activation patterns during working memory (WM) tasks with mixed results demonstrating either increased or decreased activation during WM tasks in patients versus controls. Our study evaluated neural activation in high school boys with sports-related concussion versus controls using a multi-level (0,1,2,3,control) n-back fMRI paradigm on a 3 T MRI scanner in an attempt to further elucidate the neural alterations that occur with pediatric concussions.
Materials and Methods
Twenty-four participants, all right-handed boys aged 15-18 years, were enrolled in our study. Of these participants, 13 had SRC within past seven days at the time of the study and 11 were normal controls (reaffirmed with retrospective inspection of the anatomical MRI). The respective age for the control and SRC groups is 16.16±1.05 and 15.89±1.07. All subjects took a WASI IQ exam and had a MRI session. The MRI session lasts about an hour and includes anatomical MRI, DTI, ASL, and working memory fMRI. The scanning parameters for the fMRI are: TE=30ms; TR=2.13s; FA=90 degree; FOV=204mm and Slice Thickness=3mm. The working memory fMRI is conducted with a letter n back paradigm. The fMRI session includes three separate trials (runs), each with different randomization of task ordering. Each run lasts approximately four minutes, with the entire fMRI session lasting about 15 minutes. Accuracy and reaction times are recorded. The lower n tasks (i.e., target and 1 back) primarily test vigilance while higher n tasks (2 and 3 back) target the working memory networks. The fMRI analysis was conducted using the FSL software package (fMRIB’s Software Library, www.fmrib.ox.ac.uk/fsl). Because each participant had fMRI scan with three separate runs, a three level GLM was used. The fMRI data from each trial for each participant was processed individually using the first level GLM based on the paradigm setup, following typical fMRI preprocessing including motion correction, denoising, etc. The three first level results for each subject subsequently were averaged using a second level GLM. The second level results then were grouped based on subject condition and compared statistically using a third level regression. A Z value greater than 1.9 and cluster corrected p<0.05 were used. The results of the mean activation for the controls, SRC, and controls-SRC for working memory minus vigilance were targeted.

Results
Groups did not differ in accuracy or reaction time across n-back conditions, however the SRC group demonstrated a statistically significant decrease in activation in the right frontal lobe relative to controls during working memory tasks. No other areas of statistically significant differences in activation were detected between the control and SRC subjects during working memory tasks.

Conclusions
Alterations in neural activation were present on fMRI scans of the brain in children who sustained a single concussion within 2-7 days after the injury compared to controls. Despite similar IQs, differences in neural activation are demonstrated, with significantly reduced activation in the right frontal lobe compared to controls. This is hypothesized to be related to deficits in attention in these recently concussed children. These findings correlate with the working memory literature that implicates frontal lobe dysfunction in patients with recent concussion. Decreased activation could be related to decreased cerebral blood flow in these children as recently described in the pediatric SRC literature. Moving forward, we are now comparing fMRI findings and ASL-based cerebral blood flow (CBF) measures in an effort to help decipher the complex, likely multifactorial, pathophysiological states responsible for SRC in children.

KEYWORDS: Functional Brain Mapping, Pediatric Brain, Traumatic Brain Injury
Parenchymal Brain Lacerations in Abusive Head Trauma

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Purpose
Abusive head trauma (AHT) is a significant cause of neurologic morbidity and mortality in infants and young children. Signs and symptoms of inflicted injury may range from nonspecific to severe. Additionally, historical information on the cause of injury may be difficult to obtain. Up to 30% of AHT is missed in initial evaluation by physicians due to confounding history and vague presenting symptoms. Typical pathology in AHT includes subarachnoid hemorrhage, subdural hemorrhage, and primary and secondary brain injuries. Parenchymal brain lacerations (PBLs) have been identified on imaging of some AHT patients, but no study to date has compared the incidence of PBLs in AHT versus accidental brain injury. The purpose of this observational study is to determine if the presence of parenchymal brain lacerations are a pattern of primary brain injury unique to AHT in children three years and younger. The recognition of PBLs in infants may provide an additional imaging criterion to discriminate between AHT and accidental head injury.

Materials and Methods
We retrospectively reviewed the medical charts, autopsy reports in fatal cases when available,
and cross-sectional brain imaging (CT and MRI) in two age-matched patient cohorts (AHT and accidental head injury) of infants and children up to three years of age between January 2005 and November 2013. Abusive head trauma was determined by confession and/or confirmed evaluation by the institutional child abuse medical evaluation team. The second cohort comprised of patients who were coded as moderate to severe accidental head trauma as defined by a Glasgow Coma Scale < 13. MR imaging was utilized as the gold standard for the detection of parenchymal brain lacerations; therefore, cases were excluded when supporting MRI was not available. A parenchymal brain laceration is typically subcortical and defined by a linear or oval morphology with length $\geq 5$ mm. It may contain a fluid-fluid level or demonstrate variable signal alteration depending on the chronicity of injury.

Results
In the AHT cohort, PBLs were observed in 18 of 137 patients, while no PBLs were observed in the 28 accidental head injury patients. MR imaging is performed much less frequently in accidental head injury than in victims of possible AHT and is primarily reserved for those with the most severe clinically evident injuries. These results indicate an association between head injury mechanisms and parenchymal brain laceration ($p = 0.045$), with sensitivity, specificity, PPV and NPV of 13.1%, 100%, 100% and 19.0%, respectively, for AHT.

Conclusions
Our retrospective observational review of age-matched pediatric head trauma groups, one with AHT and the other with accidental injury, demonstrates that PBLs are reflective of the complex comotio mechanisms observed frequently in AHT. Parenchymal brain lacerations serve as a reliable predictive indicator of AHT in infants and children up to three years of age as they are not seen in cases of accidental trauma, even with profound impact injuries resulting in death.

KEYWORDS: Abusive Head Trauma, MR Imaging Brain

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Value of Multiplanar 3-Dimensional Reconstruction of Head Computed Tomography in the Diagnosis of Pediatric Skull Fractures

G Orman, T Bosemani, D Seeburg, C Zamora, A Oshmyansky, L Hines, A Tekes, A Poretti, T Huisman

\textit{The Johns Hopkins University School of Medicine, Baltimore, MD}

Purpose
Head trauma is a leading cause of mortality and high morbidity in children. Skull fractures occur in 2.1% to 26.6% of children with head trauma. Skull fractures commonly are associated with intracranial brain injury and their presence should lead to careful search for associated lesions. A high sensitivity in the diagnosis of a skull fracture is important. We aim to compare axial 2-dimensional (D) with axial 2D and 3D multiplanar reconstruction of head computed tomography (CT) data in the diagnosis of skull fractures. We hypothesize that 2D CT images with 3D reconstruction has a higher sensitivity and specificity in detecting skull fractures compared to axial 2D CT images alone.

Materials and Methods
Head CT studies of 250 consecutive children with a history of minor or major head trauma were
included in this retrospective study. All head CT studies were evaluated independently by a third year radiology resident (DS), a neuroradiology fellow (CZ) and a junior pediatric neuroradiology attending (TB). All readers evaluated first only axial 2D images and subsequently axial 2D images with 3D multiplanar reconstruction. The individual evaluations by the three readers were compared with a reference evaluation in consensus by two pediatric neuroradiologists with 18 (TAGMH) and six (AT) years of experience, respectively.

Results
The children of our study included 167 males and 83 females. At the CT study, the mean age of the patients was 7.82±5.63 years (range 0.01 to 17.4 years). Eighty-two skull fractures in 76 children were diagnosed. The sensitivity to depict skull fractures was significantly higher for axial 2D CT images with 3D multiplanar reconstruction (81.3%) compared to axial 2D images alone (74.5%, p=0.015). The specificity was similar for both evaluations: 89.1% for axial 2D images alone and 90.5% for axial 2D CT images with 3D multiplanar reconstruction (p>0.05).

Conclusions
Our study shows that 3D multiplanar reconstruction increased the sensitivity of head CT studies significantly in the diagnosis of pediatric skull fractures. Three-dimensional multiplanar reconstruction is particularly helpful to detect skull fractures located in the plane of the axial 2D CT slices. Three-dimensional multiplanar reconstruction, however, does not reduce the misinterpretation of cranial sutures as skull fractures. Three-dimensional multiplanar reconstruction is cost-effective, does not require additional radiation, adds clinically valuable information and should be performed routinely for head CT studies in children with head trauma.

KEYWORDS: CT, Fracture, Skull

O-155

Acute Imaging in Pediatric Encephalitis: What Do We See and What Don't We Know

J Bykowski1, P Kruk2, J Gold3, J Crawford3

1University of California San Diego Health System, La Jolla, CA, 2San Diego Imaging/Rady Children's Hospital San Diego, San Diego, CA, 3Rady Children's Hospital San Diego, San Diego, CA

Purpose
The diagnosis of acute infectious pediatric encephalitis can be difficult and confounded by noninfectious mimics such as vasculitis, collagen vascular disorders, paraneoplastic syndromes, autoimmune conditions, or white matter disease. Our aim was to review acute brain imaging findings of the full spectrum of clinically suspected cases of pediatric encephalitis to identify any imaging factors that may correlate with clinical course.

Materials and Methods
Data were collected prospectively, as part of the IRB-approved California Encephalitis Project (CEP). A five year retrospective review of the clinical and imaging database of a participating regional children's medical center was performed to identify pediatric patients who met clinical suspicion for encephalitis and who had CT and/or MR imaging of the brain prospectively within the acute phase of presentation. Imaging studies were reviewed and graded by a pediatric radiologist and neuroradiology fellow independently, blinded to the initial imaging
interpretation, clinical symptoms and outcome. Extent of findings including white matter disease, meningeal and/or parenchymal enhancement, diffusion restriction, hemorrhage, infarct, and hydrocephalus were scored and compared to patient age, gender, length of stay, confirmed pathogens, and outcome. Serial imaging studies were included in the analysis when available.

Results
One hundred forty-one children ages 2 days–19 years (avg 8 years) met inclusion criteria. Abnormal findings were seen in 22/94 children on head CT and 67/134 children on MR. Of the 52 with normal noncontrast head CT and MR imaging within 2 days, abnormal findings were identified on the MR in 20 (38%). T2-hyperintense lesions were seen in the following prevalence: subcortical white matter (52%), periventricular/deep white matter (21%), brainstem (21%), cortex (20%), basal ganglia (20%), cerebellum (15%), thalami (13%), corpus callosum (8%), internal capsule (7%), hippocampus (3%), optic chiasm (2%). Lesions involved 2 or more of the above areas in 46% of those children; lesions were confluent in 30%. Additional findings included: parenchymal enhancement(18%); meningeal enhancement(45%), restricted diffusion(39%), necrotizing lesions(3%), intracranial hemorrhage(10%), hydrocephalus(8%), and subfalcine herniation in 1 child. Pathogens were identified in 52%, the most common being M. Pneumoniae(30), and included one or more viral agents (38), bacterial (24), both viral and bacterial(6), M. tuberculosis(3), ricksettia(1) and amoebae(1). MR imaging was abnormal in 40% of children where no pathogen was identified on CSF or serological screening and 49% of children where a pathogen was identified. Acute MR imaging was negative in 3 children who developed MR abnormalities within 2, 5 and 7 days respectively. Of the 51 children with serial MR based on clinical symptoms, 33% showed progression of MR findings. Five children died shortly after presentation. Clinical follow-up was available for 63/73 patients where a pathogen was identified, with 48% returning to clinical baseline. Length of stay did not correlate with age or pathogen status. While 62% of children with normal acute MR were discharged within 7 days, compared to 24% of children with abnormal acute MR, the severity of white matter and additional imaging findings did not independently correlate with length of stay.

Conclusions
Abnormal MR findings are common in pediatric encephalitis patients, and imaging may lag clinical symptom onset and recovery. In the acute evaluation of pediatric encephalitis, noncontrast head CT can serve as a primary screen for complications such as hemorrhage, mass effect or herniation in the absence of MRI availability; however, should not be considered a definitive evaluation.

KEYWORDS: Encephalitis

O-156

4:03PM - 4:10PM

Pseudo-Leptomeningeal Contrast Enhancement at 3.0T in Pediatric Patients Sedated by Propofol

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¹University of Minnesota and Hennepin County Medical Centers, Minneapolis, MN, ²Hennepin County Medical Center, Minneapolis, MN, ³University of Minnesota and Hennepin County Medical Centers, Roseville, MN
Purpose
Preliminary studies have shown that propofol can modulate cerebral blood flow by decreasing the metabolic rate of oxygen, and also can dilate vascular smooth muscle (1-2). As pediatric patients undergoing MR imaging (MRI) often receive intravenous sedation, the purpose of our study was to evaluate the degree of leptomeningeal contrast enhancement (LMCE) on postcontrast brain MRIs at 3.0 T, in order to determine if differences exist between spin echo (SET1-weighted imaging) and gradient echo FFE (GET1-weighted imaging) T1-weighted images.

Materials and Methods
From 154 pediatric patients sedated with propofol between ages one to six years who underwent a brain MRI on a 3 T magnet between 11/2010-11/2013, 99 were excluded due to an absence of postcontrast imaging (n=96) or being on a 1.5 T magnet (n=3), moderate-severe brain abnormalities (n=10), or limited evaluation (n=2). The standard weight-based dosage of contrast was 0.1 mmol/kg of intravenous gadobutrol. A total of 43 were included who had received postcontrast GET1-weighted imaging (n=23) and SET1-weighted imaging (n=20). Three neuroradiologist reviewers separately graded the presence of LCME as follows: Grade 0: no vascular structures visualized within the sulci, Grade 1: small vascular structures barely visible within sulci, Grade 2: LCME/vascular structures that extend throughout the depths of the sulci, Grade 3: irregular and slightly thickened LCME, Grade 4: nodular or moderate-severe LCME or involvement of adjacent parenchyma. Interobserver variability between LMCE grades were compared using Cohen's kappa, and the grades were correlated with the TTI (time to imaging postcontrast administration).

Results
The mean patient age was 3.1 years. The range of LMCE grades for the three reviewers on GET1-weighted imaging was 1.2-1.4, and on SET1-weighted imaging was 1.9-2.1. There was a significant difference in mean TTI between GET1-weighted imaging (range 7-18 minutes, mean 12.63) and SET1-weighted imaging (range 7-18 minutes, mean 11.00 minutes); Mann-Whitney p<0.0001. The TTI did not have a significant correlation with the LMCE grade on GET1-weighted imaging (r=0.015-0.19, p=0.371-0.940) or SET1-weighted imaging (r=-0.358 to -0.475, p=0.036-0.122), although the SET1-weighted imaging correlation was weak-moderate. Notably, in six patients who underwent both sequences, the LMCE grades were higher on SET1-weighted imaging. The range of interobserver kappa's were strong on both GET1-weighted imaging (k=0.567-0.698, p<0.0001) and SET1-weighted imaging (k=0.609-0.693, p<0.0001).

Conclusions
The appearance of LMCE or pseudo-LMCE is common on postcontrast MRI of pediatric patients sedated by propofol, and should not be mistaken for disease. This occurs more commonly, and to a greater degree, on SET1-weighted imaging as compared to GET1-weighted imaging. Such findings could relate to propofol-induced vascular smooth muscle dilation, while such vascular structures may be more visible on SET1-weighted imaging at 3.0 T possibly due to its higher contrast to noise ratio, as described previously (3-4). Ongoing or future research could also evaluate if this phenomenon relates to dosage of intravenous propofol or oxygen saturation.

KEYWORDS: Leptomeningeal Disease, Pediatric Brain, Sedation
Purpose
The purpose of this research is to evaluate post-treatment imaging for cerebral necrosis among pediatric brain tumor patients treated with proton radiotherapy.

Materials and Methods
Following institutional review board approval, a retrospective review of clinical and radiological data was performed of a total of 61 pediatric patients with primary brain tumors who had undergone cranial proton radiotherapy from 1/11/2010 to 10/25/2012 at our institution. Patients were scanned at three-month intervals or sooner, if suspicious findings were found on imaging. Patients without 12 months of imaging follow up from the completion of proton radiotherapy were excluded unless cerebral necrosis or death occurred prior to 12 months. Clinical variables included age at diagnosis, tumor pathology, chemotherapy, radiation dose, and date of radiotherapy completion. Two fellowship trained board certified neuroradiologists with certificates of added qualification (CAQ) in neuroradiology evaluated all available preoperative, immediate postoperative and subsequent follow-up brain MR imaging (MRIs) of included patients. Data recorded included preoperative tumor location and size, presence of leptomeningeal disease, extent of tumor resection, immediate postoperative complications, and postradiotherapy imaging were evaluated for tumor progression as well as for any post-treatment effects including volume loss, microhemorrhages, parenchymal T2/FLAIR hyperintensities indicative of gliosis, and cerebral necrosis. A diagnosis of cerebral necrosis was reached following consensus agreement between the two neuroradiologists and was defined as new areas of parenchymal contrast enhancement which resolve without intervention within six months. Statistical analysis of cerebral necrosis and clinical variables was performed using Fisher exact test. Incidence and timing to development of cerebral necrosis was compared with historical information from conventional radiotherapy.

Results
Patient Characteristics: Ten patients were excluded due to lack of the required 12 months of follow-up imaging, for a total 51 patients evaluated. Average patient age was 6.8 years (range 0.9-18 years) with 9/51 (18%) of children less than two years of age. There was a male:female ratio of 2.4:1. Tumor Characteristics: Tumor pathology is listed in Table 1. Supratentorial tumors composed 17/51 (33%) patients involving the Cerebral Hemisphere (15.7%), Pineal (7.8%), and Sella (9.8%). Infratentorial tumors composed 34/51 (66%) patients involving the Brainstem (7.8%), and Cerebellar Hemisphere (58.8%). Surgical treatment included: Gross Total Resection (56.8%), Subtotal Resection (29.4%), Biopsy (7.8%), or None (5.9%). Imaging Outcome: Average follow up from completion of proton radiotherapy was 19.2 months (range 3-34 months). A total of five patients died prior to 12 month follow up. A total of 16/51 (31%) of patients developed cerebral necrosis as defined above. This compares to a typical expected incidence of radiation necrosis with conventional radiotherapy in the adult population 5-10%,
and a range of 5-37% reported in pediatric patients (1-3). Average time to development of cerebral necrosis was 5.8 months (median 5 months, range 2-11 months). This compares to a typical median of 1-2 years to development of radiation necrosis with conventional radiotherapy in adults, and a reported range of 1-12 months in pediatric patients (1-3). Age less than two was found to demonstrate statistically significant association with cerebral necrosis (Fisher's exact test p=0.034). Gross total surgical resection, tumor pathology, and tumor location did not demonstrate statistical correlation with presence of cerebral necrosis (Fisher's exact test p=0.35; Fisher's exact test p= 0.19; Fisher's exact test p=1.0 respectively).

Conclusions
Pediatric brain tumor patients treated with proton radiotherapy demonstrate a high incidence of cerebral necrosis and a short time frame to development of necrosis compared to historical data from conventional radiotherapy in adults, and at the upper end of reported necrosis in pediatric patients. Radiologists should be aware of the relative high rate of necrosis and the timing to development of necrosis when evaluating these patients for tumor recurrence or progression. Ultimately, the clinical outcome in these patients should be compared to a similar patient population treated with conventional radiotherapy to assess the risk and efficacy of proton radiotherapy in the pediatric brain tumor population.

KEYWORDS: Pediatric Brain, Pediatric Brain Tumors, Radiation Necrosis

Table 1. Tumor Pathology for Proton Radiotherapy Treated Patients

<table>
<thead>
<tr>
<th>Tumor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medulloblastoma</td>
<td>17</td>
</tr>
<tr>
<td>Ependymoma</td>
<td>12</td>
</tr>
<tr>
<td>Brainstem Glioma</td>
<td>4</td>
</tr>
<tr>
<td>ATRT</td>
<td>3</td>
</tr>
<tr>
<td>Craniopharyngioma</td>
<td>3</td>
</tr>
<tr>
<td>Germinoma</td>
<td>2</td>
</tr>
<tr>
<td>PNET</td>
<td>2</td>
</tr>
<tr>
<td>Mature Teratoma</td>
<td>2</td>
</tr>
<tr>
<td>Pilocytic Astrocytoma, Grade I</td>
<td>2</td>
</tr>
<tr>
<td>High grade neuroepithelial tumor with glial differentiation</td>
<td>1</td>
</tr>
<tr>
<td>Pilomyxoid Astrocytoma, WHO Grade II</td>
<td>1</td>
</tr>
<tr>
<td>Pineal Parenchyma tumor, WHO Grade II</td>
<td>1</td>
</tr>
<tr>
<td>Choroid meningioma, grade II</td>
<td>1</td>
</tr>
</tbody>
</table>
S Thust\textsuperscript{1}, E Blanco\textsuperscript{1}, A Michalski\textsuperscript{1}, K Mankad\textsuperscript{1}, W Chong\textsuperscript{1}

\textsuperscript{1}Great Ormond Street Hospital for Children, London, UK

Purpose
To characterize brain MR signal abnormalities encountered in children following treatment for medulloblastoma and primitive neuroectodermal tumor (CNS-PNET). Treatment-related changes including pseudoprogression are increasingly recognized in adults, but few reports are found on the subject in the pediatric literature. The distinction of therapy-related changes from tumor continues to be a challenge, even for specialists, highlighting the need for further investigation.

Materials and Methods
Institutional approval was obtained for a retrospective review of patients with medulloblastoma or CNS-PNET treated at Great Ormond Street Children's Hospital using high-dose sequential chemotherapy, hyperfractionated accelerated radiotherapy (HART) with or without thiopeta according to the recently introduced 'Milan' protocol. Patient demographic data, chemotherapy and radiotherapy treatment details and outcomes were recorded. Serial MR imaging (MRI) from presentation until the latest follow up or death was re-analyzed by two independent reviewers blinded to the original report and each other's analysis. Brain abnormalities were documented in a descriptive manner through serial imaging over several years and retrospectively categorized as tumor, treatment-related focal abnormalities and generalized parenchymal changes. Postsurgical parenchymal changes were recorded, but discounted from the analysis.

Results
In the study period, 14 children (aged 2-13 years, mean 7.5 years) received 153 serial MR examinations before and after treatment. Nine of 14 patients demonstrated a total of 11 episodes of new focal enhancing lesions (FEL). Over serial scans, 3/11 FEL episodes proved to represent definite recurrence, two at the resection site and one distant. However, 6/11 FEL episodes were treatment-related changes, which resolved or regressed spontaneously. Treatment-FEL occurred in the cerebellum and brainstem in the medulloblastoma group and within the cerebral hemispheres in the CNS-PNET group. In one episode of new multifocal enhancement, this was felt to represent a combination of tumor progression and treatment change. One episode of FEL could not be characterized with certainty, the disease burden being too gross to make a distinction. All primary tumors and tumor-FEL demonstrated marked restricted diffusion even in small lesions, whereas none of the treatment-FEL restricted on DWI/ADC. This was felt to represent an important feature, which could aid diagnosis in future and warrants quantitative evaluation. In most of the treatment-FEL, there was evidence of regression of pre-existing residual tumor on the same scan, which could possibly aid interpretation in patients with residual disease. On the contrary, for the tumor-FEL pre-existing neoplasia was progressive or static at the onset of new FEL. In all but one child, a degree of generalized neuroparenchymal volume loss and diffuse white matter signal abnormality were noted, which were moderate or severe in 6/14 children and more pronounced in the medulloblastoma group. Generalized white matter atrophy has not been described previously in children on the 'Milan' treatment and appears frequent from our data with possible implications for long-term neurocognitive outcome.

Conclusions
In this retrospective analysis, two patterns of treatment-related brain parenchymal signal abnormality emerged: Transient focal enhancing lesions and a leukodystrophy-like pattern, both of which appear frequently. Recognition of treatment-FEL is extremely important to avoid
misdiagnosis as tumor with potential devastating consequences for patient management. Lack of diffusion restriction in FEL (with restriction in the primary tumor) may prove to be a useful diagnostic feature.

KEYWORDS: Chemotherapy, Pediatric Neoplasms, Radiation Toxicity

O-159

Brain Imaging of Methotrexate-Related Leucoencephalopathy in Patients Treated for Osteosarcoma

P Brugieres¹, A Longuad², N Gaspar², A Maraval¹, J Lincot¹, L Brugieres²

¹Henri Mondor, Creteil, France, ²Institut Gustave Roussy, Villejuif, France

Purpose
To evaluate the incidence of methotrexate-related leucoencephalopathy (MRLE) in patients treated with high-dose methotrexate (HDMTX) for an osteosarcoma and to describe the morphological, metabolic and diffusion patterns of the disease.

Materials and Methods
Thirty-eight patients included in the French on-going OS2006 trial who received at least three courses of HDMTX (12g/m2) had brain MR imaging (MRI) FLAIR sequences, diffusion tensor imaging (DTI) and 1H-MR spectroscopy in the week following the last course on a 1.5 T Siemens Avanto system. We used the Wilson's Grading scale for the quantification of MRLE. We calculate the ratio of apparent diffusion coefficient (ADC) in the MRLE relatively to the ADC value of the normal-appearing white matter (NAWM). 1H-MRS métabolites (NAA, Cho, Cr, mI) were quantified by reference to brain water. Lactate were semi-quantitatively quantified (absent, small peak, well-defined peak). We used Diffusion-Toolkit and TrackVis softwares for fibers reconstruction. Interhemispheric fibers were reconstructed from a midsagittal region-of-interest (ROI) delineating the corpus callosum. Apparent diffusion coefficient and FA values from total brain fibers (ADCTB, FATB) and from interhemispheric fibers (ADcC, FAcc) were registered.

Results
Thirty-one patients presented a MRLE (grade 1 =13, grade 2 = 12, grade 3 = 6). Twenty patients were asymptomatic at the time of MR study, 10 had headaches, eight had transient neurological symptoms. Patients with a severe MRLE (grade 2&3) had significant lower NAA/H20 (0.22 versus 0.27 p=0.001) and Cho/H20 (0.144 versus 0.169, p=0.009) ratios, a higher ADC (MRLE/NAWM) ratio (1.35 versus 1.12, p=0.0005), presented more often (6/18 versus 2/21) a lactate peak, and had higher ADCTB (90.01E-5 mm2/s versus 85.11E-5 m2/s, p=0.0007) and ADCcc (85.2E-5 mm2/s versus 92.03E-5 mm2/s, p=0.007) values. Patients with neurological symptoms and/or headaches had significant lower FATB (0.406 versus 0.439, p= 0.002) and FAcc (0.558 versus 0.608, p= 0.0005), higher ADCTB (88.97E-5 mm2/s versus 86.05E-5 mm2/s p= 0.04), lower NAA/H20 (0.227 versus 0.264, p= 0.02) and higher Cho/H20 (0.167 versus 0.147, p= 0.04) and 8/18 presented a lactate peak. Most (6/8) of the patients with neurological symptoms showed a clear rarefaction of interhemispheric fibers mainly in frontal and parieto-occipital regions.
Conclusions
Leuco-encephalopathy linked to high dose methotrexate is a frequent complication of the treatment of osteosarcoma. High choline peak indicative of a high membrane turn-over is encountered in patients with neurological symptoms and frequently is associated with the presence of lactates and with a disorganization of the white matter tracts demonstrated by the decreased FATB and FAcc. A prospective evaluation of neurocognitive tests during and after treatment is warranted in order to evaluate the clinical consequences of this treatment.

KEYWORDS: Brain White Matter, Leukoencephalopathy, MR Spectrocopy
Purpose
Previous reports have suggested that posterior fossa ependymoma may be divided into two groups based on tumor location: lateral cerebellopontine angle (CPA) centered tumors and those centered in the IVth ventricle. Lateral tumors have been associated with incomplete resection and poor prognosis. We examined the association between the imaging location of posterior fossa ependymoma, extent of surgical resection, pattern of tumor recurrence, and patient survival status and survival time.

Materials and Methods
After institutional review board approval, pre-operative MR imaging (MRI) examinations for 107 children and adolescents diagnosed with posterior fossa ependymoma were reviewed systematically. The subjects were participants in a larger institutional trial of conformal radiotherapy following definitive surgery. Tumors centered in the IVth ventricle were categorized as central and those not centered in the IVth ventricle were categorized as lateral tumors. The extent of resection was recorded based on postoperative MRI studies. Recurrent tumor, when it was present on follow-up MRI examinations, was classified as local when present in the region of the original tumor or distant when present at a site discontinuous from the original lesion. Fisher's exact test was used to assess the association between the location of the primary tumors, extent of resection, and outcome including patient survival status and pattern of tumor recurrence. The log-rank (L-R) test was used to test for survival time differences between patients with central tumors and those with lateral tumors. A two-sided significance level of p<0.05 was used for all statistical tests.

Results
No statistically significant association was detected between the location of posterior fossa ependymoma and extent of resection, pattern of tumor recurrence or overall survival. Analysis of all subjects, regardless of survival status, showed no significant difference in survival time between individuals with central tumors and those with lateral ependymomas (L-R, p=0.0879). Among patients who died of their tumors, however, there was a statistically significant difference in survival time comparing those with central ependymomas and subjects with lateral tumors (L-R, p=0.0377).

Conclusions
After the detailed evaluation of more than 100 subjects with posterior fossa ependymoma, no association was found between tumor location, extent of surgical resection, pattern of tumor recurrence or patient survival time. These results do not substantiate those of previous studies that have found lateral tumors to be associated with incomplete resections and worse outcomes. We did find that among subjects who died of ependymoma, those with central tumors survived longer. The reason for this is unclear but could be related to comorbidities and other difficulties associated with resection of the lateral lesions. Our analysis of pediatric posterior fossa ependymomas is ongoing and will evaluate histopathological and genetic differences among the tumors as well as associations with additional clinical and demographic data.

KEYWORDS: Ependymoma, Outcomes, Pediatric Brain Tumors
Monday
4:45PM - 6:15PM
Palais des congres de Montreal, 517bc

23 - GENERAL PROGRAMMING: THE FOUNDATION OF THE ASNR
SPECIAL SESSION ON TRAUMATIC BRAIN INJURY: IS DTI READY FOR
PRIME TIME?

FASNR Introduction

Russell, E.
Northwestern University
Chicago, IL

O-161

State of the Art

Mukherjee, P.
University of California San Francisco
San Francisco, CA

O-162

MEG in TBI

Lee, R.
UCSD/VA Medical Center
San Diego, CA

O-164

Pro: Academic

Lipton, M.
Albert Einstein College of Medicine
Bronx, NY

O-165

Pro: Clinical
Walker, A.
Florida Imaging Consultants, PA
Stuart, FL

Abstract/Presentation Summary
DTI in mTBI is increasingly being used outside of large academic centers in private practices. Is this reliable and appropriate? Andrew T. Walker, M.D. Presentation Summary: The use of the advanced Neuroimaging technique Diffusion Tensor Imaging (DTI) in the evaluation of patients with traumatic brain injury (TBI) outside of large academic centers is appropriate. The use of DTI in the evaluation of TBI has been validated, peer reviewed, is based upon well-recognized scientific principles, and is utilized by clinicians evaluating and treating TBI. Standards are in place for the performance and use of DTI clinically. We recommend and abide by the standards put forward by the American Society of Functional Neuroradiology in the 2012 "ASFNR Guidelines for Clinical Application of Diffusion Tensor Imaging", and generally concur with the standard put forward by the Defense Centers of Excellence (DCoE) in July, 2013. In areas of the country where advanced imaging techniques, such as DTI, are not offered at regional academic centers, demand by clinicians and patients often leads to the development and utilization of advanced techniques in an independent setting. The most comprehensive example of this process is seen with the Department of Defense's elite traumatic brain injury institute, the National Intrepid Center of Excellence or NICoE. NICoE was funded entirely by private donations and then donated to the DOD, in response to a mandate to create a center to advance the understanding of TBI in the military. It is the pinnacle of comprehensive interdisciplinary evaluation and treatment of individuals with traumatic brain injury and comorbid psychological health conditions. The program at our independent facility is a similar collaborative effort, albeit on a smaller scale, with a neurologist who is a nationally recognized expert in sports concussion, an assistant professor of neurology at Florida State University College of Medicine, and co-authored the American Academy of Neurology's position statement on concussion in sports. In conjunction with clinical neurologic review, neurologic examination, and neuropsychological testing, our center provides Brain MRI with quantitative DTI in the interdisciplinary diagnostic evaluation of patients with traumatic brain injury. Our experience, and that of other independent facilities such as NICoE, confirms that a nonacademic independent facility can play an integral part in the comprehensive evaluation and treatment of individuals with traumatic brain injury.
Toxic encephalopathies were described in Roman writings more than two thousand years ago, and patients with toxic exposures not uncommonly present to emergency departments and outpatient clinics today. Clinical toxicity can be reversible if diagnosis and treatment is prompt, but few physicians have expertise in the full spectrum of toxic disease. I will begin the session by discussing the unique susceptibility of the central nervous system to toxic injury. I will then briefly cover the cellular pathophysiology of toxic injury, particularly emphasizing the relationship between pathophysiological terminology (eg. glutamate excitotoxicity) and imaging findings. I will discuss the environmental exposure clinical history, the role of laboratory testing, and the role of imaging for diagnosis of toxic encephalopathy. Finally, I will focus on the imaging patterns of two particular categories of toxic encephalopathy: heavy metal toxicity and pharmaceutical toxicity.
Gallagher, T.
Northwestern University Feinberg School of Medicine
Chicago, IL

O-171

Cased Based Differential Diagnosis

Huang, B.
University of North Carolina
Chapel Hill, NC

Abstract/Presentation Summary
In this case based review, the audience will be presented with patient vignettes in which the clinical and imaging differentials may include toxic disorders as part of a broader list of diagnostic considerations. In these cases, differentials for entities which typically affect the subcortical white matter and entities which involve the deep gray matter nuclei symmetrically will be discussed. In addition to selected toxic disorders, topics reviewed will include ADEM, PRES, CNS infections, hypoxic brain injury, and hemolytic-uremic syndrome. Specific distinguishing clinical and imaging features of these each of these disorders will be highlighted.

Questions and Discussion
5:55PM - 6:15PM

Monday
4:45PM - 6:15PM
Palais des congres de Montreal, 517a

25 - YOUNG PROFESSIONALS PROGRAMMING: CAREER CHOICES AND DEVELOPMENT

O-172

Benefits of Academic Medicine

Meltzer, C.
Emory University School Of Medicine
Atlanta, GA
O-173

Benefits of Private Practice

Pramanik, B.
Medical Center Radiology Group
Orlando, FL

Abstract/Presentation Summary
Private practice radiology offers a number of considerable advantages over academic radiology. One key advantage is personal freedom. There is much more autonomy to make decisions as there is less bureaucracy. The workload is predominantly clinical and there is no research or very little teaching responsibilities. Private practice enables radiologists to capitalize on a broader range of their training. Most private practice radiologists practice general radiology and see a broad range of patients encompassing every radiologic subspecialty and modality. By seeing a breadth of cases, there is more flexibility to adapt. Finally, the major advantage is compensation. Private practice salaries are higher than academic radiology. Moreover, the benefits packages including vacation are frequently more generous.

O-174

Negotiating a Position of Academic Medicine

Mukherji, S.
Michigan State University
Ann Arbor, MI

Abstract/Presentation Summary
The intent of this presentation will be to review important aspects about negotiating an academic radiology position. The attendees will be familiar with important information that will permit them to properly assess different academic opportunities.

O-175

Negotiating a Contract in Private Practice

Barr, R.
Mecklenburg Radiology Associates, P.A.
Charlotte, NC

Abstract/Presentation Summary
This will be a practical, "how to" session for attendees preparing to enter the private practice radiology workforce. The basics of the employment contract will be discussed from the perspective of the group practice. The speaker hopes to make up for a lack of legal expertise with a plethora of common-sense advice. The typical steps from recruitment to contracting will be reviewed. The talk will highlight the most important elements of the contract, including the
elements that tend to raise the most questions, such as noncompete clauses and tail coverage responsibility. We'll discuss what's typically missing from the contract, and the most common mistakes job seekers make when contracting.

O-176

Why I Did What I Did and Did I Make the Right Decision

Seidenwurm, D.
Radiological Associates
Sacramento, CA

Abstract/Presentation Summary
Choose a career that reflects a realistic assessment of your interests and capabilities, and one that will make you happy based on your priorities in life.

Discussion

Monday
4:45PM - 6:15PM
Palais des congres de Montreal, 520

26 - COMPARATIVE EFFECTIVENESS RESEARCH: WHAT'S BEING DONE, WHO'S PAYING FOR IT, WHAT IT TAKES TO GET FUNDED

O-177

PCORI, Pragmatic Trials and CER: What is it and Who Funds It?

Jarvik, J.
Univ of Washington
Seattle, WA

Abstract/Presentation Summary
In this presentation, I will discuss comparative effectiveness research and present an example of a pragmatic randomized trial. Low back pain, an Institute of Medicine priority condition for comparative effectiveness research, is of major public health importance. It is one of the most common reasons for physician visits and an important cause of functional limitation and disability. Imaging is frequently performed as part of the diagnostic evaluation and is an important contributor to the cost of back pain care, which totaled more than $86 billion in 2005.
It is well known that, even without back pain, magnetic resonance (MR) imaging of the lumbar spine frequently reveals findings such as disc desiccation or bulging. Patients and their providers may attribute greater importance to these findings, which are often age-related, than they should, because they do not have an appropriate frame of reference in which to interpret the findings. These "incidental" findings may initiate a cascade of events leading possibly even to surgery, without improving patient outcomes. The Lumbar Imaging with Reporting of Epidemiology (LIRE) Trial is a pragmatic, randomized trial to determine the effectiveness of inserting epidemiological benchmarks into imaging reports at reducing subsequent tests and treatments. Our intervention is simple, inexpensive and easy to deploy. We are passively collecting primary outcome measures of healthcare utilization both pre- and post-intervention, using robust electronic health records at our participating sites. LIRE is an example of a trial that falls at the pragmatic end of the explanatory-pragmatic spectrum described by Thorpe et al. LIRE was funded by the NIH Health Care Systems Collaboratory, but other entities such as PCORI and AHRQ, are playing a leading role in promoting and funding CER.

O-178

Costs Studies and Cost Effective Analysis

Medina, L.
Miami Children's Hosp
Miami, FL

Abstract/Presentation Summary
There are multiple types of cost studies in medical imaging. Lecture will focus on (1) cost studies such as time motion analysis and (2) cost-effectiveness analysis (CEA).

O-179

Involving Trainees in Comparative Effective Research

Anzai, Y.
Univ. Washington Medical Center
Seattle, WA

O-180

Panel Discussion on Promoting CER with Academic Research Enterprise and Breaking Down Barriers

Sanelli, P. · Fink, J. · Hoang, J. · Gupta, A.
Weill Cornell Medical College · Univ Of Washington · Duke University Medical Center · NY Presbyterian Hosp./Cornell Univ.
New York, NY · Seattle, WA · Durham, NC
Monday
4:45PM - 6:15PM
Palais des congres de Montreal, 524

27 - CSI: MONTREAL PROGRAMMING: MAKING A SCIENTIFIC PRESENTATION

O-185a

Tips on Preparing and Giving an Oral Presentation

Wiggins, R.
University of Utah
Salt Lake City, UT

Abstract/Presentation Summary
There is an art to teaching and lecturing, which is not taught in medical school. While the lecture or oral presentation is the most commonly used method of passing along knowledge in medical education, it is not the best method of educating. Our problem is that students only capture about 30% of the main points in a lecture in their notes, and 3-4 weeks later, most students remember <10% of lecture facts. So as a teacher in medical education, how can we change this? In thinking about these problems, we have 2 main goals with our oral presentations. The first is: (1) what can I do as a teacher to ensure that my students understand and recognize the main teaching points of my oral presentation, and (2) how can I create and deliver an oral presentation that will allow my students to remember these important points longer than a few days after the talk?

O-185b

How to Create an Award Winning Scientific Exhibit

Reede, D.
The Long Island College Hospital
Brooklyn, NY

Abstract/Presentation Summary
Electronic exhibits are the major format used for scientific posters at most national meetings. There are many advantages in using this format such as the ability to vary the presentation style (quiz based vs lecture format, animated vs non-animated etc.). However, many steps need to be completed before an exhibit is uploaded. This presentation will focus on choosing a topic, writing an abstract, concept development, gathering materials (cases and illustrations) and organizing the team to produce an award winning exhibit.

O-185c

How to Create an Award Winning Scientific Exhibit - II

4:45PM - 5:30PM

5:15PM - 5:45PM

5:45PM - 6:15PM
Ledermann, E.
The long Island College Hospital
Brooklyn, NY

Abstract/Presentation Summary
PowerPoint is the standard medium for lectures and scientific exhibits at most national and subspeciality radiology meetings. Understanding its applications, limitations and design capabilities will enable you to enhance the presentation of research data and educational materials. Basic and advanced techniques that can improve the overall style and design of a PowerPoint presentation will be shown. Strategies will be demonstrated to increase effectiveness and streamline the exhibit making process.

Tuesday
7:30AM - 8:30AM
Palais des congres de Montreal, 517bc

28 - PEDIATRICS SESSION (SAM)
O-186
7:30AM - 7:50AM

Pediatric Brain-Part I: Congenital Abnormalities

Dietrich, R.
UCSD Medical Center
San Diego, CA

Abstract/Presentation Summary
This session comprises a case-based review presentation of common and uncommon congenital disorders involving the pediatric brain with a focus on the approach to the differential diagnosis. Congenital central nervous system anomalies occur due to abnormal or arrested development of the brain and/or spine during the intrauterine period. As the brain and spine form within a limited period of time, insults leading to the development of congenital anomalies often affect multiple brain structures. Both prenatal and postnatal multiplanar imaging techniques are extremely useful in demonstrating the spectrum of abnormalities seen in each entity and help diagnose and give prognostic information to treating physicians and parents. This information together with increasing understanding of the genetic origins of many of these entities is giving additional insight into many of the congenital brain anomalies discussed in this session. Covered topics include: Disorders of dorsal induction including cephaloceles and Chiari malformations. Disorders of ventral induction including holoprosencephalies and septooptic dysplasia. Posterior fossa hypoplastic and dysplastic anomalies including Dandy-Walker malformation, vermian and hemispheric hypoplasia, Joubert syndrome, rhombencephalosynapsis and Llermitte-Dulcos syndrome. Migrational anomalies including lissencephaly (agyria/pachygyria), polymicrogyria, heterotopias, cortical dysplasias, schizencephaly and hemimegalencephaly. Corpus callosum anomalies including dysgenesis and hypoplasia of the corpus callosum and associated anomalies such as lipomas and interhemispheric arachnoid cysts. Neurophakomatoses including neurofibromatosis type 2, tuberous sclerosis complex and von Hippel- Lindau disease.
Pediatric Brain-Part II: Acquired Disorders

Poussaint, T.
Children's Hospital
Boston, MA

Abstract/Presentation Summary
Pediatric Neuroradiology, a radiologic discipline in which neuroimaging techniques are used to assess central nervous system (CNS) disease in the infant, child, and teenager, relies on 1) an understanding of normal brain development and maturation from gestation through adolescence; 2) a technical mastery of the neuroimaging techniques that are used in evaluating brain diseases of childhood; 3) an overall grasp of the imaging features of acquired numerous brain pathologies; and 4) the ability to select the most appropriate modality or modalities in evaluating a suspected or diagnosed case of acquired pediatric CNS disease. This presentation will provide a case-based overview of a subset of various CNS acquired diseases of childhood as well as the basic imaging features that inhere in each. The acquired disorders that will be covered in this session include metabolic white matter diseases of childhood, pediatric brain tumors, congenital infections, and vascular diseases of childhood described in the paragraphs below. Regarding white matter diseases of childhood, these disorders that primarily involve the white matter are known as leukoencephalopathies and include the peroxisomal disorders (e.g., adrenoleukodystrophies), the lysosomalleukodystrophies (e.g., metachromatic, globoid cell) and other white matter diseases (e.g., Pelizaeus-Merzbacher, Canavan, Alexander, Cockayne). Brain tumors are the most common solid pediatric tumors and the leading cause of death in children with solid tumors. The classification of CNS tumors is primarily based on histopathological criteria, molecular genetics and imaging features. Anatomic predilection and corresponding clinical signs provide other measures for classifying intracranial tumors in childhood including cerebral hemispheric tumors, tumors about the third ventricle, and posterior fossa tumors which will be reviewed. Deep or hemispheric cerebral tumors of childhood include astrocytoma (e.g., pilocytic), choroid plexus papilloma, ganglioglioma, other glial tumors, and embryonic tumors (e.g., PNET). Tumors that develop around the third ventricle (i.e., the suprasellar or pineal regions) are frequently encountered in childhood. These lesions include optic glioma, craniopharyngioma, and germ cell tumors (i.e., germinoma, teratoma). Common posterior fossa tumors of childhood include medulloblastoma, cerebellar astrocytoma, brainstem glioma, and ependymoma. Congenital infections of the CNS, which usually infect via the transplacental route, can affect the developing nervous system. Depending on the fetal age at the time of insult, manifestations of infection may vary. Congenital infections include, but are not limited to toxoplasmosis and others- syphilis, rubella, cytomegalovirus, herpes 2 and HIV (mnemonically termed, TORCH). Infections contracted during the first two trimesters may result in congenital malformations, while those occurring in the third trimester typically manifest as destructive lesions. On neuroimaging, the chronic sequelae of congenital infections include disorders of cortical development, calcifications, hydrocephalus, atrophy, demyelination, and porencephaly. There are numerous vascular diseases in childhood. Occlusive neurovascular disease in the child may be arterial or venous in origin and typically results in focal or multifocal lesions distributed within the occluded vessel or vessels. Arterial occlusive disease may occur as a prenatal or perinatal event.
(emboli of placental origin or from involuting fetal vessels), as a complication of infection (e.g., meningitis), with congenital heart disease, or from a hypercoagulopathy. Other causes include trauma (e.g., dissection), moyamoya disease, and metabolic disorders (e.g., mitochondrial cytopathies). Vascular conditions such as vein of Galen malformations and the associations of hemangioma with PHACE syndrome will be included.

8:10AM - 8:30AM

Questions and Answers

Tuesday
8:30AM - 10:00AM
Palais des congres de Montreal, 517bc

29 - ASFNR PROGRAMMING: EMERGING TECHNIQUES
O-188

7T-Potential Clinical

Hess, C.
University of California, San Francisco
San Francisco, CA

O-189

9:00AM - 9:30AM

Simultaneous Multi-slice (Multiband, Multiplexed) Sub-second fMRI and Ultrafast Imaging

Feinberg, D.
University California, Berkeley
Berkeley, CA

Abstract/Presentation Summary
Echo planar imaging (EPI) is most commonly used for fMRI due to its high BOLD contrast sensitivity, greatly reduced physiological noise compared to segmented or multi-shot imaging techniques and its high SNR/time rate during acquisition. Each EPI brain image is created from a single excitation pulse and the subsequent echo train readout in under a 100 ms, hence the image signal is recorded within a similar cardiac phase which minimizes physiological artifacts arising from pulsatile blood and CSF movement. Multi-slice EPI acquisition independently excites slices within a TR period to achieve very high efficiency in terms of image SNR per acquisition time.
To date, gradient echo (GE) EPI is the workhorse of fMRI studies. Discussed here is a rapidly developing MRI technology, recently impacting EPI based fMRI and diffusion imaging, as used in the NIH Human Connectome Project, and is a technology that will likely impact other neuroimaging sequences more widely used for clinical brain and spine imaging. Simultaneous Multi-Slice (SMS) EPI, also referred to as Multiplexed and Multiband (MB) EPI, (1-6) is a powerful new MRI development that is providing unprecedented speed in brain imaging for fMRI. SMS EPI has recently undergone improvements in its ability to separate the simultaneously recorded images, to reduce g-factor, reduce artifacts and substantially increase SNR. Improved separation of slices through deblurring using a generalizable approach of blipped controlled aliasing in parallel imaging (blipped-CAIPI) (4) now allows much higher slice acceleration (5,6), up to 12 slices recorded simultaneously, however the spatial inhomogeneity of g-factor becomes limiting in studies (4-6). A major advantage of SMS EPI over in-plane parallel imaging (Grappa, SENSE) is that SMS EPI does not accelerate by an undersampling factor R to shorten the echo train, consequently it does not incur the \(\sqrt{R}\) reduction in SNR as does parallel imaging. SMS EPI records slices simultaneously and can be used to increase brain coverage (2) or reduce TR for higher sampling rates (3). At 7T thinner slices reduce signal loss from intravoxel Bo inhomogeneity while SMS EPI allows whole brain fMRI without prohibitively long TR (2). In functional connectivity studies at 3T, SMS EPI reduced the TR required for whole brain coverage from typical TR 2s-3s down to sub-second TR 0.3-0.8s, which improved statistical definition of networks and provided additional important information on resting state connectivity (3). Recent use of SMS EPI for ASL perfusion imaging and for CSF phase velocity imaging has been evaluated.

O-190 9:30AM - 10:00AM

ASL Perfusion – Is It Reliable in Advanced Steno-Occlusive Disease?

Zaharchuk, G.
Stanford University
Stanford, CA

Tuesday
8:30AM - 10:00AM
Palais des congres de Montreal, 517d

30 - MINI SYMPOSIUM - TUMOR - PART I

O-191 8:30AM - 8:45AM

Blood Brain Barrier Imaging: Key Concepts When Evaluating Primary Brain Tumors

Cha, S.
University of California San Francisco
San Francisco, CA
Comparison of DCE- and DSC-MRI at 3T in the Grading of Gliomas

T Nguyen¹, G Cron¹, K Bezzina², P Kirstin¹, I Cameron¹, S Chakraborty¹, M Hogan¹, G Jansen¹, J Sinclair¹, R Thornhill¹, C Torres¹, J Woulfe¹

¹The Ottawa Hospital, Ottawa, Ontario, Canada, ²University of Ottawa, Ottawa, Ontario, Canada

Purpose
Tumor plasma volume (Vp) and the volume transfer constant (Ktrans) estimated by dynamic contrast enhanced MR imaging (DCE-MRI) can be biased by poor measurement of the vascular input function (VIF) (1). We have compared a novel DCE-MRI technique using a phase-derived VIF and 'bookend' T1 measurements with dynamic susceptibility contrast (DSC) MRI, in terms of diagnostic accuracy for pre-operative grading of gliomas.

Materials and Methods
This prospective study included 44 patients with new pathologically confirmed diagnosis of glioma (grade II, n=8; grade III, n=10; grade IV, n=26). Each patient underwent a preoperative MRI at 3 T which included two injections of 5ccs Gadobutrol 1.0 for DCE- and DSC-MRI. During DCE-MRI, both magnitude and phase images were acquired to estimate Vp_Φ and Ktrans_Φ (calculated using a phase-derived VIF and bookend T1 measurements) as well as for Vp_SI and Ktrans_SI (calculated from a magnitude-derived VIF without T1 measurements). From DSC-MRI, both the corrected cerebral blood volume normalized to the contralateral white matter (rCBV) and leakage factor (K2) maps were computed. For each patient, four regions-of-interest (ROIs) were placed over the solid part of the tumor and the highest value among the ROIs was recorded (hot spot). A neuropathologist diagnosed and graded the tumor according to the 2007 WHO criteria. A Mann-Whitney U test was used to test for difference between grades. Diagnostic accuracy was assessed using ROC analysis.

Results
Vp_Φ, Ktrans_Φ and rCBV values were statistically different between grade 2 and grade 3 as well as between grade 3 and grade 4 (P<0.05). Such a difference was not found for Vp_SI, Ktrans_SI and K2 (P>0.05). In differentiating low grade from high grade gliomas, there was no statistically significant difference between AUCs of Vp_Φ, Ktrans_Φ, and rCBV which were 0.96 (0.90-1), 0.91 (0.74-1) and 0.87 (0.68-1) respectively. AUCs for Ktrans_SI, Vp_SI, and K2 were 0.84 (0.71-0.97), 0.82 (0.61-1) and 0.71 (0.48-0.95). A statistical difference in AUCs was found between Vp_Φ and Ktrans_SI, and also between Vp_Φ and K2.

Conclusions
In the pre-operative grading of gliomas, diagnostic accuracy of DCE-MRI parameters obtained from phase-derived VIF and bookend T1 mapping is similar to DSC-MRI-derived rCBV.

KEYWORDS: Dynamic Contrast-Enhanced MR, Neoplasm, Permeability MR Imaging

Median values of the maximal perfusion parameters for different grades of gliomas

<table>
<thead>
<tr>
<th>Grade</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</thead>
<tbody>
<tr>
<td>Vp_Φ</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ktrans_Φ</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>rCBV</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Median</td>
<td>95% CI</td>
<td>Median</td>
</tr>
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<td>---------</td>
<td>--------</td>
<td>-------------------</td>
<td>--------</td>
</tr>
<tr>
<td>$K_{\text{trans} _ \Phi}$</td>
<td>0.000425</td>
<td>0.0000973 - 0.0141</td>
<td>0.0191</td>
</tr>
<tr>
<td>$K_{\text{trans} _ SI}$</td>
<td>0.0116</td>
<td>0.00126 - 0.0696</td>
<td>0.0615</td>
</tr>
<tr>
<td>$V_{\text{p} _ \Phi}$</td>
<td>0.228</td>
<td>0.000 - 1.062</td>
<td>1.668</td>
</tr>
<tr>
<td>$K_2$</td>
<td>1.150</td>
<td>-0.0375 - 5.225</td>
<td>2.052</td>
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</tbody>
</table>

Diagnostic accuracy of $r\text{CBV}$, $V_{\text{p} \_ \Phi}$ and $V_{\text{p} \_ SI}$ in preoperative grading of glioma

(Filename: TCT_O-192_figure_ROC_abstract.jpg)
A New Mosaic Pattern in Glioma Vascularization: Endothelial Progenitor Cells may Become a Therapeutic and Imaging Probe to Overcome Antiangiogenic Resistance

X Chen¹, J Fang¹, W Zhang¹
¹Institute of Surgery Research, Daping Hospital, Third Military Medical University, Chongqing, China

Purpose
Emerging evidence suggests that glioma stem-like cells (GSCs) transdifferentiating into vascular endothelial cells (ECs) possibly contributes to tumor resistance to antiangiogenic therapy. Endothelial progenitor cells (EPCs), showing active migration and incorporation into neovasculature of glioma, may be a good vehicle for delivering genes to target GSCs transdifferentiation. Thus we aimed to investigate whether exogenous EPCs integrated into the vessels containing the tumor-derived ECs in C6 glioma rat model. Furthermore, to show the feasibility of using MR imaging (MRI) to track and quantify these cells.

Materials and Methods
Forty-eight C6 glioma rat models in situ were established. Spleen-derived EPCs from healthy Sprague-Dawley rats were obtained, maintained and identified, then labeled with USPIO and fluorescein. Rats in the EPC group were transplanted with double labeled EPCs via tail vein on 10 days after glioma established. MR imaging was performed at a 3.0 T MR system using specific small animal head coil before EPCs transplantation and on 1, 3, 5, 7 day post-transplantation of EPCs. The MRI sequences included T2-weighted imaging and susceptibility-weighted imaging (SWI) were used to track the migration of these double labeled EPCs, additionally, T2-map was used to detect the T2 value and corresponding ΔR2 value. The distribution of double labeled EPCs was detected by Prussian blue staining and immunofluorescent staining. The corporation of these homing EPCs into tumor vessels was performed by immunofluorescent staining and TEM.

Results
We found a new mosaic pattern that exogenous EPCs integrated into the vessels containing the tumor-derived ECs in C6 glioma rat model. Further, the transdifferentiation frequency of C6 glioma cells and the expressions of key factors on GSCs transdifferentiation, i.e., HIF-1α, Notch1, and Flk1 in gliomas with or without EPCs transplantation showed no significant difference between these two groups. Similar results were observed in a series of in vitro experiments, including flow cytometry, tube formation and western blot analysis of transdifferentiation-induced C6 glioma cells treated with or without EPCs conditioned medium. Additionally, magnetic resonance imaging could track the migration and incorporation of EPCs into glioma in vivo, which was confirmed by Prussian blue staining. The number of magnetically labeled EPCs estimated from T2 maps correlated well with direct measurements of labeled cell counts by flow cytometry.

Conclusions
Our findings may provide a rational base for the future application of EPCs as a therapeutic and imaging probe targeting GSCs transdifferentiation to overcome antiangiogenic resistance for glioma and monitor the efficacy of this treatment.

KEYWORDS: Glioma, MR Imaging, Stem Cell
ASL in the Evaluation of Primary CNS Tumors: Are We There Yet?

Maldjian, J.
Wake Forest University School of Medicine
Winston-Salem, NC

Abstract/Presentation Summary
Arterial spin labeling (ASL) perfusion MRI imaging has been in development for over a decade (1-3). During this time, it has remained predominantly a research tool. With the recent availability of the technique from a variety of MRI vendors, ASL is now entering more broadly into the clinical realm. Unlike conventional bolus gadolinium techniques, ASL does not require intravenous contrast, is quantitative, and is readily repeatable. Perfusion studies can provide useful information in the evaluation of patients with CNS tumors. Tumor grade frequently correlates with a variety of perfusion parameters, based predominantly on bolus gadolinium techniques (4-7). Tumor studies using ASL are now emerging. Hypoperfused tumors on ASL are frequently of lower histologic grade (4), and for malignant neoplasms, the higher the perfusion of the mass, the higher the histologic grade (4-7). High ASL perfusion can be seen frequently in non-malignant tumors such as meningiomas and hemangioblastomas. Metastatic lesions demonstrate a variety of perfusion patterns, with solid tumors tending to be hyperperfused.

Blood Pool Contrast Agent High-resolution MR Angiography in Glioblastoma: Tumor Vasculature as a Biomarker for Survival

Puig, J; Blasco, G; Daunis-i-Estadella, J; Remollo, S; Hernandez, D; Essig, M; Jain, R; Sanchez-Gonzalez, J; Pedraza, S

1 Girona Biomedical Research Institute (IDIBGI), Hospital Dr Josep Trueta, Girona, Spain, 2 University of Girona, Girona, Spain, 3 Hospital Dr Josep Trueta, Girona, Spain, 4 Hospital Vall Hebron, Barcelona, Spain, 5 University of Manitoba, Winnipeg, Manitoba, Canada, 6 New York University Langone Medical Center, New York, NY, 7 Philips Healthcare Ibérica, Madrid, Spain

Purpose
Vascularity, defined histologically or with molecular techniques, correlates with poor survival in patients with glioblastoma. Regionally heterogeneous vascularization limits histologic markers, which are measured only in some tissue sections. More accurate assessment of valid vascular biomarkers such as digital subtraction angiography or dynamic susceptibility contrast (DSC) perfusion MRI represents a challenge; thus far, MR angiography has been unable to characterize glioblastoma vascularity. Gadofosveset is an albumin-binding contrast agent approved for imaging blood vessels. It remains largely intravascular because it forms reversible noncovalent bonds with albumin, resulting in a 4- to 5-fold increase in blood relaxivity at 1.5 T compared to extracellular contrast agents. We aimed to (a) assess the vascularity of newly diagnosed glioblastomas using gadofosveset high-resolution MR angiography, (b) correlate the findings with dynamic DSC and diffusion MR imaging (MRI) parameters for contrast-enhancing lesion
(CEL) and surrounding non-CEL, and (c) determine whether high resolution MR angiography of tumor is useful in predicting survival.

Materials and Methods
Before treatment, 33 patients (23 men; mean age, 63 years) with histologically proven glioblastoma underwent MRI including anatomical sequences, first-pass DSC images and postcontrast T1-weighted SE images after gadobutrol (Gadovist; Bayer Schering Pharma, Berlin, Germany) at 0.1 mmol/kg and, 48 hours later, high-resolution MR angiography acquired after gadofosveset (Ablavar, Lantheus Medical Imaging, North Bilerica, USA) at 0.03 mmol/kg with a 0.6 mm isometric voxel. Two independent observers evaluated presence of vessels on high resolution MR angiography. Volumes of interest for CEL, NCEL, and contralateral tissue were obtained for cerebral blood volume ratio (rCBV), cerebral blood flow ratio (rCBF), permeability constant (k2), mean temporal maximal intensity projection (tMIP), and apparent diffusion coefficient (ADC) using Olea Sphere V.2.0 software (Olea Medical, La Ciotat, France). Statistical analyses included Pearson correlation, linear regression analysis, and interclass correlation coefficients. Prognostic factors were evaluated by Kaplan-Meier survival and Cox proportional hazards analysis.

Results
Eighteen (52.94%) glioblastomas were vascular and 16 (40.5%) avascular on high resolution MR angiography (Figure); interobserver reliability was good (K=0.745). In vascular glioblastomas, mean tMIP values were higher (p=0.024) and there was a trend to lower mean ADC values (p=0.068) (Table). Median survival for avascular and vascular glioblastomas treated with surgery and with radiotherapy plus chemotherapy was 15 months (95% CI, 4.5-30.2) and 8.5 months (95% CI, 2.9-14.1), respectively. When treatment was incomplete, median survival for avascular and vascular glioblastomas was 6.5 months (95% CI, 3.1-9.8) and 3.5 months (95% CI, 2.1-4.9), respectively. Vascular pattern was the best survival predictor for glioblastoma at 5.25 months (AUC 0.794, 81.2% sensitivity, 77.8% specificity, 76.5% positive predictive value, 82.4% negative predictive value). Vascular pattern yielded the highest hazard ratio (14.012; 95% CI: 2.436,80.579; P=0.003).

Conclusions
High resolution MR angiography using gadofosveset can detect vascularity in glioblastoma. Vascularity is a useful imaging biomarker that correlates with worse survival in newly diagnosed glioblastoma.

KEYWORDS: Glioblastoma, MR Imaging/MR Angiography, Outcome

<table>
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<th>Contralateral gray matter</th>
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<th>Contrast-enhancing lesion</th>
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<tbody>
<tr>
<td></td>
<td>Avascular</td>
<td>Vascular</td>
<td>p-value</td>
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<tr>
<td>rCBF</td>
<td>18.3 (5.66)</td>
<td>16.58 (6.48)</td>
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<td>rCBV</td>
<td>1.68 (0.63)</td>
<td>1.46 (0.7)</td>
<td>0.343</td>
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<tr>
<td>rCBVc</td>
<td>1.25 (0.49)</td>
<td>1.03 (0.52)</td>
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<td>5.74 (1.31)</td>
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<td>Tmax</td>
<td>3.06 (0.61)</td>
<td>3.11 (0.59)</td>
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<td>TTP</td>
<td>38.12 (18.47)</td>
<td>42.47 (17.71)</td>
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<td>K2</td>
<td>-46.75 (33.34)</td>
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<td>Cmax</td>
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<td>0.12 (0.03)</td>
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<tr>
<td>ADC</td>
<td>79.6 (4.17)</td>
<td>82.05 (3.89)</td>
<td>0.091</td>
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</table>
Non-invasive Assessment of Intratumoral Vascularity Using Arterial Spin Labeling: a Comparison to Susceptibility-weighted Imaging for the Differentiation of Primary Cerebral Lymphoma and Glioblastoma
Purpose
Using conventional MR imaging (MRI) methods, the differentiation of primary cerebral lymphomas (PCNSL) and other primary brain tumors, such as glioblastomas, is difficult due to overlapping imaging characteristics. The purpose of this study was to determine the utility of normalized vascular intratumoral signal intensity values (nVITS) obtained from pulsed arterial spin labeling (PASL) to differentiate between PCNSL and glioblastomas in a routine clinical setting, and to compare the diagnostic accuracy of this new method with the accuracy of intratumoral susceptibility signals (ITSS) values obtained from susceptibility-weighted imaging (SWI). This could ultimately result in a totally noninvasive method to differentiate lymphoma and glioblastoma.

Materials and Methods
Using conventional MRI methods, the differentiation of PCNSL and other primary brain tumors, such as glioblastomas, is difficult due to overlapping imaging characteristics. This study was designed to discriminate tumor entities using nVITS obtained from PASL, combined with ITSS from SWI. Thirty consecutive patients with glioblastoma (n=22) and PCNSL (n=8), histologically classified according to the WHO brain tumor classification, were included. MR images were acquired on a 3 T scanner, and included PASL and SWI sequences. nVITS was defined by the signal intensity ratio between the tumor and the contralateral normal brain tissue, as obtained by PASL images. Intratumoral susceptibility signal was determined as intratumoral low signal intensity structures detected on SWI sequences and were divided into four different grades. Potential differences in the nVITS and ITSS between glioblastomas and PCNSLs were revealed using statistical testing. To determine sensitivity, specificity, and diagnostic accuracy, as well as an optimum cut-off value for the differentiation of PCNSL and glioblastoma, a receiver operating characteristic analysis was used.

Results
We found that nVITS (p=0.011) and ITSS (p=0.001) values were significantly higher in glioblastoma than in PCNSL. The mean of the ITSS value was 0.43 for lymphoma and 2.77 for glioblastoma. For nVITS values, the mean was 1.10 for lymphoma and 2.16 for glioblastoma. For illustration, also see the box-and-whisker plots in Figure 1. The optimal cut-off value for nVITS was 1.41 and 1.5 for ITSS, with a sensitivity of 100%, a specificity of 95.5%, and an accuracy of 95.5%. Intratumoral susceptibility signals were detected in all glioblastomas (100%) and in three of seven lymphomas (0.43%). One T-cell PCNSL was excluded due to extensive intralosomal macrohemorrhage.

Conclusions
nVITS and ITSS values, obtained from PASL and SWI sequences, provide truly noninvasive approaches to the differentiation of glioblastomas and lymphomas on the basis of tumor vascularization. The cut-off values determined in this study could serve as an objective support for decision-making in the routine clinical diagnostic protocol to distinguish these two tumor entities. These methods offer beneficial, fast, and easily applicable tools for integration into routine MRI diagnostics, which would result in a potentially high clinical impact for the treatment and management of patients with these tumors.
Evaluation of a Novel Pulsed Arterial Spin Labeling Protocol in Pediatric Brain Tumors: a Feasibility Study in Comparison with Dynamic Susceptibility Contrast Perfusion

C Ho¹, S Kralik¹, J Smith², J Boaz², L Ackerman², D Fulkerson², Y Wang¹
¹Indiana University School of Medicine, Indianapolis, IN, ²Goodman Campbell Brain and Spine, Indianapolis, IN

Purpose
To compare a novel pulsed arterial spin labeling (PASL) method to dynamic susceptibility contrast (DSC) perfusion in the clinical setting of pediatric central nervous system (CNS) tumors. The experimental PASL protocol uses multiple inversion times (TI) to minimize bias in rCBF estimates due to regional differences in arterial arrival time, in addition to improving the signal to noise ratio by combining two consecutive PASL scans in ascending and descending slice order for the same TI.

Materials and Methods
IRB approval was obtained for this study. Nine children with primary CNS tumors were imaged with our PASL technique followed by DSC perfusion. Tumor diagnosis and tumor grade were recorded by available pathologic data or consensus from expertise and follow-up imaging. For each case, CBF maps were generated from the PASL scan, as well as CBF and CBV maps from DSC. Regions of interest (ROIs) were placed in the tumor areas with highest perfusion on the CBF maps and compared to normal contralateral gray matter (GM) with both types of perfusion...
techniques. For DSC, the highest ROI values in the tumor also were compared to normal contralateral white matter (WM) for both CBV and CBF maps. Spearman's rho was calculated for the resulting ratios compared to the tumor grade. Multiple regression analysis was performed for all ratios and tumor grade.

Results
To date, six low grade tumors and three high grade neoplasms were studied. All cases were pathologically confirmed, except two presumed low grade tumors from multidisciplinary consensus, lack of symptomatic change, imaging characteristics, and stability. The PASL protocol averaged 11 minutes for acquisition. Positive Spearman's rho was found for all ratios compared to tumor grade. Significant positive correlation was noted between rCBV-DSC and tumor grade (0.67, p=0.04), rCBF-DSC and tumor grade (0.74, p=0.02) and rrCBF-PASL and tumor grade (0.72, p=0.05). Multiple regression analysis demonstrates positive correlation between all ratios and tumor grade with the strongest correlation between rCBV(WM) and rCBF(WM) for DSC (0.89, 0.55-0.98), rCBF(WM) and rCBF(GM) for DSC (0.88, 0.52-0.97), and rCBF-DSC(GM) and rrCBF-PASL(GM) (0.86, 0.46-0.97). Figures: Sixteen-year-old male with pathology proven primitive neuroectodermal tumor. Axial postcontrast 3D T1-weighted image shows an enhancing mass in the left lentiform nucleus with corresponding increased perfusion on rCBF-PASL map (white arrows). An area which does not show enhancement in the anterior insular cortex also shows increased rCBF indicating tumor involvement (black arrows).

Conclusions
A novel PASL protocol with multiple-TI was introduced at clinically acceptable scan durations and demonstrates good correlation with DSC and tumor grade in pediatric brain tumors. This allows perfusion data with less bias from differences in arterial arrival time to be obtained without the use of gadolinium-based contrast in children.

KEYWORDS: ASL, Dynamic Susceptibility Contrast-Enhanced, Pediatric Brain Tumors
O-198

Update on MRS in Brain Tumor Evaluation

Castillo, M.
UNC Chapel Hill
Chapel Hill, NC
Abstract/Presentation Summary

This lecture explores the following issues: Do we understand what MRS means? Is it reliable and reproducible? Is it helpful in initial tumor evaluation and biopsy planning and treatment planning? Is it useful after treatment? We know that NAA is a neuron-marker only but that its function is unknown although it serves as marker of neuron density and viability. Choline reflects cellularity but not its origin which can be due to proliferation or accumulation. Creatine is a marker of energy and may be elevated in low grade gliomas. Lactate indirectly measures aerobic metabolism and although it generally implies ischemia (high grade) it may be elevated in pilocytic astrocytomomas. Finally, lipids are markers of necrosis but many times are contaminants from outside of voxel sampling. The reproducibility of MRS has improved but it remains limited in the evaluation of small changes in metabolites due to its inherent low signal-to-noise and the fact that major biological alterations must be present before being reflected by MRS. MRS is perhaps not helpful in initial tumor evaluation and low grade gliomas may have falsely low choline levels while some glioblastomas may show a normal spectral pattern. MRS may be helpful in distinguishing between 1ry gliomas and metastasis and tumefactive demyelinating lesions but perfusion is equally helpful in these situations and easier to perform and interpret.

MRS may be helpful in guiding biopsy towards areas containing high choline levels especially in heterogeneous tumors such as gliomatosis. Finally, finding elevated myoinositol and glutamine in a hemisphere contralateral to a glioma may indicate diffuse tumor spread and in some gliomas the presence of certain metabolites may correlate with genetic alterations such as mutation of the IDH1 gene. MRS may add certainty to the diagnosis of treatment-induced necrosis but is limited in cases of pseudoprogression. Unfortunately, MRS is not covered by most insurances due to the fact that most articles are levels of evidence 3 or 4 and its impact in diagnosis and tumor treatment have not been proven.

O-199

9:45AM - 9:51AM

PH-Weighted Molecular MRI in Human Glioblastoma using Chemical Exchange Saturation Transfer (CEST) Imaging of Glutamine at 3T

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1University of California Los Angeles, Los Angeles, CA, 2Cedars-Sinai Medical Center, Los Angeles, CA

Purpose

A decrease in pH within the tumor microenvironment has been shown to result in malignant transformation, resistance to radiation therapy, resistance to specific chemotherapies, increased probability of metastasis, immunosuppression, increased tumor invasion, increased rate of mutations, increased chromosomal rearrangements, altered gene expression, and angiogenesis. Thus, a noninvasive imaging method for evaluating tumor tissue pH would be valuable for early detection of treatment response, tumor progression, and/or treatment failure in malignant gliomas. In the current study we used chemical exchange saturation transfer (CEST) imaging, a new MR imaging (MRI) technique, to identify tumor tissue with low pH (acidic tissue) by targeting MR excitation of amine protons on glutamine, one of the major sources of fuel for tumor cells.
Materials and Methods
All experiments were performed on a 3 T Siemens Trio (Siemens Healthcare, Erlangen, Germany). We performed extensive experiments involving glutamine in solution at various concentrations and pH in order to establish the relationship between extracellular glutamine and pH. We performed serial CEST imaging at 3 T in 10 patients with glioblastoma before, during, and after radiation therapy and concurrent temozolomide. Additionally, we performed CEST imaging in select patients with suspected tumor recurrence and patients treated with bevacizumab, an anti-angiogenic agent. Chemical exchange saturation transfer imaging was performed by selecting 51 offset frequencies ranging from -5 ppm to 5 ppm with respect to water resonance, using a saturation power of B1 = 2 μT and a series of 100 ms Gaussian pulses at 50% duty cycle. B0 homogeneity correction was performed. Chemical exchange saturation transfer asymmetry was calculated at 2.8 ppm, corresponding to glutamine proton resonance, by \[\text{Asym} = (2.8 \text{ppm} - 2.8 \text{ppm}) + 2.8 \text{ ppm} \times 100\%\].

Results
Results suggest that a positive asymmetry exists for acidic pH environments when targeting glutamine. This asymmetry increased with increasing concentration of glutamine. Serial pH-weighted imaging during radiation therapy showed increasing volume of tissue with low pH in areas of the tumor not responding to therapy as indicated by growing tumor on subsequent follow-up scans. Patients with new regions of contrast enhancement after radiotherapy and no corresponding change in pH-weighted imaging were shown to have characteristics of pseudoprogression. Areas of necrosis also showed low pH, consistent with known biology. At tumor recurrence, the volume of tissue with low pH corresponded to areas of contrast enhancement along with areas surrounding the tumor. Patients with prolonged bevacizumab therapy showed areas of low pH within atypical necrotic regions, consistent with previous reports.

Conclusions
Chemical exchange saturation transfer imaging targeting glutamine proton exchange is a novel approach to visualizing and quantifying tumor tissue with low pH. This information may be valuable for early identification of treatment failure and differentiating tumor recurrence from pseudoprogression.

KEYWORDS: Glioblastoma, Magnetization Transfer Imaging, Molecular Imaging

O-200
9:51AM - 9:57AM

Variable density interleaved spiral MRI for amide proton transfer imaging on U87 glioblastom xenograft model at clinical 3T scanner

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\textsuperscript{1}University of Iowa, Iowa City, IA, \textsuperscript{2}Massachusetts General Hospital/Harvard Medical School, Boston, MA

Purpose
Amide proton transfer (APT) imaging has demonstrated promising potentials in brain tumor activity measure which may be useful as a biomarker for evaluating therapeutic response to glioblastoma (GBM). Preclinical imaging on GBM xenograft models is crucial to test validity
and reliability of this new technique. However lack of easy access to small animal MRI facility have been hampering clinical translation of APT imaging. Variable density (VD) spiral sequence has many desirable properties that come from its concentric circular geometry allowing oversampling near the origin of k-space and reduced hardware demand on gradient switching. In this work, we developed a new APT imaging sequence with VD interleaved spiral readout and applied this method on orthotopic GBM xenograft models in immune-deficient rats to test feasibility of preclinical APT imaging at clinical 3 T scanner.

Materials and Methods

Four male athymic nude rats 7-8 weeks of age were implanted with U87 MG cells in the right frontal caudate region stereotaxically, and imaged at 20-25 days after tumor implantation on a 3 T clinical MR imaging (MRI) scanner equipped with a quadrature transmit/receive RF coil. Local shimming was followed by acquisition of multi-shot VD spiral-out APT-weighted images with 31 pulsed saturation RF irradiation (B1=1.5 µT) and 21 frequency-labeling offsets from -5 ppm to 5 ppm with respect to water (TR/TE=1600/1.7 msec, spiral interleaves=20, slice thickness=3 mm, FoV=40 mm, matrix=96x96, average=2, acquisition time=14:25 min). B0 inhomogeneity was corrected with Z-spectrum fitting on double-echo gradient field maps. The APT effect was calculated based on the MT-ratio asymmetry. Additionally T1 mapping with variable flip angle FLASH, T2 mapping with multi-echo turbo SE, and ADC mapping on RESOLVE DWI with a three-point multi-exponential fitting (b=0, 1000 and 2800 s/mm2) were performed.

Results

All U87 GBM xenograft demonstrated enhanced APT effect compared to the normal brain. Figure 1 shows the Z-spectra and APTR plots from each GBM xenograft model. Amide proton transfer ratio measured from the tumors were ranged from 3.40 to 5.28% (4.2±0.83; mean±S.D.) higher than those from the normal side of the brain (Table 1). Figure 2 shows example images of T1 map (A), T2 map (B), ADC map (C), APTR map (D), and histopathologic correlation of a U87 GBM xenograft (E,F).

Conclusions

Efficient use of gradient hardware in VD spiral sequence allowed small field-of-view acquisition while maintaining reasonable signal-to-noise ratio for small animal brain scan at clinical 3 T scanner. This method also can significantly reduce scanning time and still maintain spatial resolution which are desirable attributes for practical translation of APT-weighted imaging. In this small study, we observed a trend of APT effect measures positively correlate with degree of pseudopalisading necrosis within the GBM on microscopy, which needs to be further investigated in a larger scale study.

KEYWORDS: Animal Model, Glioblastoma

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Vascular Malformations in Neonates

Rossi, A.
G. Gaslini Children's Hospital
Genova

Abstract/Presentation Summary
Vascular malformations in neonates comprise arteriovenous malformations (AVM), mainly represented by the vein of Galen aneurismal malformation (VGAM), and dural sinus malformations (DSM). Other vascular malformations that are proper of older age groups, such as pial AVMs and cavernomas/developmental venous anomalies (AVMs) are more seldom encountered in the neonate. Frequently, the diagnosis of these disorders is already made prenatally thanks to a combined use of ultrasound and MRI. A challenge of fetal MRI is represented by the absence of reliable MR angiography techniques; thus, appraisal of the vascular nature of the lesion must be made by a combination of "conventional" T1 and T2-weighted sequences, complemented by Doppler ultrasound. VGAM accounts for 30% of vascular malformations in the pediatric age group, and is the most common in neonates. It results
from abnormal connections established between choroidal arteries and the median prosencephalic vein at 6-11 weeks gestation, which prevent the physiologic regression of this vein. MRI allows for classification between choroidal (>4 afferents) and mural (<4 afferents) types, and is crucial for assessing parenchymal trophism and presence of negative prognostic factors such as encephalomalacia, calcifications, and hydrocephalus. DSM is a giant venous lake, usually but not necessarily involving the torcular. It may be fed by AV fistulas, and intraluminal thrombosis is part of its natural history. Although it accounts for fewer than 2% of vascular malformations in the pediatric age group, it is the second most common in neonates. Outcome is satisfactory in the majority of cases, but the role of endovascular treatment remains controversial. Lateral DSM (ie, involving only one transverse-sigmoid sinus) has a better prognosis than median DSM (involving the torcular). "Anterior" DSM (involving the inferior sagittal sinus) is an uncommon entity which we have seen in association with large DVAs.

**O-202**

**Pediatric Aneurysms**

Vossough, A.
University of Pennsylvania
Philadelphia, PA

Abstract/Presentation Summary
Pediatric intracranial arterial aneurysms are uncommon compared to adults and despite many similarities, there are distinct differences between pediatric and adult aneurysms. The epidemiology of pediatric intracranial aneurysms will be first presented and how it can differ from adult aneurysm statistics. The features of pediatric intracranial aneurysms and classifications into traumatic, dissecting, saccular, vasculopathic, and infectious types of aneurysms will be discussed. The pathophysiologic mechanisms of aneurysms will be briefly reviewed in the context of the various types. A number of underlying disorders have an increased incidence of cerebral aneurysms in the child. The associated comorbidities and the various congenital cerebral aneurysmal vasculopathies will be briefly examined in the context of pediatric cerebral aneurysms. The incidence of subarachnoid hemorrhage and subsequent intracranial vasospasm is also different in children and will be discussed. Basic treatment strategies will be briefly reviewed. Finally, prognosis and outcome of treatment of pediatric aneurysms will also be discussed.

**O-203**

**Endovascular Treatment**

Rodesch, G.
Hopital Foch
Suresnes

Abstract/Presentation Summary
AVMs in neonates (from birth to 1 month of age) represent challenging lesions far beyond pure
technique, and their treatment cannot be indeed summarized to a miniaturized endovascular therapy. Two main types of lesions share this a group: Vein of Galen Arterio-venous Malformations (VGAMs) and Dural Sinus Malformations (DSMs). They can both be considered as "true "congenital embryologic malformations. High Flow arterio-venous fistulas (AVFs) and malformations (AVMs) are rarely seen in neonates, pointing to the fact that this type of shunts is created later in life, most often after infancy. Symptoms of VGAMs and DSMs in neonates differ from the usual ones associated to "adult type" malformations. VGAMs often present in neonates with systemic disorders that can even have begun in utero. Application of specific clinical scores allows to recognize which patients will benefit from embolization and at what moment this treatment should be applied (delayed until 5-6 months of age under close radio-clinical follow up, or in emergency). Endovascular occlusion with acrylic glue has proven to be the most efficient therapy in these diseases. DSMs may also present at that age with hemodynamic symptoms. The challenge in these latter malformations is however different because of the associated immaturity of the venous system and the risk of spontaneous thrombosis. Midline locations have usually poor prognosis as compared to lateral ones. Cavernous sinus capture and maturation of the sigmoido-jugular junction will dictate clinical outcomes. Precise recognition of the type of the disease, of its patho-physiology and consequences on the brain (melting brain or focal atrophies…) or other body organs, as proper evaluation of the optimal therapeutic window to treat the patients represent the most important steps to follow to obtain satisfactory results. The main primary goals to reach in this age group are obviously not obligatorily the cure of the malformation, but are represented by the relief of the symptoms presented by the baby and the maturation of the brain, allowing normal neurologic and neurocognitive development.

Tuesday
8:30AM - 10:00AM
Palais des congres de Montreal, 520

32 - INTERNATIONAL SESSION: ESNR: EUROPEAN TEACHING CAROUSEL
O-204
8:30AM - 8:50AM

Neuroradiological Assessment of Traumatic Brain Injury: A Pattern-Based Approach

Parizel, P.
Antwerp University Hospital/University of Antwerp
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Abstract/Presentation Summary
CT and MRI examinations constitute an essential part of the diagnostic work-up of patients admitted with (acute) traumatic brain injury. Imaging studies often direct patient management and greatly influence the clinical course, especially the acute setting. CT remains the preferred technique to determine the presence and extent of injuries (such as fractures, intra-and extra-axial hemorrhage, mass effect, etc.). CT findings are crucial in planning and guiding neurosurgical intervention. Multi-detector CT scanning allows simultaneous assessment of head and cervical spine, thereby obviating the need for plain X-rays. MRI of the brain plays an increasingly important role in the assessment of craniocerebral trauma, especially in those individuals in whom there is a discrepancy between the patient's clinical status and the CT findings. In these
cases, MRI may reveal evidence of parenchymal damage (e.g. diffuse axonal injury) or hemorrhage, not seen on CT. During this presentation, we shall propose a pattern-based approach, in order to obtain a quick and complete inventory of the traumatic brain lesions. It is important to distinguish primary and secondary lesions. Primary injuries occur as a direct result of the impact with damage to brain tissue. Examples include fractures, different types of traumatic haemorrhage (epidural, subdural, intracerebral, subarachnoid), cerebral contusion, diffuse axonal injury (DAI). CT- and/or MR-angiography are useful techniques to document traumatic blood vessel injury. Secondary injuries are caused by systemic factors such as increased intracranial pressure, edema, brain herniation, decreased cerebral blood flow, excitotoxic damage. Increasingly, there is an important role for MRI of the brain in patients admitted with traumatic brain injury. In the head-injured patient, a multiparametric MRI examination should include diffusion, perfusion, and susceptibility-weighted imaging. Diffusion tensor imaging with fractional anisotropy mapping may show microstructural abnormalities in patients with mild TBI, even when traditional MRI sequences appear normal. Neuroimaging also plays a role in the chronic stage, identifying sequela, determining prognosis, and guiding rehabilitation. In conclusion, recent technological advances in CT and MRI have greatly improved our understanding of the pathophysiology of craniocerebral trauma and allow us to detect abnormalities, even in patients with mild head trauma, when routine imaging studies appear normal.

O-205

Infections

Tali, E.
Gazi University School of Medicine
Besevler, Ankara

Abstract/Presentation Summary
Infections of the CNS frequently present diagnostic and therapeutic challenges. Central nervous system infections are not frequent, accounting for 1% of primary hospital admissions and 2% of nasocomially acquired infections, 2-7% of osteomyelitis. When encountered, prompt diagnosis and initiation of specific treatment often are necessary to allow the best chance of recovery without sequelae. The prognosis depends on rapid identification of the site of the inflammation and pathogen. Most CNS infections can be treated successfully as long as they are detected early. Delayed diagnosis remains a major cause of disability. It is particularly unfortunate if a rapidly progressive but treatable disease remains undetected until irreversible damage is caused. Even at present, many cases reaching a neurosurgical centre could have been detected and referred early if the imaging had been correctly interpreted in the clinical setting. Radiological evaluation plays an important role in the diagnosis, subsequent treatment and treatment monitoring. Improvements in diagnostic imaging, in particular computed tomography (CT) and magnetic resonance imaging (MRI) have greatly facilitated the diagnosis and treatment planning, treatment and treatment monitoring of intracranial and spinal infections.

O-206
**Demyelination**

Thurnher, M.
Medical University Of Vienna
Vienna

Abstract/Presentation Summary
Evaluation of MR imaging in a patient with an intramedullary lesion should focus on key-features: a) the location of the lesion on the cross sectional area of the cord, best evaluated on axial images, b) the length of the lesion evaluated on sagittal images, c) the presence of cavitation and cysts, d) signal intensity on T2-WI, e) the presence of enhancement and enhancement type, and f) associated leptomeningeal enhancement. The knowledge of the presence or absence of the brain lesions is important information for narrowing the differential diagnosis. Finally, clinical information, demographics, and immune status should be incorporated. In this lecture imaging characteristics and typical patterns of intramedullary lesions will be presented. A diagnostic algorithm, which includes imaging, clinics and CSF analysis, will be discussed.

**O-207**

**Pediatric Tumors**

Rossi, A.
G. Gaslini Children's Hospital
Genova

Abstract/Presentation Summary
Brain tumors are the most common solid pediatric tumors and are the leading cause of death in children from solid tumors. The estimated incidence of all childhood primary brain and central nervous system tumors is 4.8 cases per 100,000 person-years. In neonates and infants up to the age of 3 years, supratentorial tumors are more common, whereas infratentorial tumors predominate until adolescence. The wide availability of CT for diagnosing patients presenting acutely, particularly in the emergency room setting, has produced several advantages including its ability to detect a sizable mass lesion, identify mass effect, and check for ventricular enlargement, lesional hemorrhage, calcification, and osseous involvement. Owing to its superior soft tissue resolution, multi-planar capability, and lack of ionizing radiation, MRI with contrast is the modality of choice for determining lesion size, location and characterization. Conventional sequences for MR evaluation include T1, T2, FLAIR and post gadolinium (multiplanar T1) images. While contrast enhancement typically reflects disruption of the blood-brain barrier; the degree of contrast enhancement does not always correlate with tumor grade. For example, benign tumors (e.g., choroid plexus papillomas and pilocytic astrocytomas) can enhance avidly, whereas anaplastic astrocytomas or primitive neuroectodermal tumors may not enhance at all. MRI is also used to assess tumor response and progression and monitor treatment effects. Craniospinal MR with gadolinium is useful in evaluating the degree to which tumor may have disseminated in the CSF pathways. Advanced MR imaging modalities, such as diffusion-weighted imaging (DWI), diffusion tensor imaging (DTI), perfusion-weighted imaging (PWI), magnetic resonance
spectroscopy (MRS), and functional MRI have significantly improved our understanding of the physiopathology of brain tumours and have provided invaluable additional information for treatment planning and monitoring of treatment results.

32-5

Questions

Tuesday
8:30AM - 10:00AM
Palais des congres de Montreal, 524

33 - SOCIOECONOMIC PROGRAMMING: CURRENT PAYMENT POLICY
O-208

CPT Update

Tu, R.
Progressive Radiology
Washington, DC

Abstract/Presentation Summary
CPT has identified procedures which occur together with request for bundling. ASNR was the lead society in the code change proposal for myelography as the injection procedure and imaging guidance codes for myelography were identified as codes reported together 75% or more of the time. The Relativity Assessment Workgroup requested that a bundled coding solution be perused for this family of codes. ASNR as lead with ACR, ARRS, and RSNA submitted 4 code change proposals bundling injection and image guidance for myelography procedures. The current injection and radiologic supervision and interpretation codes for myelography were retained as myelography is occasionally performed by 2 physicians, one performing the contrast media injection and the second providing radiology radiological supervision and interpretation. The code change was accepted by CPT and reviewed by National Correct Coding Initiative. SIR was the lead presenter for Percutaneous Vertebroplasty and Augmentation and ASNR with ACR, ARRS, RSNA, AANS, AAOS, ASNR, and SNS as cosponsors for code change proposal describing vertebral augmentation including imaging which was approved.

O-209

RUC Update
Nicola, G.
Hackensack University Medical Center
Hackensack, NJ

Abstract/Presentation Summary

ASNR SOCIOECONOMIC PROGRAMMING: CURRENT PAYMENT POLICY-RUC Update

CURRENT PAYMENT POLICY-RUC Update talk will focus on the fundamental role the "Relative Value Scale Update Committee" (RUC) plays in the current fee for service physician Medicare payment system, and, how does the American Society of Neuroradiology (ASNR) participate in the process. Key topics will include detailing the composition of the RUC, meeting schedule, and its influences on Medicare payment policy. The concept of "relative value units" (RVU) for professional and technical component payments will be introduced. An expanded look will be made into the RUC survey process, data collection, data analysis, and data presentation used to determine relative value units. Recent results of the ASNR/RUC interaction will be critiqued. Trends in health care economics and statutory requirements changing the way the RUC operates, and potential impacts on radiology will be reviewed. Examples of how the general membership may take part in supporting the ASNR in its dealing with RUC are explored.

O-300

CMS Update

Silva, E.
South Texas Radiology Group
San Antonio, TX

Abstract/Presentation Summary

This presentation will build upon the earlier discussions of actions taking place at the CPT Editorial Panel and the RVS Update Committee, the RUC. The CMS update will highlight the broader regulatory climate at the Centers for Medicare and Medicaid Services (CMS). Focus will be paid upon policies which impact radiology including changes to the Medicare Physician Fee Schedule, the Hospital Outpatient Prospective Payment System and the Inpatient Prospective Payment System. A discussion of the various pay for performance initiatives impacting radiology payment will occur with focus paid upon two major changes to the PQRS program this year: (1) the emergence of a radiology specific quality measures group, Optimizing Patient Exposure to Ionizing Radiation (OPEIR) and (2) the emergence of Qualified Clinical Data Registries as a means to report. Comments will be made regarding challenges faced by CMS in implementing the Patient Protection and Affordable Care Act, including the impact of the health insurance exchanges on local insurance networks.

O-301

Guidelines Update
Abstract/Presentation Summary
This presentation will outline the ACR Collaborative Guidelines Process, including the Neuroradiology Guidelines Committee structure and function. The current status of the Guidelines Committee activity, including recently reviewed guidelines, those currently in the pipeline, and those up for review in the upcoming cycle will be summarized. In addition, the debate over harmonizing guideline prescriptive elements with ACR Accreditation requirements will be presented. Ongoing discussions of an accelerated course for guideline approval, as well as conforming pertinent guidelines to meet the IOM Guideline criteria will be addressed. Distinct features of the Technical Standards, Guidelines and Appropriateness Criteria will be emphasized. Finally, the ASNR's role in extramural guideline endorsement will be reviewed.

Discussion

Tuesday
10:30AM - 12:00PM
Palais des congres de Montreal, 517bc

34 - PARALLEL PAPERS: Interventional: Aneurysms I
O-302

The natural history and clinical outcome of unruptured fusiform intracranial aneurysms

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¹Toronto Western Hospital, Toronto, Ontario, Canada, ²Toronto Western Hospital/University Health Network, Toronto, Ontario, Canada

Purpose
The management of unruptured fusiform intracranial aneurysms is controversial, largely due to the paucity of data related to their natural history. Although more uncommon and etiologically different than their saccular counterparts, it is unclear whether approaches to management decisions should differ. Both surgical and endovascular therapy to repair or exclude fusiform aneurysms often are challenging and accompanied by a definite risk which must outweigh the natural history of the disease in order to be of benefit. We undertook a retrospective study of the natural history in this population to help guide management decisions in these patients.
Materials and Methods
We performed a retrospective analysis on all patients with unruptured fusiform intracranial aneurysms seen in our multidisciplinary neurovascular clinic between January 2000 and October 2013. Exclusion criteria were aneurysms that were giant (>2.5cm), entirely extradural or associated with intracranial atherosclerosis (presence of thick eccentric wall plaques in the presence of systemic risk factors). Natural history was assessed using change in MR spectroscopy (MRS) scale at last follow up and aneurysm growth measurements on serial imaging follow-up studies. Patients who underwent treatment of their aneurysm were analyzed separately for outcomes of treatment.

Results
We identified 108 aneurysms in 96 patients. Thirty-nine aneurysms (36%) were located in the posterior circulation. Aneurysm dimensions were mean diameter 7.49mm (2.4mm – 23mm) and mean length 12.80mm (2mm – 39.4mm). Fifteen patients (16%) were symptomatic at presentation [8 stroke/TIAs, 5 with mass effect (two ophthalmoplegia) and two occipitocervical headache secondary to dissection]. Natural history follow-up data were available in 87 patients (91%) and imaging follow up in 82 patients/94 aneurysms (85%/87%). There were 193 person years clinical follow up (mean 27 months), and 477 aneurysm years of imaging follow up (mean 61 months). There was one aneurysm-related death from SAH during follow up (rupture rate 0.51% per year) but no other significant aneurysm-related change in the MRS scale for the remaining cohort. Eight patients (9%) showed evidence of aneurysm growth, with an overall risk of aneurysm progression of 1.6 % per year. Risk factors for growth were larger aneurysm diameter (13.5mm versus 6.9mm) (p<0.01) and symptomatic clinical presentation (63% versus 9%, p<0.01). Receiver operating characteristic (ROC) curve analysis (AUC 0.89, 95% CI: 0.79-0.99) showed aneurysms >6.7mm were more likely to enlarge. Twenty-three patients (24%) underwent aneurysm treatment (15 surgical and 8 endovascular). Ten (43%) of these patients were symptomatic. Clinical follow up in treated patients was death in three patients (12.5%, two as a treatment complication and one from SAH) and moderate disability (MRS 3) in a further three patients (12.5%, all due to treatment-related events) at last follow up.

Conclusions
For patients harboring nonatherosclerotic fusiform intracranial aneurysms the overall risk of rupture is 0.51%/year. Aneurysms that are symptomatic on presentation or that are larger than 7mm in maximum diameter are more likely to enlarge and may warrant closer follow up or consideration of treatment. The high risks of treatment associated with these aneurysms should be taken into consideration when evaluating their natural history.

KEYWORDS: Aneurysm Rupture, Aneurysm Sizes, Aneurysm Treatment

O-303

Unruptured intracranial aneurysms in children with sickle cell disease: analysis of 23 lesions in six patients

M Pearl1, S Saini2, B Speller-Brown2, E Wyse3, E Meier2, R Fasano2

1The Johns Hopkins University School of Medicine, Baltimore, MD, 2Children's National Medical Center, Washington, DC, 3Johns Hopkins Hospital, Baltimore, MD
Purpose
Intracranial aneurysms (IA) are rare in the general pediatric population and account for less than 2% of all cerebral aneurysms. Children with sickle hemoglobinopathy and IA are even more rare as only nine patients (< 22 years) with sickle cell disease (SCD) and documented aneurysms have been reported to date. The purpose of this study was to determine the prevalence of unruptured IAs in children with SCD and to describe the morphological characteristics, management, and long-term outcomes of this patient population.

Materials and Methods
This study was approved by our Institutional Review Board. A retrospective review of the electronic radiology database for all children with SCD (HbSS, HbSC, HbSβ+, and HbSβ0) who underwent MR imaging (MRI)/MR angiography (MRA) of the brain from January 2002 to August 2013 was performed. Medical records were reviewed for age, gender, sickle cell genotype, neurologic symptoms, baseline hematological indices, transcranial Doppler findings, treatment approach, and long term neurological outcome.

Results
From January 2002 to August 2013, 192 children with SCD underwent MRI/MRA of the brain. Six patients (3 boys and 3 girls) were diagnosed with IA (3.1%), all confirmed by digital subtraction angiography (DSA). One patient presented with the acute onset of a third nerve palsy, whereas all other patients were asymptomatic. No instance of subarachnoid hemorrhage was noted. The mean age was 15 years (range 7-19 years) at the time of diagnosis. Five patients (83.3%) had homozygous HbSS disease, while one patient had HbSC disease. A total of 23 aneurysms were detected, of which 22 (95.6%) were in the anterior circulation. The average aneurysm size was 3 mm (range 1-5.6 mm). Five patients (83.3%) had multiple aneurysms, with bilateral distribution in four instances (67%). The maximum number of aneurysms detected in a single patient was eight. Two patients underwent uneventful surgical aneurysm clipping. The other four patients were managed conservatively with stability of their aneurysms documented by regularly scheduled MRI/MRAs and/or DSA (range of follow up 2 months – 3 years).

Conclusions
Children with SCD are at risk for developing multiple intracranial aneurysms and a high index of suspicion must be maintained when interpreting MRI/MRAs of the brain in this population. Unlike IA in the general pediatric population, we found no gender predilection, and the majority of lesions were small and involved in the anterior circulation.

KEYWORDS: Aneurysm, Sickle Cell Disease
O-304

Influence of Iterative Reconstruction Algorithm (AIDR) on the Quantification of Cerebral Aneurysms

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Purpose
Four-dimensional computed tomography angiography (4DCTA) is currently the only technique allowing the investigation of aneurysm pulsation to achieve new pathophysiological insights and possibly enable more accurate prediction of aneurysm rupture risk. Its widespread use is limited by its radiation exposure, which might be improved by use of iterative reconstruction methods. We hypothesized that filtered backprojection (FBP) and AIDR reconstruction are equal regarding pulsatility analysis.

Materials and Methods
Four-dimensional computed tomography angiography of 10 patients with a cerebral aneurysm were reconstructed using FBP and Toshiba’s AIDR algorithm. Volume changes throughout the cardiac cycle were computed with an in-house developed software. Absolute volumes and pulsatilities (maximum volume/minimum volume) were compared between both groups.

Results
Absolute aneurysm volumes and pulsatilities show very high correlations (0.93 and 0.95).

Conclusions
Absolute aneurysm volumes and pulsatilities correlate highly when obtained from data reconstructed with IR and FBP. This work shows that FBP has the potential to reduce radiation dose substantially in 4DTCA, possibly facilitating the application of this technique for further investigation of aneurysm dynamics.

KEYWORDS: Aneurysm, Cerebellar

O-305
High-Quality Low-dose C-arm CT imaging of flow diverting devices in the angiography suite

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Purpose
Flow diverting devices can be complex to deploy and difficult to see clearly with standard projection x-ray imaging. Careful assessment after deployment is required to ensure the device is well positioned and opposed to the vascular anatomy. Current state-of-the-art high-quality C-arm computed tomography (CT) acquisitions in the angiography suite can approach the dose of a CT scan, and provide high resolution details of the device. We investigated a collimated volumetric acquisition approach aimed at significantly reducing radiation dose by limiting radiation exposure to a small field of view, while still supplying desired device visibility.

Materials and Methods
Thirty patients were imaged with a volume of interest (VOI) scan following aneurysm treatment via flow diverter placement or stent assisted coiling. The exposed area of the scan was collimated to 12% of the full acquisition field. For each scan, the radiation dose-area-product (DAP) was recorded. Retrospectively, thirty full field acquisitions were identified and the respective DAP was recorded. Blinded readers were presented with VOI 3D images and assessed device
Visualization of the device and wall apposition and device visualization were judged of good diagnostic quality for VOI imaging, as well as visualization of fine details such as device porosity and for assessment of device twisting and stretching (Figure 1a, b). Flow diverter and coil relationship assessment in VOI imaging varied with packing density due to metal artifacts, with higher density packing severely impacting image quality. Dose-area-product measurements showed a reduction of 85% compared to full field acquisitions. Thermoluminescence dosimetry evaluations showed dose reduction throughout the volume (Figure 1c, d).

Conclusions
Volume of interest imaging offers a significant reduction in radiation to the patient, while still providing diagnostic quality 3D device imaging. The significant reduction of radiation dose may allow for multiple image acquisitions of focused anatomical regions during critical stages of device deployment.

KEYWORDS: Flat-Detector Cone-Beam CT, Flow Diverter, High-Resolution Imaging
Figure 1. (a) Axial slice of implanted flow diverter showing apposition. (b) Volumetric rendering of placed flow diverter aneurysm and clip. Changes in dose distribution from full field (c) to VOI (d) acquisition show a substantial reduction in dose throughout volume.
Comparison of Measurements from Automatic Intracranial Aneurysm Analysis Software and an Experienced Rater

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Purpose
Endovascular treatment of intracranial aneurysms with stent-assisted coiling or flow diverter devices requires precise measurements of the aneurysm and the parent artery. Typically, aneurysm measurements are performed manually on two-dimensional (2D) or three-dimensional (3D) images. However, these can be prone to significant errors based on the viewing angle. Several computer-assisted approaches have been proposed recently to assess the aneurysm geometry from 3D images. The primary goal of this study is to evaluate the efficacy and accuracy of a 3D digital subtraction angiography (DSA)-based automatic vessel analysis tool and compare the results with the measurements of an experienced radiologist.

Materials and Methods
Intracranial aneurysms from thirty patients that underwent endovascular treatment were evaluated in this study. Commercially available software, Intracranial Aneurysm Analysis version VC21 (Siemens AG, Forchheim, Germany), was applied to the 3D DSA images from each patient and the measurements of the aneurysm [dome height (H), neck length (L), maximum neck diameter (D)] were recorded. The software requires the operator to manually place a point in the aneurysm dome and in the proximal and distal parent vessel. These measurements were compared to the manual measurements taken by an experienced radiologist using correlation analysis.

Results
Software successfully segmented 27 out of the 30 aneurysm datasets. Seventeen of these datasets were segmented successfully on the first try, and 10 datasets required minor postprocessing modifications such as cropping vessels originating from the aneurysm. The software could not segment three datasets due to touching vessels and ill-defined neck. The average software to experienced rater errors with standard deviations were H = 0.87±0.74 mm, L = 0.67±0.52 mm, and D = 1.13±0.87 mm. The maximum errors were H = 2.77 mm, L = 1.72 mm, and D = 3.3 mm. Correlation between the software and rater was calculated using Pearson's r, for which H = 0.96, L = 0.90, and D = 0.90.

Conclusions
The software was able to segment the aneurysm in a large majority of cases either on the first try or after minor manual corrections. Results indicate that the measurements from aneurysm analysis software are comparable (r ≥ 0.9) to an experienced radiologist for each aneurysm characteristic. Hence, the software can provide a reliable means of extracting aneurysm measurements. Further studies using phantoms based on patient geometry are currently underway.
Role of vascular smooth muscle cells in the pathogenesis of cerebral aneurysm: inflammatory mediators and angiogenesis-related factors production in proinflammatory cytokine stimulation

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Purpose
The inflammation and angiogenesis have been suggested as the critical process in the
pathogenesis of cerebral aneurysms. The purpose of this study is to evaluate the pattern of production of matrix metalloproteinase (MMP) and angiogenesis-related cytokines by cultured human arterial smooth muscle cells (SMC) in the tumor necrosis factor-α (TNF-α) stimulation.

Materials and Methods
Smooth muscle cells were isolated from human superficial temporal artery wall tissues during brain surgery, and confirmed as vascular SMCs by immunohistochemical staining, and cultured according to the protocol. Cultured arterial SMCs were stimulated by different concentration (1, 10, 100 ng/ml) of TNF-α for 48 hours and also treated for various periods of time (24, 48, 72 hours) by 10 ng/ml of TNF-α. The productions of inflammatory mediator (MMPs) and angiogenesis-related factors (IL-6, IL-8, IL-17, VEGF, IFN-γ) in the stimulated SMCs were assayed by enzyme-linked immunosorbent assay (ELISA).

Results
All cultured cells expressed α smooth muscle actin, suggesting the SMC-type origin. Tumor necrosis factor-α stimulated SMCs produced the MMP-3, IL-6, IL-8, and VEGF with dose- and time-dependent pattern and showed statistically significant amount comparing with nonstimulated one. The MMP-1 production was demonstrated at nonstimulated SMCs, but not significantly increased in response to variable concentration of TNF-α. The SMCs did not produce the detectable amount of the MMP-9, IL-17, and IFN-γ.

Conclusions
The cultured arterial SMCs produced inflammatory mediator and angiogenesis-related factors in response to proinflammatory cytokines stimulation with a concentration- and time-dependent manner. The arterial SMCs may play an important role in the pathogenesis of cerebral aneurysm.

KEYWORDS: Aneurysm Formation, Experimental Aneurysms

O-308

Developing a better Understanding of the Importance of Ostium Hemodynamics for Aneurysm Rupture: Velocities at the Aneurysm Ostium correlate with the Pressure Loss Coefficient

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Purpose
To quantify the relationship between the pressure loss coefficient (PLC), a potential surrogate marker for aneurysm rupture (1), with the inflow and outflow characteristics at the aneurysm ostium. Ostium hemodynamics are of interest as they are altered by flow diverter (FD) treatment.

Materials and Methods
From computational fluid dynamics simulations (Star-CCM+, cd-adapco) of eight cerebral aneurysms, inflow and outflow mean velocities were determined at the aneurysm ostium. Statistical significance of correlations with blood velocities and pressures in the parent artery, in the aneurysm dome and with the PLC were investigated.
Results
Statistically significant correlations (p< 0.05) between PLC and mean inflow (correlation coefficient CC= 0.96) and outflow (CC=-0.88) at the ostium were found. In addition, statistically significant correlation of the PLC with the mean blood velocity inside the aneurysm was established (CC=0.89). None of the hemodynamic parameters correlated with the area of the inflow or outflow region at the ostium.

Conclusions
Inflow and outflow velocities into cerebral aneurysms at the ostium were found to strongly correlate with the pressure loss coefficient, a potential surrogate marker for aneurysm rupture. This finding is of interest towards a better understanding of hemodynamic alterations at the ostium caused by FD treatment which aims at reducing aneurysm rupture risk.

KEYWORDS: Computational Fluid Dynamics, Intracranial Aneurysms
Figure 1: A: Illustration of segmented aneurysm ostium in one computational aneurysm (case #4, color coding shows total pressure, blue: low, red: high). B: Aneurysm ostia for cases (red: area of inflow into the aneurysm, blue: area of outflow from the aneurysm). Velocity distributions for three representative cases (#3, #4 and #7) visualizing variety in cases. D: High correlation of pressure loss coefficient and blood inflow velocity into the aneurysm at the ostium (R=0.96).

O-309

Half-Year Follow-Up after Coil-Embolization of Cerebral Aneurysms. Is DSA Mandatory?

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Purpose
Whereas long term follow ups normally are performed using MR imaging (MRI) techniques the combination of catheter angiography (DSA) and MR angiography (MRA) is concerned as gold standard for half-year follow ups in endovascularly treated patients. In case of congruent results in both techniques, further control examinations with digital subtraction angiography (DSA) may be omitted. The purpose of our study was to determine whether the initial follow-up DSA half a year after the embolization is already dispensable, because MRI with at least 1.5 T provides similar results.

Materials and Methods
Five hundred and ninety-seven half-year follow-up examinations consisting of DSA, contrast-enhanced MRA (CE-MRA) and time-of-flight MRA (TOF-MRA) of 468 consecutive patients, treated endovascularly between 2003 and 2012 were reviewed retrospectively. Visualization of residual aneurysm patency with each of the MRA techniques was compared with DSA as the reference standard by two experienced readers (>10y).

Results
Recurrences could be detected in 245 aneurysms half a year after embolization. In five cases recurrence was only detectable in DSA examinations but neither in CE-MRA nor in TOF-MRA. These recurrences, however, were small (<2mm) and therapy concept was not changed. All recurrences that required treatment were detectable with at least one of the MRI techniques. In seven cases aneurysm recurrence was only visible in the DSA and TOF-MRA but not in the CE-MRA and in four cases it was not visible in the TOF-MRA but in both of the other imaging procedures.

Conclusions
Catheter angiography is dispensable in the half-year follow up. MR imaging is as effective as DSA in detection of residually patent aneurysms if CE-MRA and TOF angiography are performed.

KEYWORDS: Aneurysm, Angiography, Coil Embolization

O-310

BUENOS AIRES EXPERIENCE WITH SURPASS (SNEG)

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Purpose
Surpass device (SNEG) is indicated for the treatment of saccular, wide neck or fusiform intracranial aneurysms (IA) arising from a parent vessel with a diameter between _2mm and _6mm. We present our initial experience in the treatment of IA with SP device and early follow-up results.

Materials and Methods
Patients with IA considered having a high probability of failure or recurrence with conventional endovascular techniques were selected for treatment with SNEG. All patients were pretreated with dual antiplatelet medication. Angiographic and clinical follow up was performed at three, six and 12 months.
Results
Fifty-seven patients with 66 IA, 48 female, were treated with the SNEG device; 44 had saccular IA; 20, fusiform IA; and two, blister like IA. A total of 64 SNEG were used. Eighty percent were treated with a single SNEG. Complete angiographic occlusion was achieved at three months in 40 of 52 aneurysms (77%); at six months, in 29 of 33 (88%); and at 12 months, in 22 of 24 (92%). 75.4% IA were symptomatic, (14 had an acute stroke; 12, mass effect; and 17 with previous SAH; 14 were incidental). Two patients had thrombotic complications: one patient who suffered a brainstem stroke finally died due to a pseudomona pneumonia during follow up, and it was the only major complication within this series. Four patients with TISS were observed in the follow up without clinical consequences. Morbimortality rate was 5.2%.

Conclusions
Our initial experience in the endovascular treatment of selected IA with the Surpass device shows that it can be safely achieved with a low rate of complications. A longer follow up is needed.

KEYWORDS: Aneurysm Treatment, Flow Diverter

O-311

COVERED STENT VS FLOW DIVERTER IN THE TREATMENT OF COMPLEX ANEURYSMS OF THE INTERNAL CAROTID ARTERY

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Purpose
To demonstrate that covered stents are an excellent option for treating complex aneurysms that originate proximal to the anterior choroidal artery. Background: The recanalization rate in wide-necked, large or giant aneurysms treated with detachable coils is very high. Additionally, such aneurysms also represent serious difficulties for surgeons because of bony obstacles and difficulty in proximal control. Recently these aneurysms have been treated with flow diverters that have been associated with late occlusion, thrombosis, hemorrhage and embolism without resolving the problem.

Materials and Methods
From November 2003 to November 2013, 19 patients with big and wide-necked aneurysms located under the anterior carotid artery have been treated with covered stents. Under general anesthesia with a triaxial system, premedicated with antiagregants (Clopidogrel and Aspirin) three days before the procedure. Five thousand units of heparin in bolus were used at the beginning of the procedure followed by 1500 units per hour. After the procedure, patients stayed on Aspirin and Clopidogrel during six months followed by Aspirin for life. Jostent Graftmasters Coronary stent grafts were utilized along with Tracker Excel 14 microcatheters, Transed EX micro guides, PT Choice extra support 300 cms and Envoy guide catheter 6F.

Results
Twelve aneurysms were excluded immediately from circulation after stent deployment without contrast material filling into the aneurysm cavity. Eight were thrombosed as shown by late control in angiography, computed tomography (CT) or MRI imaging (MRI) evaluations. The
patients treated had complex aneurysms and the internal carotid artery was favorable for navigation. There was no mortality and morbidity because embolism was present in one patient who did not take the antiagregant medication after the procedure. At three-month follow up this patient had recovered completely. All patients had three to 36 month follow ups with angiography, showing exclusion of the aneurysm from the circulation and permeability of the internal carotid artery.

Conclusions
Covered stents would be a very effective alternative treatment for complex carotid aneurysms located under the origin of the anterior choroidal artery whenever anatomy is favorable for navigation. Covered stents occlude aneurysms faster and in a higher percentage than flow diverters. Although the initial results are promising, longer follow up and larger clinical trials are required.

KEYWORDS: Aneurysm Treatment, Carotid Artery, Stents

O-312

Initial experience with p64, a retrievable and controlled detachable intraluminal flow modulation implant, in the treatment of neurovascular dissections and aneurysms

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Purpose
Endovascular flow diversion and modulation recently became an accepted method for the treatment of neurovascular dissections, fusiform and side-wall aneurysms. p64 is a braided, self-expanding Nitinol implant, which is connected to an insertion wire and is accepted by an 0.027". In comparison with most other devices with a similar function, p64 has a radial force in the same range, offers denser vessel wall coverage and can be withdrawn after complete deployment. The initial clinical experience with this device will be presented. We sought to evaluate both safety and efficacy effects of p64.

Materials and Methods
One hundred thirty-six patients (59 male) with 139 target lesions underwent 159 treatment sessions in a single neurovascular center. The target lesions (per procedure) included 81 saccular aneurysms, 56 fusiform aneurysms, 13 neurovascular dissections and seven CCFs. Apart from 88 unruptured lesions without any previous treatment, 33 target lesions were treated previously with a flow diverter or a stent, 19 were remnants after coiling and six were treated after partial clipping or failed surgery. The majority of target lesions (123) were located in the anterior circulation, with 34 lesions in the posterior circulation. The fundus of the saccular aneurysms had a median diameter of 4 mm. In 118/157 procedures a single p64 was deployed.

Results
Complete coverage of the target lesion was achieved in 94%. No device malposition was encountered. Predilatation was performed in 17 cases, postdilatation in nine. During the first angiographic follow up after 91 days (median), complete occlusion was confirmed in 52/110 lesions, minor remnants were found in 25/110 and significant remnants were present in 33/110. For 38 lesions a second DSA follow up was available after 8.6 months (median). Complete
occlusion and a minor remnant was observed in 24 and five lesions, respectively. A significant remnant was present in nine lesions. Neither a SAH from a target lesion nor an ICH in the dependent brain or in a remote location occurred. Neurological deficits due to ischemic events were transient in 11 and permanent in three patients. Two patients died (1 from pneumonia, 1 from access related ICA dissection). Seven out of 10 side branch occlusions remained asymptomatic. All 11 patients with minor to moderate intimal hyperplasia developed no related symptoms.

Conclusions

p64 allows safe and efficacious reconstruction of extra and intracranial vessel dissections. In saccular aneurysms a single device is mostly sufficient to induce vessel remodeling, resulting in aneurysm obliteration. Fusiform aneurysms may need more complex procedures with the use of several devices.

KEYWORDS: Aneurysm, Flow Diverter

O-313

LONG TERM FOLLOW-UP FOR ENDOVASCULAR TREATED RUPTURE INTERNAL CAROTID ARTERY PSEUODANEURYSM AFTER RADIOThERAPY FOR NASOPHARYNGEAL CARCINOMA

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Purpose

Internal carotid artery pseudoaneurysm developed after postradiotherapy in nasopharyngeal carcinoma is a rare but life-threatening condition. The methods and safety of endovascular treatment in this life-threatening disease is still equivocal. Our aim of this study is to evaluate the efficacy, complications, and clinical outcome of different methods of endovascular treatment of ruptured internal carotid artery pseudoaneurysm developed after postradiotherapy in nasopharyngeal carcinoma patients.

Materials and Methods

From a prospective data repository, we retrieved records of 24 consecutive patients with ruptured radiation-induced internal carotid artery (ICA) pseudoaneurysm that were treated endovascularly between October 1999 and October 2013, in Queen Elizabeth Hospital. Hospital records, angiographic findings, intraprocedural and 30 days clinical morbidity and mortality, long-term clinical outcome were retrieved and analyzed after treatment, with subsequent clinical and imaging follow up. Descriptive statistical analysis was carried out by using Statistical Package for the Social Sciences for Windows, version 19.0 (SPSS, IBM).

Results

During the 14 years study period, 24 patients (21 male; age range 33-78 years) with history of nasopharyngeal carcinoma treated with radiotherapy, developed ICA pseudoaneurysms, and were treated by endovascular means in our hospital. The average time interval for pseudoaneurysm development after completion of radiotherapy was 11 years (range 2-19 years). Presenting symptoms were epistaxis in 13 patients (54%), otorrhagia (bleeding from ear) in eight patients (21%), and two (8%) with both epistaxis and otorrhagia. Most pseudoaneurysms were
arising from petrous segment of ICA (46%), followed by cervical segment (33%) and lacerum segment (17%). Therapeutic complete occlusion of the affected internal carotid artery was performed in five patients, and stenting of the affected artery (with or without coils obliteration of pseudoaneurysm) was performed in 19 patients. Immediate hemostasis was achieved in all patients. Nineteen (80%) patients were discharged successfully from hospital, 17 patients (71%) without any major neurological defects (mRS <2), and two patients have cerebral infarcts with mRS >2. There were total seven complications encountered within 30 days after the procedure. Two patients rebleed during hospitalization and five patients encountered cerebral infarctions. Three (16%) complications (2 rebleed and 1 cerebral infarct) occurred in patient with stenting performed; whereas, four (80%) cerebral infarctions occurred in parent artery occlusion. Five mortalities (20%) happened within 30 days postop, three (60%) occurred in parent artery occlusion and two (11%) in parent artery stenting. The result of this study showed statistical significant differences in complication rates (p=0.01) and mortality (p=0.04) between parent artery occlusion versus parent artery stenting procedures in ruptured postradiotherapy related ICA pseudoaneurysm.

Conclusions
Ruptured internal carotid artery pseudoaneurysms following radiotherapy is a rare complication but life-threatening condition. Endovascular treatment by endoluminal vascular reconstruction of internal carotid artery with stents, provide immediate hemostasis and obliteration of the pseudoaneurysms. Long term results from this study showed lower complication and mortality rates for endoluminal vascular stent reconstruction than parent artery occlusion in treating postradiotherapy related ICA pseudoaneurysm.

KEYWORDS: Aneurysm, Aneurysm Embolization, Aneurysm Treatment

O-314

LARGE AND GIANT INTRACRANIAL ANEURYSMS TREATED WITH FLOW DIVERTER EMBOLIZATION DEVICE (PED) : BUENOS AIRES COHORT.

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Purpose
We present our results with Pipeline embolization device (PED) in the treatment of large and giant intracranial aneurysm (IA), focused on clinical and angiographic results and long term follow up.

Materials and Methods
Patients with giant and large IAs were treated with PED. Clinical presentation was: mass effect in 147 IAs; 57 IAs were incidental; 69 IAs had previous subarachnoid hemorrhage; others seven IAs; 58 had previous treatment. Anterior/posterior circulation IAs were 229 and 51, respectively.

Results
Between March 2006 and October 2013, 280 patients with 99 giant and 181 large IAs were treated with PED; 209 patients were female; average age was 62.1 years (7-85). One hundred and forty-two IAs were treated with 1 PED, 61 with 2 PED, and 32 IAs required three or more PED (mean, 1.38 PED/IA). Follow-up angiograms were performed between 1 and 84 months.
The follow-up occlusion rate at 12 months was 85.4%. All patients with an initial mRS of 0-1 were unchanged at 3-6 month of follow-up. The global morbimortality was 6.3%. Six patients died (2.14%) and 11 patients (3.9%) experienced transient neurologic deficit or exacerbations of pre-existing cranial neuropathies or headache after PED treatment, but these symptoms were resolved within the first month.

Conclusions
Our results have shown that large/giant IAs can be safely treated with PEDs. This clinical result is highly encouraging, and our technique may significantly improve the endovascular treatment of this kind of intracranial aneurysms.

KEYWORDS: Aneurysm Treatment, Flow Diverter

O-315

Experimental Testing of New Generation of Flow Diverter “FRED” in Sidewall Aneurysms in Rabbits

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Purpose
The Flow Re-Direction Endoluminal Device (FRED™) system (MicroVention, Inc., Tustin, CA) is a dual layer, aneurysm hemodynamic disturbing device. The purpose of this study was to evaluate the effectiveness and tissue reaction of FRED device in sidewall aneurysm model in rabbits.

Materials and Methods
The FRED devices were implanted in 22 sidewall aneurysms and 22 abdominal aortas in the New Zealand white rabbits and followed for one (n = 5), three (n = 5), six (n = 4) and 12 months (n = 8). Rabbits at each time-point were classified as Group 1, 2, 3, 4 accordingly. Extent of intra-aneurysmal flow disruption was graded on a 3-point scale based on digital subtraction angiography (DSA) immediately following device implantation and before sacrifice, including Grade 1 (complete flow cessation); Grade 2 (near complete flow cessation); Grade 3 (incomplete flow cessation). Comparison of aneurysm occlusion situation at follow up was based on angiographic images immediately after treatment and before sacrifice. Toluidine blue and basic fuchsin (TB-BF) staining was used for histologic specimen process. Scanning electronic microscopy (SEM) examination of abdominal aorta with device attached was performed. Histological healing at aneurysm lumen and neck were evaluated. Aneurysm sizes between different groups were compared by using the Student's t-test.

Results
Mean aneurysm sizes (including aneurysm neck, width, and height) of the 22 aneurysms in four groups were shown in Table 1. There was no significant difference of aneurysm neck, width, and height among different groups (p > .05). Incomplete aneurysm occlusion was shown in 19 (86%) cases immediately after device deployment. The other three (14%) aneurysms were occluded nearly completely. At one month follow up, complete occlusion was noted in four (80%) of five cases, near complete in one (20%) case (Figure 1 A-C). At three-month follow up, complete occlusion was noted in four (80%) of five cases, near complete in one (20%) case (Figure 2 A-
C). At six-month follow up, all (100%) of the aneurysms were completely occluded (Figure 3 A-C). At 12-month follow up, complete occlusion was noted in seven (88%) of eight cases, near complete in one (12%) cases (Figure 4 A-C). Histological images indicated partially unorganized or organized thrombus within aneurysm and neointima coverage at aneurysm neck (Figures 1 D, 2 D, 3 D, 4 D). Scanning electronic microscopy indicated vessel branches along the device remained patent in all the cases.

Conclusions
The FRED device in experimental aneurysms demonstrated high rates of progress and complete aneurysm occlusion.

KEYWORDS: Endovascular Flow Diverter, Experimental Aneurysms

Table 1. Mean Aneurysm Sizes in Four Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Neck (mm)</th>
<th>Width (mm)</th>
<th>Height (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>4.1 +/- 1.1</td>
<td>6.5 +/- 2.1</td>
<td>7.0 +/- 1.7</td>
</tr>
<tr>
<td>Group 2</td>
<td>3.5 +/- 1.0</td>
<td>5.5 +/- 1.6</td>
<td>5.5 +/- 1.2</td>
</tr>
<tr>
<td>Group 3</td>
<td>3.7 +/- 1.1</td>
<td>6.3 +/- 1.7</td>
<td>5.9 +/- 1.4</td>
</tr>
<tr>
<td>Group 4</td>
<td>3.6 +/- 1.0</td>
<td>5.5 +/- 1.5</td>
<td>6.0 +/- 1.4</td>
</tr>
</tbody>
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(Filename: TCT_O-315_Fredimage.jpg)
Tuesday
10:30AM - 12:00PM
Palais des congres de Montreal, 517d

35 - MINI SYMPOSIUM - TUMOR - PART II
O-316

Diffusion - Weighted Imaging and Primary CNS Tumors: Application and caveats

Ellingson, B.
University of California Los Angeles
Los Angeles, CA

O-317

Correlation of FA values and Mean Diffusivity (MD) with the Ki-67 Proliferation Index in Gliomas

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\textsuperscript{1}Medanta-The Medicity, Gurgaon, India

Purpose
Assessment of glioma grade is important in predicting the response to treatment and survival. The purpose of this study was to correlate fractional anisotropy (FA) and mean diffusivity (MD) values in newly diagnosed gliomas with Ki-67 proliferation index.

Materials and Methods
Ten patients with newly diagnosed gliomas who underwent diffusion tensor imaging (DTI) for presurgical evaluation followed by biopsy/surgery were retrospectively reviewed. MR imaging (MRI) was done on 3 T scanner in all patients using multishot EPI sequence. Fractional anisotropy and mean diffusivity values were calculated at the point of infiltration in white matter tracts and within the estimated tumor margins. The values were correlated with Ki-67 proliferation index.

Results
Higher FA and lower MD values correlated with a high Ki-67 labeling index representing higher tumor cell density.

Conclusions
Fractional anisotropy and MD values tend to represent the histology of gliomas and the tumor cell density correlating well with Ki-67 labeling index. Higher FA and lower MD values represent higher tumor cell density and malignant potential.

KEYWORDS: Diffusion Tensor Image, Mean Diffusivity, Neoplasm

O-318

10:51AM - 10:57AM
Combined ADC Diffusion and CBV Perfusion Maps predict Survival in Patients with Newly Diagnosed Glioblastoma

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Purpose
Minimum apparent diffusion coefficient (MinADC) values on diffusion MR imaging (MRI) maps are supposed to be correlated with high cellularity and hence malignancy in patients with glioblastoma. In contrast maximum cerebral blood volume (MaxCBV) values on dynamic susceptibility contrast (DSC)-weighted perfusion maps should be correlated with increased vascularity and hence malignancy. In this study we investigated if a specific distribution of MaxCBV values and MinADC values either in the enhancing area or the surrounding area of the tumor can identify subtypes of glioblastoma with different prognosis.

Materials and Methods
Diffusion-weighted imaging (DWI), DSC and contrast-enhanced T1-weighted (ce-T1) imaging using DOTAREM (Gadoterate meglumine) was performed in 67 patients with newly diagnosed and histologically proven glioblastoma before surgery on a 3 T MR system. Apparent diffusion coefficient and CBV maps were calculated and coregistered on ce-T1 images. A region of interest (ROI) was delineated manually on ce-T1 images encompassing the enhancing lesion with a 1 cm margin. Within this ROI, pixels with ADC < the 30th percentile (MinADC), pixels with CBV > the 70th percentile (MaxCBV) and the corresponding overlap were calculated automatically and visualized (MinADC blue, MaxCBV green, intersection red; Figure 1) on ce-T1 images. The acquired maps were assessed by two neuroradiologists and qualified as "infiltrative subtype" if MinADC values were located mainly in the surrounding area and MaxCBV values mainly within the enhancement (Figure 1 A) and as "vascular subtype" for the opposite distribution (Figure 1 B). If the intersection of MinADC and MaxCBV was larger than 25% of the visualized area (MinADC and MaxCBV) patients were subgrouped as "big intersection subtype" (Figure 1 D). In case of an intersection below 25% and no specific distribution of MinADC and MaxCBV values, patients were subgrouped as "nonspecific subtype".

Results
Thirty patients were classified as "invasive subtype", five as "vascular subtype", 17 as "big intersection subtype" and 15 as "nonspecific subtype". Patients of the "invasive subtype" showed a significantly shorter overall survival (8.2 +- 8.4 months, logrank-test p<0.00028) than those of the "vascular subtype" (21.0 +-11.2 months), "nonspecific subtype" (13.5 +- 9.1 months) and "big intersection subtype" (18.8 +-8.5 months).

Conclusions
A possible explanation for the bad prognosis of the "invasive subtype" may be that this subtype is characterized by an early and extensive invasion of tumor cells in the surrounding tissue, resulting in the specific localization of MinADC within the surrounding tumor area. The pathophysiological mechanism underlying this distribution might be that migrating tumor cells in the invasion front, represented by areas of MinADC, produce and secrete neoangiogenic factors, leading to a "trailing behind" of the vascular-rich tumor border, represented by MaxCBV. In subtypes with a big intersection of MinADC and MaxCBV the above-mentioned "trailing behind
mechanism" might be less pronounced, resulting in a decreased invasiveness of the tumor and a prolonged survival of the patients.

KEYWORDS: Glioblastoma

Comparison of Compressed-Sensing Accelerated Diffusion Spectrum Imaging vs. Diffusion Tensor Imaging in Patients with Brain Tumors

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Purpose
To compare tractography results from compressed-sensing diffusion spectrum imaging (CS-DSI) and diffusion tensor imaging (DTI) in patients with brain tumors.

Materials and Methods
Using 3 T MR imaging (MRI) (Discovery MR750, GE Healthcare, Milwaukee, WI), DTI and CS-DSI were performed in 11 patients with brain tumors (6 high-grade gliomas, 3 low-grade gliomas, 1 meningioma, 1 metastasis). The median age was 49 years (range, 35-86) with seven
males and four females. Diffusion tensor imaging was acquired at 25 directions (n=11) with ASSET R=2, b=1,000 sec/mm², matrix=128×128, thickness=3mm, TR/TE=11,000/64msec, time=4.5 min. Diffusion spectrum imaging was acquired at 127 directions (n=7; R=4; slices=34; time=14 min) and 102 directions (n=4; slices=50; time=10 min) with 11-cube q-space, b=6,000-10,000sec/mm², thickness=3mm, TR/TE=5,000/116msec). Compressed-sensing-DSI was processed on parallelized code written in Matlab (Mathworks, Natick, MA). Diffusion tensor imaging and CS-DSI tract quantification were performed using Trackvis (Wang, Boston, MA). Based on prior experience, angle thresholds were set to 38°. Total 2-5 tracts/patient were selected by an experienced neuroradiologist as potentially affected by the tumor and/or peritumoral abnormality. Semi-automatic segmentation with manual editing was performed to seed the selected tracts. Diffusion tensor imaging and CS-DSI tract counts (TCs) were compared using Wilcoxon signed rank tests with p<.05. For both DTI and CS-DSI, the tumor and normal contralateral tracts were compared within patients, and designated as consistent with pathology if TCratio<0.9 (decreased TC on side of tumor) and inconsistent if TCratio>1.2.

Results
Compressed-sensing DSI provided greater TCs than DTI overall, with median difference=255 (p<.00001) and qualitatively fewer extraneous tracts. Specifically, CS-DSI yielded greater TCs in four tracts (anterior thalamic radiations, cingulum, inferior fronto-occipital fasciculus, superior longitudinal fasciculus) with median difference =66-392 (p<.0007). Similar TCs were found in the other two tracts (inferior longitudinal fasciculus, uncinate fasciculus) with median TC difference =8-66 (p>.377). For DTI, total of 21 tracts were predicted to be consistent with pathology and nine to be inconsistent. For CS-DSI, total of 26 tracts were consistent with pathology and 0 were inconsistent.

Conclusions
Compressed-sensing DSI provided greater TCs in tumor affected white matter tracts than DTI. Compressed-sensing DSI also revealed greater differences in TC ratios between tumor and nontumoral sides, suggesting greater consistency in predicting tracts affected by tumor and/or peritumoral abnormality. These results suggest that CS-DSI outperforms DTI in tracking in brain tumor patients through areas of low anisotropy and in following small and/or crossing fibers. Further work is necessary to investigate the role of CS-DSI for preoperative planning and potential correlations with white matter infiltration.

KEYWORDS: Diffusion Tensor Image, MR Imaging Brain, MR Imaging/Diffusion
**Figure.** In a patient with a low grade oligodendroglioma in the left temporal lobe, CS-DSI (LEFT) shows higher tract counts (yellow, brown) than DTI (RIGHT), and fewer extraneous tracts (purple).

Key: yellow=uncinate fasciculus; brown=inferior longitudinal fasciculus; purple=superior longitudinal fasciculus; pink=anterior thalamic radiations; green=inferior fronto-occipital fasciculus; light green=cingulum

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**O-320**

**Pre-Surgical Brain Mapping of Intracranial CNS Tumors**

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**O-321**

**Comprehensive Survival Analysis of Preoperative Imaging Features in Patients with Glioblastoma**

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Purpose
Glioblastoma (GBM) is the most common and most aggressive primary brain tumor in adults
which carries poor prognosis, with median survival of approximately 14.6 months. Neuroimaging plays a pivotal role in diagnosis and monitoring therapeutic response. The prognostic role of pretreatment imaging characteristics of GBM has been studied but remains controversial. The purpose of this study was to assess the significance of over 35 quantitative and qualitative preoperative imaging variables with regards to overall and progression free survival of these patients.

Materials and Method
We retrospectively analyzed magnetic resonance imaging (MRI) characteristics of 111 patients with previously untreated GBM using the collection of the original material and data provided by The Cancer Imaging Archive (TCIA) corresponding to the patients of The Cancer Genome Atlas (TCGA) project. The imaging data set based upon Visually Accessible Rembrandt Images (VASARI) feature set for human glioma consists of 26 imaging features, with standardized terminologies. Volumetric analysis using Slicer 3.6 (slicer.org) and volumes were obtained from the area of contrast enhancement, necrosis, and edema/invasion, as previously described by our lab. Ratios, groupings and subgrouping were performed of the quantitative volumetric parameters. The Kaplan Meier curve was used to measure patient survival. The statistical significance of relationship between each imaging variable and survival was identified by performing multivariate Cox regression analysis. The statistical analyses also were performed after adjustment for the potential explanatory clinical variables including age, Karnofsky Performance Status (KPS) scale, gender, and regimens of therapy.

Results
A total of 15 quantitative and qualitative imaging parameters were statistically significant robust predictors of survival.

Conclusions
Specific pre-operative MR parameters have a significant role in the prognosis of patients with GBM. Given the statistical significance of specific pre-operative MRI brain tumors features with regards to survival, these imaging prognostic parameters can now be used for imaging biomarker and imaging genomic biomarker development and validation. Imaging signatures derived from these can be used as stratification and endpoint imaging biomarkers in clinical trials.

KEYWORDS: Glioblastoma, Image Processing, Imaging Biomarker

O-322 11:21AM - 11:27AM

Using Diffusion Tensor Tractography to Predict Routes of Progression and Design Theoretical Radiation Therapy Plans in Patients with High Grade Gliomas

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Purpose
To examine the utility of tractography to predict recurrent tumor growth patterns in patients with high grade gliomas (HGGs). We hypothesize that tractography-driven anisotropic radiation
therapy (RT) plans will provide superior coverage of the recurrent tumor while decreasing total patient radiation dose.

Materials and Methods
The prospective study cohort consisted of 39 patients (mean age 54 years, range 29-76) with pathologically proven glioblastoma (n=30) or anaplastic astrocytoma (n=9). Diffusion tensor imaging (DTI) was acquired as part of the treatment planning MRI and streamline tractography was performed using Nordic BrainEx (NordicNeuroLabs, Milwaukee, WI). The major (largest) and maximal length (longest) fiber tracts originating from the tumor region were identified. Standard RT (RTStand) and theoretical tractography-driven RT (RTTract) plans were developed and compared in terms of dose, volume and coverage. Based on Response Assessment in Neuro-Oncology (RANO) criteria, tumor recurrence was determined on follow-up scans and categorized as central, regional or remote. Progression-free survival (PFS) was measured.

Results
For the 39 patients, RTTract resulted in smaller planning target volume (PTV) than RTStand (mean decrease=26.1%, 95%CI 15.4-36.8%) with p<.0001 (Wilcoxon signed-rank test) and provided equivalent or slightly superior coverage of the recurrent tumor in 24/31 (77.4%) patients. Of the 31 recurrent tumors, RTTract yielded a smaller PTV than the conventional RT plan in 25/31 (80.6%) patients and a larger PTV in 6/31 (19.4%) patients. RTTract resulted in a smaller PTV and equivalent or superior coverage in 18/31 (58.1%) patients and a smaller PTV but inferior coverage in seven patients (22.6%). For 6/31 (19.4%) patients, RTTract provided equivalent or superior coverage but with a larger PTV. A total of 31/39 (79.5%) patients developed recurrence during the follow-up period, with mean PFS of 7.9 months (range, 0.5-19.7). The most common recurrence pattern was central (n=20), then regional (n=5), remote (n=4), and central/remote and central/regional/remote (n=1 each). The majority of recurrences (27/31, 87.1%) occurred along a generated fiber tract: maximal length (n=9, 29.0%), maximal/major (n=8, 25.8%), major (n=7, 22.6%), unlabeled (n=3, 9.7%). Recurrence was local rather than along any tract in two (6.5%) patients, and tractography failed for technical reasons in the remaining two (6.5%) patients.

Conclusions
We found that theoretical tractography-driven RT plans may be helpful in predicting the site of recurrent tumor. Tractography results may be helpful in designing anisotropic RT plans to achieve superior or equivalent coverage of the tumor site with smaller treatment volumes.

KEYWORDS: Diffusion Tensor Image, Glioma, Radiation Therapy
Figure. (Left) Pre-RT tractography overlaid on contrast sagittal T1-weighted image shows major/maximal fascicles (green) emerging along the inferior fronto-occipital fasciculus from the anterior superior medial margin of interest (blue sphere) placed at the surgical cavity in the occipital lobe. (Right) 13 months post-RT, a T1-weighted image reveals recurrent tumor in the anterior temporal lobe. Expanded to specifically include the occipital fasciculus, the theoretical $R_{\text{Tract}}$ still achieved a 7.7% decrease in PTV (not shown).

O-323

HIFU: Principles, Current Applications and Future Possibilities

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O-324

Towards Improved Characterization of Brain Tumors by Sodium (Na)-MR Neuroimaging

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Purpose
Sodium (Na)-MRI can provide three different image contrasts, which reflect the average tissue Na concentration (NaT contrast) and Na ions with short relaxation times (NaR and NaS contrast). The NaR signal is obtained by an inversion-recovery pulse, whereas the NaS contrast is based on weighted subtraction of images at different echo times (1). Previous work demonstrated a strong association between the Ki-67 proliferation index of brain tumor cells and both, the NaR and NaS signal (1). This finding emphasizes the added benefit of Na-MRI to canonical neuro-oncological imaging as used in clinical routine. In this study, we examined a larger patient population suffering from brain tumors to evaluate the robustness of the Ki-67/NaR association. Furthermore, Na-MRI is compared to conventional T1-weighted gadolinium enhanced (T1W GAD+), T2-weighted (T2W) and FLAIR imaging.

Materials and Methods
Na-MRI was conducted on a 7 Te MR system (Magnetom, Siemens Healthcare, Erlangen, Germany) using a double-resonant (H/Na) quadrature birdcage coil (Rapid Biomed, Rimpar, Germany). Na-MR sequences were based on a 3D density-adapted projection reconstruction technique (2). To detect the tissue Na signal (NaT) relaxation weighting was minimized using a short echo time (TE = 0.35 ms) and a long repetition time (TR = 160 ms). A nominal spatial resolution of 3 x 3 x 3 mm³ was achieved in an acquisition time of TAQ = 10 min 40 s. A second echo (TE = 12 ms) was used to calculate a weighted subtraction image (NaS) as described previously (1). To suppress signal from extracellular fluids such as cerebrospinal fluid, an inversion recovery sequence (NaR) was applied with the following parameters: TE = 0.75 ms; TR = 185 ms; TRO = 16.7 ms; inversion time: TI = 41 ms; TAQ = 9 min 52 s; nominal spatial resolution: 4.4 x 4.4 x 4.4 mm³. Canonical T1w GAD+, T2w and FLAIR imaging was performed on a 3 T MR system (Tim Trio, Siemens Healthcare, Erlangen, Germany). N = 20 patients suffering from naïve brain tumors WHO grade 1 to 4 were measured including 2 Pilocytic Astrocytomas, 2 Astrocytomas, 1 Oligodendroglioma, 4 Anaplastic Astrocytomas, 2 Anaplastic Oligodendrogliomas, 1 Anaplastic Ependymoma, 1 Gliomatosis Cerebri, 7 Glioblastomas. For all patients, histopathologic evaluation of tumor specimens was performed including Ki-67 monoclonal antibody staining. Ki-67 is a cellular marker for proliferation (3) and is known to correlate with tumor growth (4, 5). Na and proton images were coregistered to the individual standard space by FLIRT (part of FSL) (6).

Results
Correlation analyses revealed strong correlations between the NaR signal of the tumor and its Ki-67 index (r = 0.85, p < 0.001; Fig. 1a) and between the NaS signal and the Ki-67 index (r = 0.87, p < 0.001). There was no correlation between histopathologic tissue parameters and NaT, conventional T1w GAD+, T2w and FLAIR imaging.

Conclusions
In this study, we are able to reproduce previous findings (1) on the association between the relaxation-weighted Na signals (NaR and NaS) and the Ki-67 proliferation index of brain tumors, despite the differing tumor subtypes between both studies. A local cellular energetic breakdown mainly of the Na+/K+ ATPase, changes in Na+/H+ exchange kinetics (7) and a sustained cell depolarization initiating cell division might represent the pathophysiological correlates of this
association (8). All mechanisms result in an elevated intracellular Na+ concentration, which is reflected by the NaR and NaS contrast. NaT and clinical routine MR sequences including T2, T1 GAD+ and FLAIR imaging failed to detect these specific changes of tumor tissue (cf. Figure). This underlines the limited specificity (9) in tumor characterization of these sequences but also emphasizes the added value of NaR and NaS imaging to conventional neuro-oncological MRI. In future, Na-MRI might help to limit the use of contrast media and stereotactic biopsies for brain tumor diagnosis.

KEYWORDS: Brain Neoplasms, Glioma, MR Imaging
**Figure**: Exemplary T1w GAD+ (a, d), NaT (b, e) and NaR (c, f) data of a *Pilocytic Astrocytoma* (PA, WHO 1, a-c) and a *Glioblastoma* (GBM, WHO 4) demonstrate the benefit of relaxation-weighted Na-MRI: T1w GAD+ in both tumors is impossible. However, the NaR contrast reveals a low signal of PA (c) and a high signal of the GBM (f) which enables the correct diagnosis. Improved accuracy of relaxation-weighted Na neuroimaging compared to conventional T1w GAD+ (and T2w and FLAIR imaging; data not shown) is due to the strong association with the Ki-67 proliferation index of the tumor cells.
Multifrequency Magnetic Resonance Elastography: high resolution assessment of viscoelastic properties in intracranial tumors

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Purpose
While magnetic resonance elastography (MRE) is already a clinically available imaging technique for liver examinations, the intracranial utilization lags behind, due to the more difficult accessibility of the skull-surrounded brain tissue. Recent studies proved, that MRE is capable of measuring global changes of the viscoelastic properties of cerebral tissue in aging, as well as in diseases like Alzheimer, Parkinson and Multiple Sclerosis (1-4). The purpose of our study was to implement latest developments of high-resolution multifrequent three-dimensional cerebral MRE for evaluation of focal viscoelastic properties in intracranial tumors.

Materials and Methods
Twenty-six patients (63±13 years, 18 female) were included in our study and examined on a clinical 3 T scanner before neurosurgical resection or biopsy. A spin-echo EPI sequence with flow-compensated motion encoding gradient (15 slices, TR/TE 3000/71 ms; FoV 250x187 mm, iPAT=2, spatial resolution 2x2x2 mm temporal resolution 8 dynamics per wave cycle, scan time 75 sec) was used. Seven harmonic vibration frequencies (30 to 60 Hz, 5 Hz increment) were induced by an acoustic driver, connected to a head cradle. Data postprocessing included the proposed multifrequency dual elasto-visco (MDEV) inversion (5) to generate high-resolution maps of the magnitude |G*| and the phase angle Φ of the complex shear modulus of the human brain.

Results
The tumor entities included in this study were all located supratentorial and consisted of: glioblastoma multiforme WHO °IV (n=11), anaplastic astrocytoma WHO °III (n=3), meningioma (n=7), cerebral metastasis (n=4), and intracerebral abscess formation (n=1). Compared to the normal appearing contralateral white matter (NAWM) as well as to all other entities, meningiomas appeared to be more viscous giving rise to a higher ratio of Φtumor/ΦNAWM as can be seen in Figure 1. Primary brain tumors and cerebral metastases were not distinguishable in terms of |G*| and Φ. In our group, a trend was delineable that WHO grade II and III tumors are stiffer compared to grade IV glioblastoma. The group of glioblastoma multiforme exhibited the largest range of |G*| values.

Conclusions
In this pilot study, using 3D multifrequent MRE and MDEV inversion, it is possible to characterize intracranial tumors by their mechanical properties with improved spatial resolution compared to previous work in MRE on tumors (6, 7). We were able to clearly delineate meningiomas from intra-axial tumors, while for the latter group an overlap remains in viscoelastic terms.
Permeability imaging of the pituitary gland: a novel application of RADIAL VIBE with GRASSP technique

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Purpose
The pituitary gland is located outside of the blood-brain barrier. Dynamic T1-weighted contrast-enhanced sequence is considered to be the gold standard to evaluate this region. However, it does not allow assessment of permeability characteristics of the gland. The purpose of this study was to demonstrate the utility of recently developed Radial-VIBE with GRASP to evaluate permeability characteristics of individual components (anterior, posterior gland and median eminence) of pituitary gland in routine patients.
Materials and Methods
A retrospective study was performed in 79 patients with normal appearing pituitary gland (M:F=20:59). Imaging was performed at 1.5 T and at 3 T. Regions of interest (ROI) were placed in the anterior gland, median eminence, and posterior pituitary gland to generate signal-time curves. A statistical analysis was performed using a paired-sample Wilcoxon signed rank test to evaluate the mean peak values, mean time of maximum enhancement (TME), mean area under the curves (AUC), and mean wash-in and wash-out in the ROIs.

Results
Curves from the posterior pituitary gland and median eminence demonstrate a faster wash-in and TME with a lower peak of enhancement compared to anterior pituitary gland, which shows a slower wash-in, delayed TME and higher peak of enhancement. Compared to the posterior pituitary gland, anterior pituitary and median eminence show a faster washout (p<0.005) (Figure 1 and Table 1).

Conclusions
This validation study, by demonstrating unique signal-time curves distinct for each component of the pituitary gland, confirms the ability of GRASP technique to evaluate the hitherto unexplored permeability characteristics of the pituitary gland.

KEYWORDS: Permeability MR Imaging, Pituitary Gland

<table>
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O-327

Novel Permeability Criteria to Assess Function of Morphologically Normal Pituitary Gland in Patients with Central Endocrinologic Disturbances
Purpose
Conventional dynamic pituitary MR imaging (MRI) is routinely employed to evaluate for pituitary lesions in patients with endocrinologic disturbances. However, often times a normal sized pituitary gland with no focal areas of differential enhancement is seen in patients with endocrine disturbances suspected to be of central origin. We hypothesize clinical hypopituitarism without any structural abnormality could be associated with abnormal permeability characteristics of the pituitary gland. The purpose of our study therefore is to evaluate the permeability parameters using radial-VIBE with GRASP in patients with "central" endocrine disturbances and a normal appearing pituitary gland.

Materials and Methods
A retrospective study was performed in 43 patients (M:F =14:29). The control group (group 1) consisted of 33 patients with normal appearing anterior and posterior pituitary glands. Group 2 consisted of 10 patients with clinical and laboratory evaluation consistent with hormonal deficiency of suspected central "pituitary" origin, and no morphological abnormalities on routine dynamic MR imaging. All 43 patients were evaluated on 3 T utilizing radial-VIBE with GRASP. Regions of interest (ROI)-based method was used to obtain signal-time curves (STCs) from the anterior and posterior pituitary gland. Statistical analysis was performed to compare the mean area under the curves (AUC), mean peak, mean time of maximum enhancement (TME), mean washin and washout parameters for the anterior and posterior pituitary glands between the two patient groups.

Results
Signal-time curves from anterior and posterior pituitary gland demonstrated a statistically significant difference (p < 0.05) in the AUC, peak, washin and washout parameters between the patient population when compared to the control group (Figure 1 and Table 1).

Conclusions
This pilot study utilizing radial-VIBE with GRASP demonstrates relative hypoperfusion within the "normal appearing pituitary gland" in patients with "central" endocrinologic disturbances.

**KEYWORDS:** Permeability MR Imaging, Pituitary Gland

<table>
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Optimizing MR acquisition time for dynamic pituitary gland evaluation utilizing Radial-VIBE with GRASP Reconstruction

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Purpose
Dynamic postcontrast T1-weighted sequence remains the gold standard to evaluate the pituitary gland. This sequence is especially utilized to evaluate a microadenoma, the most common indication. The acquisition time for this sequence varies among different institutions ranging from 150 seconds to 180 seconds. Radial-VIBE with GRASP technique allows adequate evaluation for structural permeability providing excellent temporal information with high spatial resolution. The purpose of our study is to evaluate the signal-time curves (STCs) obtained utilizing Radial-VIBE with GRASP technique to optimize the acquisition time for dynamic pituitary gland evaluation.

Materials and Methods
A retrospective study was performed in 20 patients with known microadenomas. All patients were evaluated on a 3T MR imaging (MRI). Using GRASP images, ROI-based STCs were generated from normal appearing anterior pituitary gland and the microadenoma to evaluate peak enhancement (PE) values every 10 seconds beginning at 60 seconds (T1) following contrast administration, for a total time period of 140 seconds (T9) (Figure 1). For each time T>1, the mean, standard deviation (SD), median, maximum and the lower and upper limits of a 95% confidence interval of the mean for the percentage change in the peak enhancement was estimated from time T-1 to time T.

Results
The mean PE for the anterior pituitary gland was reached at T = 80 seconds (±19 seconds) without significant change in the values after time T4 (90 seconds) (Table 1). The PE values for the microadenoma measured from time T1 (60 seconds) to time T4 (90 seconds) showed a
statistically significant difference when compared to peak enhancement values of the anterior pituitary gland at comparable times (p < 0.001).

Conclusions
We successfully demonstrate that an acquisition time of 90 seconds following contrast administration is sufficient to provide adequate dynamic evaluation of the pituitary gland and microadenoma. This significantly shortens acquisition time of dynamic T1-weighted sequences from 150 – 180 seconds as reported in current imaging literature, allowing optimum utilization of magnet scanning time. According to our literature search, this is the first pilot study to evaluate STCs to optimize acquisition time of the dynamic contrast enhanced sequence for pituitary gland evaluation.

KEYWORDS: Permeability MR Imaging, Pituitary Gland

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O-329

Development of an Automated Quantification Method for Cerebrospinal Fluid Dynamics in the Cerebral Ventricles using an MR Spin Labeling Real Time Imaging Technique

T. Shiodera1, S. Nitta1, T. Takeguchi1, M. Yui2, T. Yamaoto2, S. Yamada3
Purpose
The Time-Spatial Labeling Inversion Pulse (Time-SLIP) technique, which is based on selective inversion recovery technique, can provide visual information for blood flows and for cerebrospinal fluid (CSF) flows without using contrast medium. Previous studies have evaluated visual assessments of CSF dynamics using the Time-SLIP technique. Our previous work has shown an automated quantification method for CSF dynamics using a half-Fourier fast spin-echo sequence as pseudo cine imaging. The objective of this study is automated quantification of CSF dynamics in the cerebral ventricles using the Time-SLIP real time imaging technique.

Materials and Methods
A series of 2D images with incremental inversion recovery times were acquired by 1.5 T MR imaging (MRI) scanner using Time-SLIP sequence with balanced steady-state free precession (bSSFP) real time imaging. The bSSFP scanning conditions were FOV = 24.0 x 26.3 cm, matrix = 64 x 192, slice thickness = 7 mm, TR/TE = 4.2/2.1, FA = 90, initial inversion time (TI) = 0.6 s and TI step = 0.101 s. Region of interest was outlined automatically based on signal intensity analysis and shape of region for a given point. Subsequently, labeled CSF regions were detected using the image binarization method. Cerebrospinal fluid average speed and total variation was calculated using TI values and the corresponding traveling CSF positions. Correlations between the proposed method and manual annotations of the quantified values were evaluated in the prepontine cisterns.

Results
Thirty-two datasets from four healthy volunteers were studied. The proposed method detected the labeled CSF region as examples shown in Figure 1. The correlation factors between the proposed method and manual annotations were $R^2 = 0.91$ ($p < 0.001$) for the CSF velocity and $R^2 = 0.85$ ($p < 0.001$) for the CSF total variation. The processing time was less than 3 seconds per data.

Conclusions
This paper presented a new automated quantification method of CSF dynamics using the Time-SLIP real time imaging technique.

KEYWORDS: Cerebrospinal Fluid, Image Processing, MR Imaging

(Filename: TCT_O-329_image.gif)
IVIM Perfusion in Acute Stroke

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1CHUV, Lausanne, Switzerland, 2University of Virginia, Charlottesville, VA, 3CIBM, Lausanne, Switzerland

Purpose
Local brain perfusion measurement, either with MR imaging (MRI) dynamic susceptibility contrast (DSC) or CT perfusion (CTP), currently is used clinically in the context of acute stroke to assess altered perfusion, while restriction in diffusion-weighted imaging is used to assess the ischemic core, and their mismatch the salvageable tissue, also called penumbra. Because both DSC and CTP depend on the arterial input function (AIF), both may fail to properly take into account leptomeningeal collateral blood flow supply, which is essential for clinical prognosis (1). Measuring perfusion with intravoxel incoherent motion (IVIM) MRI (2) might theoretically solve this issue, as it is independent on the AIF, and thought to be mainly dependent on the local microvascular perfusion. It also would allow a gain of time, as no iv contrast medium is needed, and therefore, no vein puncture before imaging is necessary. To our knowledge, only one study of IVIM perfusion fraction measurement in acute ischemic stroke in human patients has been reported (3), without maps, and with somewhat counterintuitive quantitative results, the majority of f values being reported as negative in the infarcted area. In the context of a regain of interest in IVIM as a method to measure brain perfusion (4-6), we re-evaluated IVIM perfusion measurement in the context of acute stroke.

Materials and Methods
Images were collected in patients who presented with symptoms of acute ischemic stroke. Exclusion criteria were onset of symptoms to imaging > 5 days, hemorrhagic transformation, infratentorial lesions, and small lesions < 0.5 cm in minimal diameter. We collected 17 cases (Table 1). Intravoxel incoherent motion images were performed at 3 T, using a spin-echo sequence with embedded Stejskal-Tanner pulsed gradients, with parameters as previously described (4), using 16 b-values from 0 to 900 s/mm2 in three orthogonal directions. Quantitative analysis was performed by placing a region of interest (ROI) around the largest stroke area on an axial slice, as defined by reduced apparent diffusion coefficient (ADC), and in the collateral region, avoiding cerebrospinal fluid. The trace of the signal was first averaged for each b value, before fitting the bi-exponential IVIM model (2).

Results
Parametric IVIM perfusion maps showed an area of decreased perfusion fraction f in 14/17 patients (Figure 1). Two patients showed a mismatch, while two other patients showed a not fully overlapping ischemic core and hypoperfusion areal, without quantitative mismatch. Quantitative analysis showed high statistically significant decrease in both IVIM perfusion fraction f (0.026 ± 0.019 versus 0.056 ± 0.025; p = 1.1・10-6) and diffusion coefficient D in comparison to the contralateral side (3.9 ± 0.79・10-4 versus 7.5 ± 0.86・10-4 mm2/s; p = 6.5・10-21).

Conclusions
Intravoxel incoherent motion perfusion measurement is feasible in the context of acute stroke. Because this permits acquisition of both perfusion and diffusion information in a single 3 min MRI sequence, without iv contrast injection, a significant gain in imaging time could be achieved.
in the context where minimal time to treatment is seen as the most critical predictor of positive outcome. Further studies should evaluate the potential for IVIM in predicting clinical outcome and treatment response.

**KEYWORDS:** Ischemia, Penumbra, Stroke

<table>
<thead>
<tr>
<th>Patient demographics: age (years), sex, NIHSS clinical severity score, onset of symptoms to IVIM imaging (hours), and number of patients treated with i.v. tPA before imaging. Avg ± std dev, when appropriate.</th>
</tr>
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O-331
Whole Brain Perfusion Imaging at 70 kVp with Adaptive Temporal Sampling: Reduced Dose, Superior Quality and Improved Consistency.

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Purpose

Despite the widespread application of perfusion CT for neurologic steno-occlusive disease, radiation dose concerns remain. In the effort to minimize dose via lower tube current (mA), image quality and signal to noise ratio can suffer. Restricting the sampling period length can lead to inconsistency as variability in cardiac output can mean that scanning ends before venous return to baseline, challenging rendering based on deconvolution principles. Perfusion studies typically employ fixed sampling intervals (every 1-3 seconds) and a limited scanning period (40-50 seconds) with sampling time directly proportional to dose. Inevitably, in a modest percentage of cases, sampling stops before baseline signal is restored, making longer scanning periods desirable. As certain segments of the contrast passage have a lesser need for high sampling frequency, such as the pre-enhancement baseline and the downward slope toward the return to baseline, scanning at variable intervals is appealing: slow (every 3 seconds) during the pre-arrival baseline, fast (every 1.5 seconds) targeting the rise and fall of enhancement and slower (every 7.5 seconds) to extend the temporal sampling window. The recent availability of lower kVp for perfusion scanning also is attractive as a dose reduction method. As 70 kV more closely approximates the k-edge of iodine, lower tube current values and net CTDI values may be acceptable. The purpose of this retrospective study was to evaluate the impact on quality, consistency and radiation dose of these two clinical innovations: the use of lower kV values – 70 rather than the traditional 80 kVp, and the use of longer sampling periods with variable rather than fixed sampling intervals -- by comparing to studies performed with traditional 80 kV and regular sampling within the same institution.

Materials and Methods

Forty consecutive stroke patients who underwent CT perfusion between 1/2013 and 12/2013 were enrolled in this retrospective study. Nineteen low dose 70 kV adaptive CTA perfusion examinations performed on a Siemens AS+ 128 scanner, and 21 80 kV CT performed on a GE Lightspeed VCT scanner were evaluated. All perfusion studies were processed with CT Perfusion 4D on a GE Advantage Workstation 4.6 by a neuroradiologist. Three experienced neuroradiologists independently subjectively rated overall quality and cortex-white matter differentiation of the CBF, CBF and transit time maps on a three-point scale (Table 1). The first-pass perfusion temporal enhancement curves were analyzed objectively to assess the rate at which each protocol captured the desired portions of the enhancement cycle as intended: fast sampling during the contrast transit through the brain and successful capture of the venous return to baseline. Radiation doses were recorded and compared for all studies.

Results

Qualitative Analysis. The inter-rater reliability in the assessment of image quality parameters was high. Overall image quality was significantly better at 70 kV for all three parameters: transit time (p=0.01), CBF (p=0.02) and CBV (p=0.04). Gray white differentiation with CBV was significantly higher at 70 kV (p=0.03) but not statistically different on CBF and transit time maps. Quantitative Analysis. Dose: The low kV, adaptively sampled protocol was 15% lower in
overall dose than the fixed sampling protocol at 80 kV (1538 versus 1831 DLP). The CTDI at 70 kV was 106 and at 80 kV was 193, 55% lower per whole brain pass for the 70 kV protocol.

Temporal enhancement curves: Analysis of the temporal enhancement curves revealed that with the fixed interval, limited length protocol (38-43 seconds) did not go long enough to capture the venous return to baseline in 53% of cases, provoking a change in protocol for these scanners at our institution at the cost of some increase in dose. The adaptively sampled longer protocol (52 seconds) captured the venous return to baseline in 95% of cases. Rapid sampling during the critical arterial arrival and washout period was captured in 100% for both protocols.

Conclusions
Whole brain adaptive perfusion imaging at 70 kVp produces statistically significant improvement in image quality compared to traditional 80 kV acquisitions with greater consistency of capture of the critical phases of contrast passage at lower radiation doses. As low kV and variable sampling capability become more widely available these techniques should be integrated into clinical practice.

KEYWORDS: CT And Stroke, CT Brain Perfusion, CT Perfusion

O-332

Brain Dynamic Susceptibility Contrast (DSC) Perfusion Using a Reduced Contrast-dose at 3.0T: Comparison of Bayesian Method and Circulant Singular Value Deconvolution (cSVD)

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Purpose
Increased use of brain dynamic susceptibility contrast (DSC) perfusion in combination with other enhanced applications such as contrast-enhanced MR angiography (MRA) for evaluation of patients with acute stroke (1) or with DCE perfusion in evaluation of brain tumors (2), has necessitated a demand for contrast dose reduction. The lower signal to noise ratio (SNR) associated with reduced contrast dose remains a limiting factor (3). Bayesian probabilistic method, which is inherently less sensitive to noise (4) has the potential for more accurate calculation of cerebral perfusion in low-dose protocols. The purpose of this study was to establish the feasibility of a reduced contrast dose (0.05 mmol/kg) brain DSC perfusion using Bayesian method and compare the result with block-circulant singular value deconvolution (cSVD) that is used routinely in clinical practice.

Materials and Methods
In this prospective study, 20 patients (12 male, 34-70 years old) who were referred for contrast-enhanced brain MRI underwent two consecutive DSC-perfusion (gradient-EPI, TR/TE: 1450/22 msec, FA 90º) at 3 T using two different doses of gadolinium (Gd). A total of 0.1 and 0.05 mmol/kg of Gd was used for full-dose (FD) and half-dose (HD) scans which were performed eight minutes apart. Using a FDA approved software (Olea Medical, La Ciotat, France), all DSC scans were processed with cSVD and Bayesian probabilistic method. Coregistered parametric maps of cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transit time (MTT) from both FD and HD scans were analyzed for quantitative measurement along the middle
cerebral artery distribution using a ROI-based analysis. The quantitative perfusion values between the cSVD and Bayesian methods in FD and HD groups were compared with regression analysis and unpaired t-test.

Results
The mean of SNR values was significantly (p< 0.0001) lower in the HD group (12.9) compared to FD group (20.1). Using Bayesian method, the mean of CBF (ml/100 g/min), CBV (ml/g) and MTT (sec) values in FD/HD group were 48.6/38.9 (p=0.16), 1.8/1.5 (p=0.1) and 3.6/3.4 (p=0.9) respectively. Using cSVD method, the mean of CBF (ml/100 g/min), CBV (ml/g) and MTT (sec) values in FD/HD group were 44/25 (p< 0.0001), 1.9/1.3 (p=0.004) and 4/5.2 (p=0.01) respectively. In FD scans, there was no statistically significant difference between Bayesian and cSVD for calculation of CBF (P=0.52), CBV (p=0.61) and MTT (p=0.17). In HD scans, there was statistically significant difference between Bayesian and cSVD for calculation of CBF (P=0.009), and MTT (p=0.001) but not for the CBV values (p=0.14).

Conclusions
Bayesian probabilistic method is inherently less sensitive to low SNR (4) and outperforms cSVD in HD group where the SNR is lower by approximately 36%. Reduced contrast dose (0.05-mmol/kg) DSC perfusion of the brain is feasible at 3.0 T using Bayesian probabilistic method with comparable quantitative results to 0.1 mmol/kg.

KEYWORDS: Deconvolution, Dose Reduction, Dynamic Susceptibility Contrast-Enhanced

O-333

Patient Motion: Small Annoyance or Call To Action?

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¹University of Washington, Seattle, WA, ²University of Washington, Kirkland, WA

Purpose
Patient motion frequently degrades MR examinations, often resulting in suboptimal image quality that negatively impacts radiological interpretation. While many motion-correction techniques have been proposed (1-4), often the most promising methods are available in the research domain only. Additionally, the prevalence of patient motion that results in significantly degraded MR examinations is documented poorly in the literature. We sought to assess the prevalence of significant patient motion in MR examinations of the neuroaxis at an academic level 1 trauma center. Within our population there are a wide range of patients and illnesses and a focus on neurological diseases (especially vascular, traumatic, and infectious), and a large spine population (both traumatic and degenerative).

Materials and Methods
HIPAA and informed consent were waived. The patient population presenting for MR imaging at our institution is comprised of ~50% inpatient (IP) and emergency department (ED) patients and ~50% outpatients (OP). This study included manual review of one full calendar week of MR examinations sent to the picture archiving and communication system (PACS). All exams were performed at a single institution on three different MR scanners: a 1.5 T OP only scanner, and 1.5 T and 3 T in-hospital scanners capable of accommodating IP and OP examinations. All patient images were reviewed manually at a PACS station for the detection of significant patient
motion; subtle movement within the globes, pulsation artifact, and mild interleaved motion artifacts were generally disregarded.

Results
Seventy percent of the MR examinations performed at our institution are of the neuroaxis (brain, head & neck, and spine). The remaining 30% primarily involve imaging of the musculoskeletal system (~25%), with some general body MR imaging (MRI) performed (~5%). In this study, 175 total MRI examinations were completed in one calendar week (53.1% were OP examinations; 46.9% were IP and/or ED examinations). Of these, 55 (31.4%) were sent to PACS with at least some motion degradation (47.6% of IP/ED exams; 17.2% of OP exams). Within the 55 motion degraded exams, 29 contained additional "repeat" sequences sent to PACS (16.6% prevalence among total cases), for which 27 of these (49.1% of all motion degraded exams) were examinations of the brain, head and/or neck (including MR angiograms), representing 15.4% of total completed examinations. Thus, a total of 84 sequences were motion degraded, and 47 of these were dedicated to imaging the human brain (56%). These numbers likely represent an underestimation of the exact prevalence of motion degradation affecting MR examinations, since partially completed sequences and failed examinations not sent to PACS were not included in our evaluation. Furthermore, examinations requiring sedation for motion control were not differentiated. While an exact dollar amount is difficult to calculate given complex and nontransparent hospital costs, the current reimbursement scale, the variability in sedation requirements, and in-hospital referral and practice patterns, we estimate the cost to the hospital in correcting patient motion may be as much as $813/hour* ($13/min), which can be lost due to patient motion (lower than the associated outpatient reimbursement rate for MR examinations). This would represent a cost, using conservative estimates, of $5,694 per week at our institution, assuming 5-minutes lost per repeat sequence.

Conclusions
Patient motion represents a frequent cause of MR image degradation affecting up to 31% of neuroaxis MR examinations in this patient population, similar to a prior report that significant motion may be seen in 10-42% of images (based on computed percent of missing data) (5). Motion degradation and repeat sequences represent an additional, unclear cost not reimbursed in the current system. Since the indication for patient sedation is multifactorial (and may include the anticipation of motion), this may increase motion-related imaging costs, which we conservatively estimate to approach $296,092.00/year. The retrospective nature of this study, small sample size, and short duration may appear to weaken the results; however we think these costs are underestimated given that not all attempted/failed examinations may have been captured by this study design. Patient motion represents a formidable challenge, potentially affecting the global MR community, and may result in significant inefficient use of hospital resources and suboptimal radiological interpretations. Elimination of wasted effort and unnecessary work is increasingly important as payors focus on controlling reimbursement for medical services as part of the general trend toward decreasing the cost of U.S. medical care. The results of this study suggest that this represents an opportunity to improve efficiencies in health costs and that more attention should be directed toward providing practical solutions to this dilemma.

KEYWORDS: Economics, Motion Correction

O-334
Acute Ischemic Stroke in Non-Human Primates: A Validation Study Using Near Infrared Spectroscopic Tomography for Cerebral Monitoring of Stroke and Intracranial Hemorrhage.

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Purpose
Near-infrared spectroscopic (NIRS) tomography is an evolving and exciting portable technology for continuous cerebral monitoring in critical care and operative procedures. We developed and validated an endovascular acute ischemic stroke nonhuman primate (NHP) model with NIRS monitoring of acute cerebral ischemic and hemorrhagic events in real-time.

Materials and Methods
During stroke induced by unilateral microcatheter occlusion of the middle cerebral artery, we used a NIRS imager with a 270 source-detector (5 X 6 measurement geometry; see Figure: Individual Channel Monitoring) channel array for cerebral monitoring of anesthetized Bonnet Macaques. We performed experiments in five Macaques using three hours of reversible unilateral occlusion of the middle cerebral artery (MCA) to induce ischemia/stroke, with continuous recordings of total hemoglobin (Hbtotal) levels and hemoglobin saturation (HbsO2) from each channel comparing pre/post events and bilateral hemisphere measurements. Near-infrared spectroscopic data also were used to construct three-dimensional tomographic functional images of the scalp and brain. Comparative analyses were performed for pre- and post-stroke events within and between cerebral hemispheres. We also performed immediate post-stroke CT perfusion, MR imaging (MRI), and postmortem brain histopathology to confirm ischemic and hemorrhagic stroke injury.

Results
Ischemia was achieved in five of five animals as confirmed by CT perfusion and/or MRI diffusion imaging and pathology at autopsy. After refinements in the NIRS monitoring protocol during the first three experiments, successful recordings were obtained in the last two subjects. Inadvertent vessel perforation in one case allowed us to study subarachnoid hemorrhage. Near-infrared spectroscopic tomography findings correlated with histopathology, CT, and MRI during acute cerebral ischemia and subarachnoid hemorrhage in these two subjects. Significant localized decreases in Hbtotal resulting from contrast boluses mimicking transient ischemia were noted [19 injections: statistically significant left-right differences in 15 (79%) cases (p < 0.0001); inter-hemispheric differences had expected directionality in 18 of 19 (94.7%) cases]. Regional verapamil injections increased Hbtotal levels on the ipsilateral side (p = 2x10^-8), whereas diffuse subarachnoid hemorrhage produced bilaterally increased Hbtotal compared to baseline levels (p = 0.0001). Following microcatheter-induced cerebral ischemia, Hbtotal levels fell in the region corresponding to the occluded artery, compared to the same region in the contralateral cerebral hemisphere (p < 0.0001).

Conclusions
Endovascular microcatheter occlusion of the MCA successfully created acute strokes in anesthetized adult male nonhuman primates. Near-infrared spectroscopic tomography accurately
captured both cerebral ischemia and hemorrhage in real time. These findings demonstrate the potential of NIRS tomography for noninvasive cerebral monitoring in a critical care setting.

KEYWORDS: Acute Stroke, Animal Model, Functional Brain Mapping

O-335

ASL Reveals Subtle Perfusion Changes in DWI-Negative TIA: Comparison with DSC

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Purpose
Determining a vascular etiology for transient ischemic attack (TIA) symptoms and negative diffusion-weighted imaging (DWI) is a clinical challenge. The purpose of this study is to compare arterial spin labeling (ASL) and dynamic susceptibility contrast-perfusion (DSC) in the detection of perfusion deficits in DWI-negative TIA.

Materials and Methods
Pseudocontinuous ASL with 3D background-suppressed gradient and spin-echo with four second post-label delay and DSC-perfusion were acquired in 145 patients presenting with stroke-like symptoms. All patients had DWI-negative scans and MR angiographies (MRAs) without significant intracranial stenosis. Arterial spin labeling arterial-transit-time (ATT) and DSC-time-to-peak (TTP) maps were generated and scored from 1-3 based on the presence and conspicuity of perfusion deficits by two independent observers blinded to patient history. Disagreements between the observers were resolved by consensus. The laterality of the perfusion disturbance was recorded in patients with hemispheric TIA for comparison with neurologic symptoms at onset.

Results
Arterial spin labeling detected 23 perfusion defects in DWI-negative TIA (16%), while DSC detected five perfusion deficits (3%). Of the 23 perfusion defects detected by ASL, 14 patients had symptoms referable to a specific hemisphere; nine of these lesions were lateralized to the symptomatic hemisphere. Of the five perfusion defects detected by DSC, one of these lesions
was lateralized to the symptomatic hemisphere. The average conspicuity ratings on ASL ATT maps was 1.2±0.49 versus 1.05±0.27 on DSC TTP maps (p=0.00164).

Conclusions
Arterial spin labeling-perfusion may be more sensitive than DSC-perfusion in the detection of subtle perfusion deficits in patients presenting with TIA symptoms and DWI-negative MRI.

KEYWORDS: Arterial Spin-Labeling, Dynamic Susceptibility Contrast-Enhanced, TIA

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O-336

MEG Delta wave changes related to Impact location in High School Football

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Purpose
Injured brain tissue can produce low-frequency signals in the delta band (0-4 Hz) that are measurable with magnetoencephalography (MEG) (1). The purpose of this study is to determine if the location on the helmet with the greatest exposure to head impacts during a season of high school football is associated with detectable changes in MEG delta band power.

Materials and Methods
Head impact exposure was measured by instrumenting the helmets of 31 high school football players (ages 14-18) with helmet-mounted accelerometer arrays to measure linear and rotational acceleration using the head impact telemetry (HIT) system. Helmet impact locations were computed as azimuth (AZ) and elevation (EL) relative to the center of gravity of the head. Impact locations were divided into equally spaced increments of AZ and EL. Peak linear acceleration within each increment was summed to compute the cumulative linear acceleration experienced by the athlete to each impact increment. The AZ/EL increments were converted to Cartesian coordinates and mapped to MNI space. The impact location with the greatest exposure was correlated visually with the location of greatest change in delta wave power. Eight minutes of eyes-open, resting-state MEG data were acquired for each subject using a 275 channel CTF whole-head system pre and postseason, and structural MR imaging (MRI) was acquired using a 3 T Siemens Skyra scanner for coregistration. Using the SPM12b software, the MEG data were down-sampled to 100Hz, baseline corrected, band-stop filtered at 60Hz, band-pass filtered to 1-4Hz (delta spectrum), and divided into 10000ms epochs. Magnetoencephalographic data then were projected into standard (MNI) source space using the Bayesian group inversion and greedy search constraint within SPM. These data for each subject were exported to a 4D file where each voxel represented the power for the delta range for each 10000ms epoch. Two athletes sustained clinically diagnosed concussions and were excluded from this analysis. Impact locations with the greatest exposure were compared visually with areas of greatest increase in delta band power from pre to postseason.

Results
Table 1 demonstrates the HITS maximum impact locations and brain areas of increased MEG delta power. For most of the head impact locations, coup and contra-coup relationships were apparent in the MEG spatial locations. Players with frontal impacts tended to have increased MEG delta wave changes in the occipital lobes, particularly near the falx.

Conclusions
The impact location with the greatest exposure in high school football players may demonstrate relationships to areas of increased brain MEG delta wave activity. This adds to a growing body of literature that a season of high school football can result in brain changes that have been associated with mTBI, even in the absence of clinically diagnosed concussion.

KEYWORDS: Biomechanical, Concussion, MEG

Table 1: Impact Locations and increased delta waves

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The accuracy of Flat Detector CT Cerebral Blood Volume Mapping Source Images in Diagnosing Intracranial Arterial Stenosis

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Purpose
Flat detector cerebral blood volume mapping (FDCTCBV) can provide intracranial hemodynamic information in the angiographic suite without patient transfer. CTA-like datasets can be reconstructed from the fillrun of FDCTCBV. The aim of our study was to evaluate the reliability of FDCTCBV source images for detection of intracranial stenosis and occlusion with digital subtraction angiography (DSA) as the reference.

Materials and Methods
Eleven DSA exams were included in this retrospective analysis. FDCTCBV and DSA were performed simultaneously for all the patients with suspected acute infarction or post-SAH vasospasm. Axial, coronal and sagittal maximum intensity projections were reconstructed from the source images of FDCTCBV. The imaging quality and degrees of stenosis were read by two independent neuroradiologists, who were both blind to the results of DSA.

Results
The imaging quality of the reconstructed FDCTCBV source images was all sufficient for
diagnosis. The intraclass correlation between two raters was excellent (ICC = 0.876). The FDCT-CBV source images had an averaged sensitivity of 86.6% and a specificity of 62% for detecting intracranial stenosis (>=50%) compared with DSA.

Conclusions
Flat detector cerebral blood volume mapping can provide valuable intracranial hemodynamic information by using the angiographic C-arm FDCT without patient's transfer. The reconstructed source images of FDCTCBV can be a feasible and time-saving tool for evaluating intracranial vasculature.

KEYWORDS: Flat-Detector Cone-Beam CT, Flat-Panel Angiographic CT, Vasospasm

O-338

11:54AM - 12:01PM

CT Metal Artifact Reduction in the Spine: Can an Iterative 3D Reconstruction Technique Really Improve Visualization?

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Purpose
Metal-related artifacts from spine instrumentation can obscure relevant anatomy and disease in neuroimaging. We evaluated the utility of a new prototype three-dimensional iterative metal artifact reduction (3D-IMAR) technique for spine CT.

Materials and Methods
After IRB approval, we performed a retrospective analysis of imaging data collected between July 2012 and August 2013. Inclusion criteria were prior instrumented fusion and CT imaging of the spine (Definition FLASH; Siemens Healthcare). Computed tomography (CT) images were reconstructed using weighted filtered back projection (WFBP) and a prototype 3D-IMAR using spine hardware setting, 0.6mm slice thickness and B35s kernel. Two neuroradiologists (ALK, DRD) reviewed both WFBP and 3D-IMAR exams in soft tissue (ST) and bone windows in consensus. On ST window settings, the paravertebral anatomy was given an overall visualization score in the region of the spinal hardware (0= totally obscured to 5 = seen with high confidence), with a separate artifact score (analogous 0-5 scale, 0 worst) given in the region of the worst visualized anatomical structure. Using bone windows, the angle (degrees) of vertebral cortex obscured by artifact and length of "flame" artifact (lower-attenuation linear projection from ends of hardware, mm) also were measured. Radiologists estimated impact on diagnostic confidence (unclear, probable or definite increase or decrease). Statistical analysis was performed using two-tailed paired t-tests.

Results
Sixty-eight patients met inclusion criteria with one failure of 3D-IMAR (additional metallic dental work). In the ST images, the mean visualization scores for overall anatomical appearance were 1.38 and 2.79 for WFBP and 3D-IMAR image respectively (p < 0.0001). The mean artifact scores were 0.85 and 2.44, respectively (p < 0.0001). There was overall improvement in visualization and artifact scores > 1 point in 55 and 60 cases, respectively. Mean angular obscuration of the vertebral body cortex for WFBP and 3D-IMAR images were 36 and 16° respectively (p = 0.002). Mean "flame" artifact lengths were 29 mm and 11mm, respectively (p <
0.0001). Iterative metal artifact reduction resulted in probable or definite improvement in diagnostic confidence in 24 (36%) and 22 (33%) cases, respectively, and decreased confidence in one case (1%).

Conclusions
The prototype 3D-IMAR improves anatomical visualization and reduces metal artifacts by subjective and objective measurement, resulting in improved diagnostic confidence in the large majority of patients.

KEYWORDS: CT Artifacts, Spinal Instumentation
BMD Values Derived from Routine Lumbar Spine MDCT Predict Osteoporotic Vertebral Fractures and Screw Loosening

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Purpose
Established methods available for measuring bone mineral density (BMD) such as quantitative computed tomography (qCT) or dual energy x-ray absorptiometry are associated with radiation exposure of the patient. Validating a method to assess BMD in routine lumbar MDCT data could avoid additional radiation exposure and examination time for patients. First aim of this study was to correlate BMD values derived from routine lumbar spine MDCT scans (BMDMDCT) to BMD values obtained from qCT (BMDqCT). Second, we analyzed the use of baseline BMDMDCT values to differentiate between patients with and without baseline fractures and whether these values predict incidental fractures and screw loosening in patients with spondylodesis.

Materials and Methods
In 38 patients (mean age ± SD 74±6.5; 25 female), BMD was assessed in qCT as a standard of reference, as well as in sagittal reformations derived from standard MDCT studies without iv contrast. For this purpose, standard built-in PACS measurement tools were used. MDCT-to-qCT conversion equations were calculated and then applied to baseline MDCT scans of further 62 patients (mean age ± SD 71±5.8; 29 female), using a linear regression model. After a mean follow-up time of 15±6 months, patients were re-assessed for incidental fractures (n=62) and screw loosening after spondylodesis (n=49). Correlation analysis was performed using general models adjusting for age, gender, follow-up time and application of intrathecal contrast medium.

Results
The conversion equations BMDMDCT=0.78xHUMDCTmg/ml (correlation with BMDqCT R²=0.92, p<0.001) for 120 kVp tube voltage and BMDMDCT=0.86xHUMDCTmg/ml (R²=0.81, p<0.001) for 140 kVp were observed, respectively. Seven patients (11.3%) had existing osteoporotic vertebral fractures at baseline while eight patients (12.9%) showed incidental osteoporotic vertebral fractures. Screw loosening was detected in 28 patients (57.1% of patients with spondylodesis). Patients with existing vertebral fractures showed significantly lower BMDMDCT than patients without fractures (p<0.01). At follow up, significantly lower baseline BMDMDCT values were found in patients with incidental fractures and screw loosening after spondylodesis, respectively (p<0.001 each).

Conclusions
This study presented an easy and fast method to obtain converted BMD values from standard lumbar spine MDCT scans. This method may be easily integrated into routine clinical practice using already available standard PACS tools. Converted BMD values are able to differentiate not only between patients with and without baseline fractures, they also are able to show increased risk for incidental fractures and screw loosening in patients with spondylodesis. Thus, such a quantification adds significant information to a standard preoperative MDCT exam of the lumbar spine.

KEYWORDS: CT, Osteoporosis
Brain Development and Myelination is Influenced by Route of Nutrition in a Preterm Pig Model

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Purpose
Perinatal brain development is sensitive to nutrition. Preterm infants are at greater risk of behavioral, cognitive, and motor developmental impairment. Intensive care unit (ICU) support of preterm infants is often reliant upon long-term parenteral nutrition (PN), however the impact of this on brain development as opposed to enteral nutrition (EN) is unknown. We used a preterm pig model of neonatal ICU support to evaluate the differences of EN and PN on brain growth and myelin maturation.

Materials and Methods
Eight preterm pigs harvested by caesarian section at 92% of term gestation were randomized to EN (n=4) and PN (n=4). After 12 days of support in a preterm-pig neonatal intensive care unit, animals were euthanized and the brains were explanted. Brains were weighed, formalin fixed, and evaluated using high spatial resolution T1-, T2-weighted MR imaging (MRI) and diffusion tensor imaging on a 3 T scanner. MR images were reviewed in a blinded manner by a neuroradiologist and the extent of myelination in the corticospinal tract, corticobulbar tract, and optic radiations were assessed on a four-point Likert Scale.

Results
All pigs survived the 12 day observation period without need for ventilator support. Brains of pigs receiving EN weighed 32.9 ± 1.8 g, compared to 27.9 ± 2.0 g for pigs dependent upon PN (p=0.009). The PN group had higher somatic growth with a 73±11% gain from birth weight, compared to 30±2% increase in the EN pigs (p<0.001). Myelination in the pyramidal tracts and optic radiations was more mature, and involved a larger volume of white matter in the EN brains (p<0.05).

Conclusions
Brain volume and myelination are impacted by route of nutrition in preterm pigs harvested at a stage of development analogous to late preterm humans. In this model of 12 days of NICU care, PN fostered higher somatic growth, whereas EN elicited greater growth in brain mass and accelerated myelin maturation in visual and motor pathways. These findings are novel and correspond with the developmental impairment often reported for preterm infants. Parenteral nutrition often is administered to preterm infants to reduce complications such as necrotizing enterocolitis, however PN may compromise brain development compared to EN, independent of somatic growth.
Fetal MR Quantitative Ontogenetic Study: Progressive Normal Relative Diminution of the Mesencephalon Through Fetal Development

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Purpose
To address the appearance of the disproportionately large size of the quadrigeminal plate in the second trimester, sometimes mistaken for causing aqueductal stenosis in fetuses with isolated bilateral and third ventricular enlargement. We perform a quantitative ontogenetic study using midsagittal T2-weighted fetal MR images to measure the size ratios of the mesencephalon, specifically the quadrigeminal plate, compared to the cerebellar vermis through fetal development.

Materials and Methods
Two hundred fetal MR images (MRIs) performed at a single, large academic institution were evaluated retrospectively after obtaining IRB approval. Studies were excluded if imaging
findings demonstrated a fetal neurologic abnormality, if no diagnostic midsagittal T2-weighted fetal MR images were acquired, or if estimated fetal age by either ultrasound or last menstrual period was not available. Twenty-five studies met inclusion criteria. Estimated fetal age ranged from 19 to 37 weeks (mean 27 weeks, SD 5.5 weeks). Height and freehand region of interest (ROI) areas of the quadrigeminal plate (midbrain tectum) were used for the mesencephalon. Height and freehand ROI areas of the cerebellar vermis were used for baseline measurement. Linear regression analyses of mesencephalon to cerebellar vermis height and area ratios were performed to determine R squared values. Spearman's rank correlation coefficients were calculated to determine statistical dependence of height and area ratios to fetal age. Spearman's rank-order calculations were performed to determine p values.

Results
The relative sizes of the midbrain tectum to the cerebellar vermis decreased with greater fetal age. Both mesencephalon to cerebellar vermis height and area ratios demonstrate an inverse relationship to fetal age. Height ratios demonstrated an R squared value of 0.68, a Spearman rho of statistical dependence of -0.82, and a p value of < 0.00001. Area ratios demonstrated an R squared value of 0.59, a Spearman rho of statistical dependence of -0.83, and a p value of < 0.00001.

Conclusions
The disproportionately large relative size of the quadrigeminal plate to the cerebellar vermis, especially in the second trimester, is a normal phase of fetal development and should not be mistaken for causing aqueductal stenosis. Fetal MR quantitatively demonstrates a strong inverse linear size relationship between the mesencephalon and the cerebellar vermis on both height and area ratios. These findings are consistent with ontogenetic, phylogenetic, qualitative, and anatomical fetal studies previously published. Recent advances in fetal MR imaging with rapid, high spatial resolution sequences allow for quantitative ontogenetic studies to be performed.

KEYWORDS: Embryology, Neonatal, Neonatal MR Imaging
Fetal brain injury in survivors of twin pregnancies complicated by demise of one twin as assessed by in utero MR imaging

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Purpose
Twin pregnancies are the commonest type of multiple pregnancy, occurring in 2% of pregnancies and twin pregnancies are considered high risk. In a particular subtype both types share the placenta, i.e., are monochorionic. The shared placenta that defines monochorionic pregnancies
often contains blood vessels that may carry blood to either fetus and can be the source of potentially serious problems. If one fetus in a monochorionic pregnancy dies there is opportunity for either hemodynamic changes to affect the other fetus or for harmful blood-borne materials (e.g., embolus, substances affecting clotting) to pass from the dead twin to the healthy one. In this situation there is a high risk of injury to the brain of the surviving twin. One complication of monochorionic twin pregnancies that produces very high risks is twin-twin transfusion syndrome (TTTS) where one fetus 'donates' blood supply to the other. In these cases prognosis is poor with death of one or both twins occurring in 60% to 100% of cases. We report our experience of performing in utero magnetic resonance (iuMR) imaging of the fetal brain in survivors of monochorionic pregnancies complicated by fetal demise of the co-twin.

Materials and Methods

This was a retrospective, observational study of monochorionic twin pregnancies complicated by demise of one twin. Two groups were created, one where there was a history of TTTS and some type of ante-natal intervention (treated TTTS group) and the other where the pregnancy was not complicated by TTTS (spontaneous demise group). The pregnant women were referred from nine feto-maternal centers in Britain but all had their iuMR examination at the Academic Unit of Radiology, University of Sheffield. The women had ante-natal ultrasonography performed by an experienced feto-maternal consultant prior to the iuMR examination. In cases of treated TTTS the type of intervention and gestational age at which it performed was recorded as well as the time at which the twin demise was first recorded and the demise-to-scan time. For cases of spontaneous demise of a twin only the estimated demise-to-scan time was recorded. All iuMR procedures were carried out on 1.5 T whole body systems, from 2004 to 2007 - Infinion (Philips Medical Systems, Best, Netherlands) and from 2008 to 2013 - HDx (GE Healthcare, Milwaukee, USA). The reports of the ante-natal ultrasound and the co-temporaneous iuMR examinations were compared in order to make assessments of the overall rate of acquired brain pathology in the surviving twin and to make an assessment of the differences in diagnosis between the ultrasound and iuMR examinations.

Results

A search of our institutional MR database located 73 appropriate cases from 2004 to 2013, 32 with treated TTTS and 41 with spontaneous demise of one twin. Of the 34 cases with treated TTTS 29 had laser ablation of placental blood vessels and five had selective reduction of the pregnancy (RF ablation or cord occlusion). The ultrasound and iuMR examinations both were reported as showing no evidence of acquired brain injury in 64/73 (88%) overall, including 28/32 (88%) of the treated TTTS group and 36/41 (88%) of the spontaneous demise group. The rate of brain pathology was approximately the same in both groups (12%). In the abnormal group (n=9) three of nine cases ultrasound and iuMR findings agreed (all cases of ventriculomegaly as the only finding). In two of nine cases the ultrasound examinations were reported as showing ventriculomegaly only but iuMR showed VM and some other brain abnormality (extensive encephalomalacia in one case and extensive encephalomalacia and reparative polymicrogyria in the other). In one further case the ultrasound examination showed ventriculomegaly and raised the possibility of brain infarction. In utero MR imaging showed extensive unilateral brain injury with a focal infarction and reparative polymicrogyria. In three of nine cases the ultrasound examination was reported as normal but iuMR in all three cases showed extensive or focal areas of encephalomalacia and reparative polymicrogyria. Thus ultrasound failed to demonstrate or underestimated the brain injury in 66%. Outcome details of the pregnancy were available in 59/73 cases (81%). Fifty-eight percent of the fetuses resulted in a preterm delivery (49%
moderate/late, 10% very preterm and 5% extreme preterm) in comparison with 7.1% in the general population. Six of the fetuses with brain abnormalities were delivered preterm including four that were very preterm.

Conclusions
In utero MR imaging is superior to ultrasound in the detection and characterization of the neurologic sequelae of cotwin demise in monochorionic twin pregnancies. The rate of such sequelae in the surviving twins in cases of TTTS is not increased in our subgroups, which is at odds with several previously published studies. Nonetheless, our study adds valuable experience to the in utero imaging of a high risk pregnancy group.

KEYWORDS: Fetal, Fetal Brain Injury, Fetal MR Imaging

O-342 10:51AM - 10:58AM

Charting the Prenatal Development of Regional Functional Connectivity: an in Utero Functional MRI Study

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Purpose
The characterization of prenatal neural functional development has been so far limited to indirect observations on fetal behavior, electrophysiological measurements, invasive measurements and translation of knowledge from animal models. Advances of fast in utero magnetic resonance imaging (MRI) enable the application of functional MRI (fMRI) approaches to critical periods of human brain development, to the time of extensive synaptogenesis during the mid- and late gestation. We aimed to portray the prenatal emergence of functioning neuronal ensembles by noninvasive neuroimaging, providing normative data of how regional, macroscopic scale functional interactions become detectable.

Materials and Methods
Our study relied on the functional examinations of 32 fetuses with no detectable morphological abnormalities. By adapting the functional magnetic resonance acquisition, motion correction and nuisance signal reduction procedures of the commonly modeled resting-state functional brain networks to fetal data we extracted BOLD activation information for major cortical and subcortical structures. Resting fMRI networks were observed for increasing regional functional connectivity during the 21-38 gestational weeks (GW) with a network-based statistical inference approach.

Results
The overall functional connectivity network, short range and interhemispheric connections showed sigmoid expansion curve peaking at the 26-29 GW. In contrast, long-range connections exhibited linear increase with no periods of peaking development. Region-specific increase of functional signal synchrony followed a sequence of occipital (peak: 24.8 GW), temporal (peak: 26 GW), frontal (peak: 26.4 GW) and parietal expansion (peak: 27.5 GW).

Conclusions
We successfully adapted functional neuroimaging and postprocessing approaches to correlate macroscopic scale activations in the fetal brain with gestational age. Our in vivo data confirm
that the mid-fetal period hosts events that cause the architecture brain circuitry to mature. This is supported by the developing complexity and increasing strengths of intra and interhemispheric functional connectivity. We characterized a diverging developmental trajectory of short- and long-range connectivity presumably marking different mechanisms that contribute to the increasing functional connectivity. The use of functional connectivity approach on a region of interest basis will allow future investigations on disease development and their correlation to healthy characteristics of connectivity strength development curves as shown in this work.

KEYWORDS: Fetal, Fetal FMRI, Fetal MR Imaging

![Development of short-range fetal functional connectivity](TCT_O-342_asnrfigure3JPG.jpg)

![Development of long-range fetal functional connectivity](TCT_O-342_asnrfigure3JPG.jpg)
Diagnosis of Polymicrogyria on Fetal MRI.

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Purpose
Fetal MR imaging (MRI) can detect and characterize brain malformations that may be difficult or impossible to diagnose on ultrasound examination. As a result, fetal MRI now is recommended for the confirmation of fetal brain anomalies suspected by ultrasound and to search for additional brain anomalies when abnormalities such as ventriculomegaly or callosal agenesis are observed. Polymicrogyria (PMG) is one of the most common cortical anomalies diagnosed on fetal MRI. While difficult to detect on ultrasound, the diagnosis of polymicrogyria remains challenging even on fetal MRI, and there is limited data on the accuracy of fetal MRI for this malformation. The purpose of this study was to assess accuracy of fetal polymicrogyria diagnosis through a retrospective analysis of cases interpreted as polymicrogyria and correlate clinical interpretations with pathology or postnatal imaging. In addition we set out to determine the impact of gestational age on accuracy, imaging findings commonly associated with polymicrogyria, and underlying etiologies where ascertainable.

Materials and Methods
The radiology database was queried for instances of polymicrogyria diagnosed on fetal MRI from January 2003 through August 2013. Reasons for referral, fetal sex, gestational age, and associated abnormalities were recorded. Where available, follow-up imaging, clinical information, and underlying etiology was obtained for these cases. One scan was performed on a Siemens Skyra 3 T system, with the remainder performed on a GE Signa HDxt 1.5 T system. Fetal and postnatal images were reviewed by three pediatric neuroradiologists, two of whom are senior members of the American Society of Neuroradiology and board certified neuroradiologists with a focus on pediatric neuroimaging.

Results
Database query yielded 27 cases where PMG was diagnosed or questioned, 14 females and 13 males. The reason for referral of these cases was enlargement of the ventricles in 44%, other brain abnormalities in 16%, spine or body anomalies in 26%, cleft lip in 7%, and for follow up of previously abnormal fetal brain MRI from an outside institution in one case. Average age of gestation at time of fetal diagnosis of definite or possible PMG was 30 weeks 2 days. MR imaging manifestations of fetal PMG were similar to postnatal imaging findings including cortical thickening/irregularity and presence of excessive number of gyral folds in locations departing from standard gyral anatomy for age. Two thirds of the cases were bilateral with 26% of total cases representing bilateral perisylvian involvement and 22% diffusely involving the cerebral cortex. Associated findings included ventriculomegaly in 48%, abnormalities of the corpus callosum in 22%, heterotopic gray matter in 15%, and cystic changes/encephalomalacia in 15%. Ultrasound reports were available for 26 of the 27 patients where PMG was suspected, in which the possibility of PMG was mentioned in two cases. Postnatal or fetopsy follow up was obtained for 16 fetuses, confirming the diagnosis in 10 instances. Retrospective analysis of the false positive cases of PMG suggested that abnormalities of sylvian fissure configuration without
discrete cortical nodularity and technical factors may contribute to spurious diagnosis of PMG in utero. False positive cases also were associated with less diagnostic certainty than true positive cases and invariably had significant other abnormalities. There was no statistically significant difference in gestational age for confirmed versus nonconfirmed PMG (p=0.4961). Of the cases with followup, confirmed etiologies included CMV infection, 11p15.4 deletion, Aicardi Syndrome, and Megaencephaly-Capillary malformation – polymicrogyria syndrome. In the majority a cause was not confirmed.

Conclusions
Polymicrogyria is a challenging diagnosis with significant implications for neurologic outcome. As such, close attention for this abnormality should be paid on fetal MRI studies in which brain anomalies are suspected. Characteristic imaging findings include areas of cortical nodularity and abnormal frequency of gyral folding in a pattern departing from normal sulcal anatomy. Associated abnormalities that may suggest a specific etiology include microcephaly with parenchymal destruction/cysts (i.e., CMV); periventricular nodular heterotopia, agenesis of the corpus callosum, and interhemispheric cysts (i.e., Aicardi syndrome); and megalencephaly with distal extremity anomalies (i.e., megalencephaly polymicrogyria polydactyly hydrocephaly, MPPH, syndrome). Potential pitfalls include acquisition factors (e.g., angulation, image artifacts, and field strength) and difficulties in resolving abnormal gyral folds in the early third trimester, a time period when secondary sulci have formed but the overall brain size remains quite small. With improvements in fetal MRI technique, these technical pitfalls are anticipated to be less frequent in the future.

KEYWORDS: Fetal, Fetal MR Imaging, Polymicrogyria

O-344

Ultrasound and MRI in the Neonate: A Head to Head Comparison.

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Purpose
Ultrasonography has been a standard in imaging the premature and critically ill neonate as most neonates are too unstable to leave the confines of the neonatal intensive care unit. The recent installation of a 1.5 T MR imaging (MRI) scanner in our neonatal intensive care unit has been advantageous in directing the care of these delicate patients. Because some may question the advantages of brain MRI over bedside head US, a study was performed to directly compare neonatal brain imaging findings and the sensitivity of the two techniques.

Materials and Methods
The study was IRB approved and parental consent was obtained. A total of 42 neonates which had both MRI of the brain and head ultrasound within a 72-hour window were enrolled. The MR exams were interpreted by a pediatric neuroradiologist and ultrasound exams by a pediatric radiologist specialized in sonography. Blinded to clinical history, the imaging was graded utilizing a brain pathology scale. Statistical comparison of the two techniques was obtained utilizing the Kappa test.
Results
Of the 42 patients with corrected gestational age ranging from 32 – 47 weeks (mean 40.1) concordance between ultrasound and MRI findings varied widely. As expected, ventriculomegaly and enlarged extra-axial fluid spaces showed good agreement. MR imaging and US showed the worst agreement when identifying cerebellar hemorrhage (0-US, 6-MRI), anomalies of the corpus callosum (1-US, 6-MRI), and extra-axial hemorrhage (1-US, 9-MRI). White matter injury and parenchymal hemorrhage also had significant discordance with US overcalling normal white matter in 9/29 cases but undercalling grade 3 injury in 8/11 cases. In cases of parenchymal hemorrhage, US overcalled in 5/31 cases and undercalled 7/11 cases. Moderate agreement was noted when comparing migrational abnormalities and germinal matrix hemorrhage. The lack of agreement in the germinal matrix injury was unexpected but was due to subacute injuries being more difficult to detect via US when compared to MRI susceptibility sequences.

Conclusions
Both US and MRI are valuable techniques in directing medical care for the neonate. Ultrasound is extremely helpful in assessing the CSF spaces. MR imaging is sensitive at detecting parenchymal abnormalities, many of which are important with regard to long term outcome. Data from our study should help guide clinicians in choosing between US and MRI in the evaluation of these youngest, critically ill neonates.

KEYWORDS: Neonatal, Neonatal MR Imaging, Ultrasonography

O-345

Study of Cerebro-Cerebellar Connectivity Development in Preterm Neonates Using MR Imaging Tractography

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Purpose
The cerebellum has been associated with a wide variety of normal motor and nonmotor functions and behaviors. It serves a vital role in normal development, and developmental impairment in the cerebellum has been correlated with motor, behavior, attention, socialization, and cognition deficits (1). Early diagnosis of abnormalities in the white matter microstructure connecting this crucial region with the cerebral cortex will allow for earlier identification of children who require clinical intervention. This will enable targeted therapy to be provided as early as possible and potentially result in improved clinical outcomes. With this aim in mind, this study characterized typical development of cerebro-cerebellar connectivity as indicated by MR imaging (MRI) tractography streamlines in preterm neonates with good outcome on neuromotor scores at six months of age.

Materials and Methods
As part of an ongoing study at the University of California, San Francisco, 23 diffusion tensor imaging (DTI) scans were taken of 19 neonates born prematurely [gestational age of 25-32
weeks, postmenstrual age (PMA) of 30-40 weeks at time of scan]. A 3 T GE MR scanner was
used and the images were collected using half-Fourier SE EPI, with a FOV of 25.6 cm, 128x128,
2 mm slice thickness, min TE, 30 directions, b-value 600 s/mm2. The cerebellum and thalamus
regions of interest (ROIs) composed of the entire cerebellum and thalamus were manually
selected using the TrackVis (2) tool for analyzing diffusion tractography. These regions were
connected by streamlines, mathematical representations of white matter tracts based on the
varying diffusivity of water through the neural tracts of the brain. The spatial extent of the
streamlines connecting the regions (corrected for the total number of voxels present in the brain)
as well as the average fractional anisotropy (FA) over these voxels were calculated for each
subject. Of the 23 neonatal scans that were analyzed, three were excluded because no streamlines
connected the ROIs, indicating a tractography error. A further two scans were excluded from FA
analysis for values more than two standard deviations outside of the mean, leaving 20 scans of
postmenstrual ages of 30.4-39.71 weeks for streamline spatial extent analysis and 18 scans for
FA analysis.

Results
Both the spatial extent of streamlines connecting the regions and the average FA showed an
increasing trend with PMA of the neonate at the time of the scan (See Figure). A linear
regression model of the relation between the corrected spatial extent of the streamlines and the
PMA resulted in r2=0.0112 and p=0.6572. A linear regression model of the relation between the
FA and the PMA resulted in r2=0.0750 and p=0.2716. The FA values ranged between 0.1876
and 0.2449.

Conclusions
Both streamline voxel count and FA values increased slightly with PMA in the final stages of
development preceding term-equivalent age. The range of the FA values and this increase with
PMA is consistent with previously reported FA values during this developmental period in other
white matter regions (3). This mild trend to increase both FA and streamline count indicates
cerebro-cerebellar connectivity may develop faster in the final stages of development preceding
term-equivalent age. It should be noted that both streamline spatial extent and FA as measures of
connectivity must be interpreted with care, as streamline voxel count is not a direct indicator of
axonal fiber volume and FA is not a direct measure of white matter integrity (4). However, the
short, direct streamlines connecting the cerebellum and the thalamus were selected as a measure
of cerebro-cerebellar connectivity to avoid errors due to fiber crossings, curvature, length and
branching. By investigating the connectivity in neonates who have shown good neuromotor
scores at six months age, we have developed a basis of comparison for further study of atypically
developing neonates. Future directions include investigating this measure in premature neonates
with poor neurological outcome.

KEYWORDS: Cerebellum, Fractional Anisotropy, Neonatal
Auditory Neuropathy Spectrum Disorder due to Infantile Thiamine Deficiency: MR Findings.

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Purpose
To report the MRI findings of seven children who were fed with thiamine deficient formula in
infancy and developed hearing impairment attributed to the auditory neuropathy spectrum disorder.

Materials and Methods
A pediatric radiologist and a neuroradiologist retrospectively reviewed the pretreatment brain MR imaging (MRI) examinations of the seven infants with auditory neuropathy spectrum disorder due to thiamine deficiency. Four patients had post-treatment MRIs following the initiation of thiamine supplementation. All MRIs included T2, FLAIR images, either IRT1 or T1-weighted images. Postgadolinium T1-weighted were available in six out of seven patients and diffusion-weighted images (DWI) were available in five patients. The MRIs were evaluated for abnormal signal and enhancement with attention to the central auditory pathway including the cochlear nuclei, the auditory fiber tracts, the inferior colliculi and the medial geniculate bodies.

Results
The time of imaging of the MRIs ranged from two to 16 months of age. Along the auditory pathway, abnormal elevated signal on the T2-weighted images was seen in the cochlear nuclei in six patients and the inferior colliculi in five patients. Abnormal elevated signal was seen on the T2-weighted images also in the posterior thalami in four patients, and in the cortex and subcortical white matter in three patients, and in other cranial nerve nuclei such as the hypoglossal and vagal nuclei. Abnormal diminished diffusion was seen in the tectum, brainstem, posterior thalami, and the basal ganglia. After the administration of thiamine, follow-up MRI exams were performed in four of the patients. Improvement in the signal abnormality was found in the brain stem in all four patients, in the posterior thalami in three patients and in all three patients with tectal involvement.

Conclusions
Our report describes for the first time the MR findings along the central auditory pathway and in the supratentorium and brain stem of infants with auditory neuropathy spectrum disorder due to thiamine deficiency.

KEYWORDS: Hearing Loss, MR Imaging Brain, Wernicke Encephalopathy

O-347 11:26AM - 11:33AM

Physiologic Pineal Region and Choroid Plexus Calcifications in the First Decade of Life

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Purpose
Benign intracranial calcifications commonly are encountered on head CT exams. Physiologic calcifications of the pineal gland, habenula, choroid plexus, and dura may be present in both children and adults. In the modern CT era with thinner image sections and multiplanar reformats, intracranial calcifications have become increasingly visible. We sought to discover the prevalence of pineal region and choroid plexus calcifications on head CTs in the first decade of life.
Materials and Methods
Head CT exams from 507 consecutive new patients at a single academic children's hospital were identified by a RIS search. Five exams were excluded due to excessive artifact or hemorrhage. A total of 502 exams were analyzed. Axial, coronal, and sagittal 5mm section bone and soft tissue algorithm images were evaluated for calcifications associated with the pineal gland, habenula, choroid plexus, and dura. Images were reviewed independently by two CAQ holding board certified neuroradiologists. A consensus reading was reached in all cases.

Results
Pineal region (pineal and/or habenular) calcifications were present in 13% (65/502) of patients. Pineal calcifications were visible in 5% (25/502; range 4.2 to 9.9 years, median 7 years) and habenular calcifications were identified in 10% (50/502; range 3.2 to 9.9 years, median 7 years). Twelve percent of patients had choroid plexus calcifications (58/502; range 1.1 to 9.9 years, median 7 years). Dural calcifications were present in 1% (7/502; range 3.9 to 9.8 years, median 4 years). The vast majority (96%; 483/502) of intracranial calcifications were found in patients over five. There was no significant difference in the sex or race of patients with and without pineal region and choroid calcifications.

Conclusions
Physiologic pineal region and choroid plexus calcifications may be present on head CT in patients in the first decade of life, principally in children older than five. The majority of pineal region calcifications are habenular in location. Pineal and habenular calcifications were never present in children less than four and three years, respectively.

KEYWORDS: Choroid Plexus, Pediatric Brain, Pineal Calcification

<table>
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<tr>
<th>Type of Calcification</th>
<th>Number Of Patients</th>
<th>Age Range (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pineal</td>
<td>25/502 (5%)</td>
<td>4.2-9.9 (median 7)</td>
</tr>
<tr>
<td>Habenular</td>
<td>50/502 (10%)</td>
<td>3.2-9.9 (median 7)</td>
</tr>
<tr>
<td>Choroid Plexus</td>
<td>58/502 (12%)</td>
<td>1.1-9.9 (median 7)</td>
</tr>
<tr>
<td>Dural</td>
<td>7/502 (1%)</td>
<td>3.9-9.8 (median 4)</td>
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</table>
Hypomyelination with atrophy of basal ganglia and cerebellum (HABC) due to TUBB4A mutations: expansion of the neuroimaging phenotype

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Purpose
Hypomyelination with atrophy of basal ganglia and cerebellum (HABC) is a rare and sporadic leukodystrophy that is characterized by childhood onset, developmental delay, a variety of extrapyramidal movement disorders, ataxia, progressive spasticity and seizures. The diagnosis of HABC is based on the characteristic neuroimaging findings including hypomyelination and selective atrophy of the neostriatum and cerebellum. Recently, a single de novo mutation in TUBB4A has been associated with HABC. The aim of this study is to report on three new patients with HABC, describe two novel mutations in the TUBB4A gene and expand the neuroimaging phenotype of HABC.

Materials and Methods
Clinical and neuroimaging data of three patients with HABC were collected by the senior author. All neuroimaging data (including at least sagittal T1- and axial T2-weighted images) were evaluated retrospectively for qualitative assessment of size and signal intensity of infra and supratentorial gray and white matter structures. Whole-exome sequencing (WES) was performed in all patients.

Results
At last follow-up, the patients were 24, 14 and 12 years old, respectively. At this age, all patients had spasticity, dystonia, microcephaly and abnormal language. Choreoathetotic movements, speech difficulties (dysarthria or anarthria), impairment of visual acuity and eye movement disorders (exotropia or nystagmus) were present in two patients, tremor in one. Ataxia was present in one patient and not testable in the other two patients. Cognitive functions were normal in one patient, while the other two patients had severe intellectual disability. For all patients, two neuroimaging studies were available. Age at first MR imaging (MRI) was between 11 months and 2.7 years, age at follow-up MRI between 8.2 and 9.8 years. In patient one and two, hypomyelination was diffuse, while in patient three it was less severe: genu and splenium of the corpus callosum as well as the posterior limbs of the internal capsule appeared to be partially myelinated at two years of age, but no progression in myelination occurred up to the next neuroimaging follow up at 8.7 years of age. In all patients, progressive cerebellar atrophy was seen over time and thalami as well as globi pallid had a normal size on all MR studies. In patient one and two, progressive atrophy of putamina and head of caudate nuclei was seen at follow up, while in patient three the size and signal of the putamina and caudate nuclei remained normal over the course of seven years. Whole-exome sequencing revealed heterozygous missense mutations in TUBB4A in all patients. Mutation in patient three appears to result in similar clinical severity, but more benign neuroimaging findings compared to mutations in patients one and two.
Conclusions
We confirm the association between mutations in TUBB4A and HABC. We expand the neuroimaging phenotype of HABC including a less severe degree of hypomyelination and lack of atrophy of putamina and caudate in one patient. Mutations in TUBB4A should be suspected in all cases of diffuse hypomyelination even in the absence of putaminal or caudate atrophy.

KEYWORDS: Cerebellar, Hypomyelination, Neurogenetics

Autism and Sensory Processing Disorders: Shared White Matter Disruption in Sensory Pathways but Divergent Connectivity in Social-Emotional Pathways

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Purpose
Over 90% of children with Autism Spectrum Disorders (ASD) demonstrate atypical sensory behaviors. In fact, hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment is included in the DSM-5 diagnostic criteria for ASD. There is, however, a group of children with isolated sensory processing disorders (SPD) who do not show primary language or social deficits, but do show atypical sensory reactivity and/or sensory interests to the same, or greater, extent as children who meet an ASD diagnosis. The comparison of children with SPD and ASD will help to define the neural underpinnings of each of these conditions. It has been demonstrated previously that these children with Sensory Processing Disorders (SPD) have impaired white matter microstructure, primarily in posterior cerebral tracts involved in unimodal sensory processing as well as multisensory integration (MSI). It was further found that this white matter microstructural pathology correlates with atypical sensory behavior. In this study, we use a diffusion tensor imaging (DTI) fiber tractography approach to compare the structural connectivity of specific white matter tracts in children with ASD and SPD.

Materials and Methods
Diffusion tensor imaging (DTI) was acquired in 16 boys with SPD, 15 boys with ASD, and 23 neurotypical boys, all ages 8-11 years. Probabilistic diffusion fiber tractography was used to define white matter tracts, and strength of tract connectivity was assessed using mean fractional anisotropy. Group differences in connectivity were assessed with two-tailed nonparametric permutation tests, using a two-sample t-statistic, at a significance level of p<0.05.

Results
Both the SPD and ASD cohorts demonstrate decreased connectivity relative to controls in parieto- and temporoo-occipital tracts involved in sensory perception and multisensory integration. However, the ASD group alone shows impaired connectivity in the lingual-orbitofrontal tracts and the fusiform-amygdala and fusiform-hippocampus tracts, which are associated with social emotional processing.

Conclusions
Our results demonstrate both overlapping and divergent white matter pathology affecting SPD and ASD, with temporal tracts traditionally associated with ASD being relatively unaffected in SPD, and with SPD subjects demonstrating more extensive white matter pathology in parieto-
occipital sensory processing tracts. These observations help elucidate the roles of specific neural circuits in neurodevelopmental disorders.

KEYWORDS: Autism Spectrum Disorder, Connectivity, Diffusion MR Imaging
Thiamine transporter–2 deficiency due to SLC19A3 mutations in the differential diagnosis of Leigh syndrome in the pediatric age

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Purpose
SLC19A3 deficiency causes acute/recurrent encephalopathy with symmetric lesions on MR imaging (MRI) and lactic acid accumulation, being initially indistinguishable from mitochondrial encephalopathy, especially Leigh syndrome (LS). We aimed to compare radiological features between patients with SLC19A3 defects and LS, and to establish neuroimaging clues for early diagnosis.

Materials and Methods
Neuroimaging features were compared between four children with SLC19A3 defects and eight children with LS [ATPase 6 (N=4), PDH-E1α (N=3)], unknown genetic defect (N=1).

Results
As compared to LS, SLC19A3 patients had lesions in the striatum (4/4), dorsal-medial thalamic nuclei (4/4) and cerebral cortex (3/4). Thiamine dramatically reversed the phenotype (clinical and radiological) only in SLC19A3 children. The following radiological criteria were established: a) Symmetric lesions affecting the striatum and medial thalami, b) Symmetric lesions in areas of higher metabolic demands of the cerebral cortex (i.e., perirolandic cortex in the neonate), c) Infratentorial involvement: tegmental part of the midbrain, pons, cerebellar white matter or dentate nuclei, d) Resolution of the lesions after thiamine supplementation.

Conclusions
Thiamine transporter-2 deficiency due to SLC19A3 mutations is in the differential diagnosis of Leigh syndrome in children, being clinically indistinguishable at onset. In children with acute encephalopathy, an excellent response to thiamine is highly suggestive of SLC19A3 deficiency. Specific brain lesions affecting the striatum, dorsal-medial thalami and cerebral cortex also are helpful in the differential diagnosis with mitochondrial encephalopathies.

KEYWORDS: Mitochondrial Disease
Cavitary Leukoencephalopathy in infants with Complex 1 Deficiency

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Purpose
To illustrate the pattern of cavitary leukoencephalopathy in infants with nuclear encoded Complex I deficiency. The mitochondrial oxidative phosphorylation system (OXPHOS) uses the electron transport chain complexes I through IV and ATP synthetase (complex V) to generate cellular energy in the form of ATP. Defects of the OXPHOS system are present in ~1 in 3-5,000 live births and affect high energy demand organs, including the brain. Complex I is the largest respiratory chain complex and is the deficiency most frequently involved in human OXPHOS disorders. There are at least 45 core subunits of Complex I; 38 are nuclear gene-encoded (NADH dehydrogenase ubiquinone or 'NDU'). The prefixes 'NDU' is followed by the subunit number, itself a description of the subunit's function or location. For example, FS denotes iron-sulfur protein region, while FV denotes the flavoprotein region. The resultant 'NDU' subunits include NDUFS1, NDUFS4, NDUFS8 and NDUFV1, amongst others. Complex I deficiency may cause a myriad of central nervous system (CNS) imaging manifestations. These include: normal imaging (+/- lactate on MR spectroscopy (MRS); isolated subependymal cysts; atrophy; Leigh or Leigh-like deep gray nuclei and brainstem involvement; and leukoencephalopathy progressing to cavitation. Genotype-phenotype correlation is not exact.

Materials and Methods
Research ethics board approved retrospective review of imaging in leukodystrophies sought infants with Complex 1 mutations and leukoencephalopathies via a word search of radiology texts (ISYS tm). MRI, DWI/DTI, MRS and change over time were assessed.

Results
We identified 13 patients with Complex I deficiency and leukoencephalopathy. Nuclear gene-encoded deficiencies included: NDUFV1 (n = 4), NDUFS4 (n = 1), NDUFS8 (n = 2), NDUFS1 (n = 1). Results of Complex I sequencing were pending or unavailable in four, although three had respiratory chain analysis on muscle tissue/fibroblast culture confirming Complex I deficiency. An additional patient with mutations in BOLA3, which plays a role in biogenesis of the iron-sulfur clusters needed for respiratory chain function had similar imaging appearance. Imaging findings: White matter swelling was present in all. Cavitary white matter changes were present in 10 patients on the initial study with progression in all six patients who had follow-up imaging. Diffuse white matter swelling on presentation with cystic changes on follow-up study was seen in two patients. Corpus callosum, brainstem, and corticospinal tract involvement was universal. Diffusion restriction (93%) and WM lactate (93.7%) were other associated significant findings. Patchy enhancement was present in 61%. Signal change in cerebellar white matter, peduncles and spinal cord were present in approximately half.

Conclusions
The presence of progressive cavitary leukoencephalopathy is a useful imaging feature suggestive of mutations in nuclear encoded Complex I.

KEYWORDS: Leukoencephalopathy, Mitochondrial Disease, MR Imaging Brain
Machine Learning Classification of Neuroimaging Measures in Epilepsy Patients with and without Mesial Temporal Sclerosis

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Purpose
A major goal of neuroimaging research is to develop individualized measures that aid in the diagnosis and treatment of neuropsychiatric disorders. Although converging evidence suggests that temporal lobe epilepsy with mesial temporal sclerosis (MTS) is associated with alterations in cortical morphology and white matter integrity, differences at the individual level is not well established. Machine learning approaches are promising methods that may help overcome this challenge. We sought to 1) characterize alterations in cortical morphology and white matter integrity in a large cohort of epilepsy patients with and without MTS and 2) develop a robust method for automatically classifying patients based on neuroimaging measures.

Materials and Methods
Our sample consisted of high resolution T1 structural scans of 182 adults with epilepsy collected across five different 1.5 T and four different 3 T scanners at UCLA over the past 10 years. Of the 182 patients, 81 had a diagnosis of epilepsy with left or right MTS and 101 were diagnosed with epilepsy without evidence of MTS or other structural abnormalities. In 165 of these patients (70 with MTS), diffusion tensor imaging (DTI) data also were collected. Groups were matched for age, scanner strength and data resolution. Raw T1-weighted anatomical MRI scans were processed with FreeSurfer's recon-all processing pipeline for whole brain segmentation and parcellation. This pipeline generated segmentations of 68 cortical and 45 noncortical regions. Nine metrics per cortical region and three metrics per subcortical region, including volume, thickness and curvature, were used as features for machine learning classification. FSL was used.
to generate average fractional anisotropy values for 48 white matter tracts as additional features. A multiple support vector machine recursive feature elimination algorithm (mSVM-RFE) was used to obtain classification accuracy and a ranked list of features. This process was wrapped in an external layer of 10-fold cross validation. Estimates of generalization error were obtained by averaging the performance of a tuned and trained radial basis function SVM classifier on the respective hold-out samples across these 10 folds.

Results
Despite high variability across different scanners and imaging acquisition parameters, we were able to obtain an overall classification accuracy of 70% (p = 1.6x10-5) for epilepsy patients with left or right MTS compared to epilepsy patients without significant structural abnormalities. Accuracy reached 82% (p = 5.4x10-15) when comparing the ipsilateral MTS hemisphere versus epilepsy patients without significant structural abnormalities. Consistent with the clinical diagnosis of MTS, the most reliable feature was decreased hippocampal volume. Peak classification accuracy was obtained with an average of ~10 features, suggesting that only a few other features contributed to accuracy. Additional features useful for classification included putamen volume, entorhinal cortical thickness, and surface area of the inferior temporal lobe, temporal pole, pars orbitalis, pars triangularis, pars opercularis and frontal pole. Measures of fractional anisotropy did not significantly contribute to classification accuracy.

Conclusions
An automated classification algorithm was able to distinguish epilepsy patients with and without MTS with 82% accuracy. In addition to reductions in hippocampal volume, we found that reduced cortical volume and thickness in inferior frontal and anterior and inferior temporal regions contributed to classification accuracy. These findings provide a novel marker of MTS by implicating extrahippocampal involvement of MTS and thus may allow clinicians to detect more subtle cases of epilepsy with MTS. Larger and more homogenous sample sizes with improved data quality would improve classification accuracy and thus aid in the eventual development of automated neuroimaging-based classification algorithms that should assist in the global neurocognitive evaluation of epilepsy patients and may help predict clinical outcomes.

KEYWORDS: Cortical Thickness, Hippocampus, Temporal Lobe Epilepsy

O-353

10:37AM - 10:44AM

Hippocampal sub-field volumes in patients with temporal lobe epilepsy: a 7T MRI study

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Purpose
To investigate the use of high resolution MR imaging (MRI) at 7 T combined with automated analysis of hippocampal subfield volumes, for the detection of structural abnormalities in patients with suspected mesial temporal lobe epilepsy (mTLE).

Materials and Methods
Seventeen patients with medically intractable epilepsy (10 male, 32±12 years) and seven normal control subjects (4 male, 36±10 years) underwent 7 T MRI using a 32-channel head coil (Philips,
Best, The Netherlands). The protocol included T1-weighted 3D MP-RAGE (0.6 mm isotropic resolution) and a coronal 2D FSE T2-weighted sequence (0.5x0.5x1 mm). Volumetric images were segmented into hippocampal substructures using an automated LDDMM-SBM pipeline, which was validated by comparison to manual segmentation in the control subjects. Final diagnosis was based on invasive EEG, clinical evaluation and (when available) pathology.

Results
Of the 17 patients, 11 had a final diagnosis of mTLE (3 with normal conventional 3 T MRI scans) and six either neocortical or cortical malformation (MCD). Segmentation Dice coefficients were on the order of ~0.8. Figure 1 shows (a) an example of a coronal 7 T T2-weighted image, (b) the results of the automated subfield segmentation in a normal volunteer, and (c) average hippocampal, CA1, dentate gyrus plus CA2/3 (DG), and subiculum (SUB) volumes ((L+R)/2, cm^3 x10^3, **P< 0.001, *P< 0.05 vs. controls). In 3 T+ve cases, volume loss is apparent in all subfields, while in 3T-ve cases, only selective subiculum volume loss was found. In the neocortical/MCD cases, both CA1 and subiculum were reduced significantly, as well as total hippocampal volume.

Conclusions
The high spatial resolution available at 7 T allows accurate automated determination of hippocampal subfield volumes. Subfield volumes are significantly reduced in mTLE, even in cases where conventional 3 T MRI is considered normal.

KEYWORDS: High Field, MR Imaging Brain, Temporal Lobe Epilepsy
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Purpose
Type 2 focal cortical dysplasia (FCD2) is one of the main causes of refractory partial epilepsy, but often remains overlooked by MR imaging (MRI), even with optimized protocol. This study aimed to analyze and characterize sulcal abnormalities near lesions located in the central region and especially to evaluate the contribution of a new sulcal pattern ("pliers sign") in FCD2 detection.

Materials and Methods
Four readers reviewed the 3DT1 MR images of 37 patients (among which 13 had negative MRI) with histologically proven FCD2 of the central region and 19 controls using a three-dimensional, mesh-based reconstruction of cortical folds (BrainVisa-Anatomist). Pliers sign referred to the interposition of a precentral segment inside "pliers" materialized respectively by a small unusual branch ascending anteriorly from central sulcus and the central sulcus itself (cf. figure). Inter- and intra-observer reliability, specificity, sensitivity were calculated. Other central sulcus variations such as interruptions, side branches and connections also were reviewed.

Results
Pliers sign was found in 62% of the patients (70% when MRI was positive and 49% if not) near the lesion, but was never found in controls (Specificity = 100%, Sensitivity = 62%). FCD2 was located precisely in the depth of the abnormal branch in 60% of the patients with pliers. In other cases, FCD2 was located in its immediate vicinity. Inter- and intra-observer rate were excellent (0.87 and 0.92 respectively). Other sulcal variations were more frequent in patients than in controls, such as the number of side branches (p=0.008) and connections with central sulcus (p=0.01).

Conclusions
Sulcal abnormalities and especially "Pliers sign" can provide additional criteria for FCD2 detection and localization, even in patients with negative MRI.

KEYWORDS: Focal Cortical Dysplasia, MR Imaging Brain, Sulcation
Voxel-based Morphometric MRI Post-processing in “Nonlesional” Pharmacoresistant Focal Epilepsies

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Purpose
MR imaging (MRI)-negative (“nonlesional”) pharmacoresistant focal epilepsy (PFE) patients are most challenging for surgical management. Discovering a previously undetected lesion can drastically change the evaluation, treatment plan, and surgical outcome. We present results from applying a voxel-based MRI postprocessing technique, implemented in a morphometric analysis program (MAP), to significantly enhance detection of subtle focal cortical dysplasia (FCD) in a consecutive cohort of MRI-negative surgical candidates.

Materials and Methods
We retrospectively reviewed the consecutive surgical series of the Cleveland Clinic Epilepsy Center from 1999 to 2012. Patients were included if they: (1) had a preoperative 1.5 T or 3 T MRI; (2) were considered MRI-negative prior to surgery; and (3) had > 12 months of postsurgical follow up. Morphometric analysis program was performed on T1-weighted Magnetization Prepared Rapid Acquisition with Gradient Echo (MPRAGE) sequence in Matlab SPM5, consistent with methodology published by Huppertz et al. The gray-white junction z-score map was calculated by comparing the patient with a scanner-specific normal database. Regions with z-score > four were considered indicative of significant gray-white blurring. These areas were presented to a neuroradiologist (SEJ), who was the final judge of whether they present true lesions. The neuroradiologist was blinded to patients’ clinical information. The concordance among MAP+ region and surgical resection was determined on a sublobar level. All patients were analyzed as an overall group and further divided for subgroup analysis, based on a review of the clinical notes from the patient management conference, during which focused re-review of the MRI was performed based on noninvasive evaluation data (EEG, PET, SPECT, magnetoencephalography). Two subgroups were studied: (1) a group in which subtle/questionable abnormalities were noted; (2) another group in which the MRI was still considered negative. Surgical outcome at 12 months was dichotomized into two groups: seizure-free and not seizure-free. Statistical significance was assessed using Fisher's Exact test and Cochran–Armitage test (for trend). Significance was defined as p ≤ 0.05.

Results
A total of 150 MRI-negative patients were identified (mean age = 28.5 years, 45% females, 63% seizure-free). Morphometric analysis program showed an overall 43% positive rate. The overall sensitivity of MAP was 0.9 and specificity was 0.67. With complete resection of the MAP+ region, 90% of patients were seizure-free; 67% of those with partial resection/no resection of the MAP+ region had recurring seizures. In the MAP negative group, 52% were seizure-free. Overall, patients whose MAP+ region was resected completely had the best seizure outcomes, followed by the MAP negative patients, and patients who had partial resection/no resection of the MAP+ region had the worst outcome (p<0.001). The outcome trend was consistent in both subgroups. Additionally, our subgroup analysis revealed that, although complete resection of the visually noted abnormalities indeed correlated with seizure-free outcomes (p=0.014), the significance was concentrated in the patients who were also MAP+ (p=0.01) and not in the MAP- subgroup (p=0.36). False-positive rate in a group of 54 age- and gender-matched normal control was 2%. Surgical pathology of the resected MAP+ abnormalities contained mainly none-balloon-cell FCD. Multiple MAP+ abnormalities were present in 7% of patients.

Conclusions
We present the largest-to-date cohort of MRI-negative epilepsy patients evaluated with MRI postprocessing. Our study reveals the usefulness of MAP in identifying subtle epileptogenic lesions, and in particular cortical dysplasia. A MAP+ region, when concordant with the patient's
electro-clinical presentation, can be targeted surgically, and thus has the potential to improve surgical outcome of "nonlesional" epilepsies.

KEYWORDS: Epilepsy, Focal Cortical Dysplasia, Voxel-Based Morphometry

O-356

10:58AM - 11:05AM

Diffusional Kurtosis Imaging Evaluation of Recent-Onset Medial Temporal Lobe Epilepsy

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Purpose
Medial temporal lobe epilepsy (MTLE) is a common neurological disorder, affecting about one million people in the U.S. alone. Despite its prevalence, however, there is a lack of reliable biomarkers for clinical management of MTLE. Diffusion MRI (dMRI) is a unique and sensitive modality for quantitative assessment of brain microstructure and axonal connectivity, and as such it may serve as a complementary tool for evaluation of network abnormalities in MTLE. Prior dMRI studies have shown microstructure and connectivity alterations in patients with chronic MTLE (1, 2). This study aims to complement previous work by investigating diffusion changes in recent onset MTLE. We hypothesize that microstructure and connectivity abnormalities are present early in the course of the disease.

Materials and Methods
Twelve patients with recent onset MTLE (duration of disease < 2.2 years) and 24 age- and sex-matched healthy control subjects underwent diffusional kurtosis imaging (DKI) scans. Image acquisition was performed on a Siemens 3 T scanner using a twice-refocused echo planar sequence with three diffusion weightings (b = 0, 1000, and 2000 s/mm²) along 30 diffusion encoding directions. Diffusivity and kurtosis parametric maps as well as the kurtosis orientation distribution function (ODF) (3) then were obtained using in-house software (4, 5). Voxel-wise analyses in standard space were employed to compare the parametric maps between patients and controls. Streamline tractography based on the kurtosis ODF was used to quantify the axonal connectivity of the temporal lobe ipsilateral to the side of seizures. The degree of connectivity between each pair of gray matter regions was calculated as the density of streamlines terminating in the two regions.

Results
Figure 1 (a) shows voxel-wise comparisons of mean diffusivity (MD), fractional anisotropy (FA), and mean kurtosis (MK) between patients with recent onset MTLE and controls. Compared to controls, patients showed increased axial, radial, and mean diffusivity in the cingulum ipsilateral to the side of seizures as well as increased axial diffusivity in the ipsilateral thalamus. Patients also showed reduced FA in the ipsilateral uncinate fasciculus, posterior limb of internal capsule, and splenium of corpus callosum. Reduced axial kurtosis was observed in the genu and body of corpus callosum, and in the retrolenticular part of internal capsule. In contrast, MK and, particularly, radial kurtosis were reduced in extensive brain regions. These included the superior corona radiata, fimbria and crus of fornix, and posterior thalamic radiation. Impaired ipsilateral temporal connectivity in patients was observed in the connections between the
Conclusions
Our results indicate that alterations in tissue microstructure and connectivity are present in patients with recent onset MTLE. This observation is consistent with the hypothesis that certain temporal network alterations may precede the abnormalities induced by chronic seizures. Moreover, kurtosis metrics appeared to capture more extensive microstructural abnormalities than diffusivity measures. Ongoing research will determine whether the observed diffusion abnormalities can predict the clinical course of the disease, such as response to anti-epileptic medications, in recent onset patients.

KEYWORDS: Diffusional Kurtosis Imaging, Fiber Tracking, Temporal Lobe Epilepsy
Purpose
Epilepsy surgery is the standard of care for refractory partial onset epilepsy. Prior to surgery, patients undergo extensive evaluation to verify seizure type, focus and etiology as well as prediction of resection risk, and prognosis. Three-dimensional computed tomography (CT) has been vital for the localization of the epileptogenic zone compared to subdural electrodes during invasive EEG monitoring. Despite ubiquitous use of CT localization, it is still difficult to ensure electrode to sulcal/gyral orientation and localization. In addition, CT has limited resolution compared to MR imaging (MRI). Therefore, we propose to use MRI and CT merge and reconstruction for localization of electrodes to the underlying anatomy.

Materials and Methods
High resolution brain MRI and spiral 0.75 mm CT were performed status postplacement of electrodes in 14 patients for presurgical planning. Subsequently, CT and MR images were merged and 3D reconstructions performed for concurrent visualization of electrodes and underlying brain on high resolution MR for surgical planning. Merging allows for 3D localization with cross-hair function. This was performed using TeraRecon an FDA approved software for fully automated registration.

Results
This new postimaging process requires approximately ½ hour of radiological technologist time in an imaging lab opposed to multiple hours of processing time by a post doc. This technique results in improved neurosurgical guidance due to clarity of anatomical structures on MRI compared to CT as well as prior authors methods using Insite ITK tool kit and Amira software (1, 2, 3), which are not FDA approved. This technique allows the formation of interactive images for localization of electrodes and the underlying brain. Of the 14 patients whose seizure foci were localized with this technique, 13 are postsurgery to the extent that Engle Outcome can be assessed. Our outcome for those 13 patients is Engle I for nine (seizure free), Engle of II for nine (>90% reduction), and an Engle of 4 (less than 50% reduction) for one patient. These are good outcomes based upon the literature since our single Engle IV patient is an extratemporal epilepsy case (4, 5, 6). We are continuing to add patients to this data base. Our imaging method is depicted in Figure 1 in a postoperative patient who exhibits a postop SDH. Despite the SDH, there is good localization of electrodes to the underlying brain for surgical guidance. These images can be rotated for interactive evaluation and cross-hair function for localization in three reference planes synchronously.

Conclusions
Multimodality, 3D CT and MR preoperative imaging with merging and reconstruction provides interactive virtual 3D models for better delineation, correlation of electrode placement to morphologic/anatomical brain foci, and surgical guidance for resection of the epileptogenic zone.
with less reconstruction time. Additionally, this technique can be performed by a radiological technologist under physician supervision. Epilepsy is the second most common neurological disorder. Despite over 20 anti-epileptic drugs, refractory epilepsy is common. For presurgical planning, accurate localization of electrodes compared to electrode-identified seizure foci with brain anatomical localization is necessary for optimal resection and epilepsy free results, and our technique improves localization compared to previously reported methods.

KEYWORDS: Brain, Epilepsy, Postprocessing
A Comparison of MRI MPRAGE T1 sequences with Double Inversion Recovery Sequences in Identifying Focal Cortical Dysplasia in Patients with Epilepsy

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Purpose
Seizures remain refractory to medical treatment in 30-40% of the 50 million people worldwide with epilepsy. Surgery provides a definitive option for a subset of patients with intractable seizures. Surgical outcomes generally are higher in patients with a radiologic evident resectable abnormality. Focal cortical dysplasias (FCDs) are a surgically remediable cause of epilepsy. These lesions can be very difficult to detect on MR imaging (MRI), often leading to a "nonlesional" report. IR-prepped heavily T1-weighted gradient echo sequences such as MPRAGE traditionally have been helpful to detect malformations of cortical development. Double inversion recovery (DIR) pulse sequences provide unique tissue contrast in brain MRI by suppressing cerebrospinal fluid (CSF) and white matter. Recent MR technical advances have enabled faster acquisition of high resolution DIR sequences in clinically acceptable times. Few reports have demonstrated the usefulness of DIR in multiple sclerosis, tuberous sclerosis, and neocortical epilepsy. None has evaluated DIR in FCD. The aim of our study was to compare DIR versus MPRAGE sequences in the identification of FCD.

Materials and Methods
We performed a case-control study in patients with radiologically and surgically identified FCD. The cases included 16 patients with FCD (7 pathology confirmed). The control groups were 13 patients with periventricular nodular heterotopias (PVNH) and 20 healthy subjects without neurologic disease. A senior neuroradiologist (RJW) re-reviewed all images and classified subjects as cases (FCD) or controls (PVNH or normal). Focal cortical dysplasia was defined as areas of gray-white blurring, subcortical signal, usually tapering to the ventricle (transmantle sign). As part of the institution's MR protocol for seizure patients, a 3D fast GRE T1-weighted MPRAGE with typical imaging parameters: TR/TE=7.5/3.1 ms, 256x256x200 matrix, FOV 24.0x24.0cm, section thickness 1.0mm, BW=±31.25kHz, 1.0 NEX, TD=2300ms was acquired. Additionally a 3D FSE DIR sequence with typical imaging parameters: TR/TE=5000/12.7 ms, 256x256x180 matrix, FOV 25.0x22.5cm, section thickness 1.0mm, BW=±62.5kHz, ETL=72, 0.5 NEX, TI/T12=2437/456 ms, 2x2 parallel imaging was acquired. All DIR scans were obtained under an IRB-approved protocol and scanned on 3.0 T and 1.5 T MR scanners. A custom software was created to display and review DIR and MPRAGE sequences in sagittal, axial, and coronal planes. Two neuroradiologists blinded to diagnosis and imaging sequence determined whether images were FCD, PVNH or normal. Sensitivity, specificity and likelihood ratios for detecting FCD using MPRAGE and DIR were calculated for each reviewer. Correct FCD identification between MPRAGE and DIR was analyzed using McNemar's test on paired proportions.
Results
Reviewer A correctly identified 81% of FCD cases using DIR versus 19% of FCD cases with MPRAGE (p=0.0016). Reviewer B correctly identified 81% of FCD cases using DIR versus 31% of FCD cases with MPRAGE (p=0.0047). Table 1 summarizes percent of correctly identified diagnosis for each reviewer by MR sequence. The sensitivity for the DIR sequence in the FCD cases was 0.88 for reviewer A and 0.88 for reviewer B. Sensitivity for DIR studies in agreement between reviewer A and reviewer B in FCD cases was 0.81. Sensitivity for the MPRAGE sequence in FCD cases was 0.38 for reviewer A, 0.25 for reviewer B, and 0.18 for the cases in agreement between both reviewers (Table 2).

Conclusions
This blinded study showed greater sensitivity for DIR sequences compared to MPRAGE in the detection of FCD. DIR sequences should be considered in patients with intractable focal epilepsy of unknown etiology. These results have implications for the selection of sequences to be used in imaging protocols for intractable epilepsy.

KEYWORDS: Congenital Brain Malformations, Cortical Dysplasia, Epilepsy

O-359

Differences in the White Matter of Patients with Mesial Temporal Sclerosis Presenting Discordant and Concordant Data: a Magnetization Transfer MRI study

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Purpose
New evidences suggest that patients with mesial temporal sclerosis (MTS) present diffuse brain alterations not restricted to the temporal lobe. In unilateral MTS we can distinguish two type of MTS patients, regarding the concordance of the laterality of the epilepsy seizure detected by EEG and the laterality of the MTS observed in the MR imaging (MRI). When the observed activity in the EEG is restricted to the hemisphere of the MTS observed in MRI, we consider the patient to be concordant. A discordant patient also will present EEG activity in the contralateral hemisphere. Magnetization transfer ratio (MTR) is a quantitative magnetic resonance imaging technique sensitive to myelin and white matter integrity. The aim of this study was to evaluate by MTR whether the white matter is affected in patients with MTS, and whether there is a difference between concordant and discordant patients.

Materials and Methods
A total of 35 patients with unilateral MTS (mean age: 34.8 +/- 10.0) and a sex- and age-matched group of 22 healthy controls (mean age: 32.8 +/- 10.6) were examined by MRI using a 3 T Intera Achieva (Philips, Best, The Netherlands) magnet and an eight-channel head coil. MR imaging exam included acquisition of three-dimensional high resolution T1-weighted images (3D-T1-TFE) and axial images with and without the application of a MT preparation pulse with 1mm3 isotropic resolution. Magnetization transfer ratio maps were constructed subtracting the axial images acquired with the MT prepulse preparation from the corresponding axial images without using this preparation. Furthermore the result of the subtraction was divided by the images without MT prepulse, and the result was multiplied by 100, in order to obtain values of MTR for
each pixel (a MTR map) expressed as a percentage. FSL software was used to segment the white matter from anatomical T1-weighted 3D images and subsequently to coregister the white matter mask to the MTR map. The MTR histogram of the white matter mask was calculated for each subject, and mean +/- SD values, and the 25th, 50th and 75th percentiles were calculated for each subject. Patients were divided in two groups: concordant and discordant, regarding the concordancy of the laterality observed in the MRI and the laterality observed in the EEG. Multiple comparisons were performed for the different MTR histogram parameters between the groups: patients versus controls; and discordant patients versus concordant patients and versus controls. Statistical analysis was performed using SPSS software.

Results
All MR images were examined by two experienced radiologists and 17 patients were classified as right MTS. By comparing the MRI to the EEG results, nine patients presented discordant data. Table 1 summarizes the obtained white matter MTR histogram parameters for three groups: controls, concordant and discordant patients. An ANOVA analysis found significant differences for the mean MTR and 25th percentile of the MTR histogram (p=0.051 and 0.025, respectively), but no differences for the other higher percentiles. For the mean MTR and the 25th percentile the discordant group presented lower values than the other two groups. Concordant patients showed also slightly lower MTR values than controls, but this decrease was not statistically significant. There was no significant differences in age among the three groups.

Conclusions
With MTR it was possible to detect a diffuse alteration of the white matter in patients with epilepsy and MTS, more specifically in patients presenting discordant data regarding laterality between MRI and EEG exams. Discordant patients presented a significantly lower MTR, suggesting an impairment of white matter integrity.

KEYWORDS: Epilepsy, Magnetization Transfer Imaging, MR Imaging Brain

<table>
<thead>
<tr>
<th>Group</th>
<th>Age</th>
<th>Mean MTR</th>
<th>25th percentile</th>
<th>50th percentile</th>
<th>75th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>33±13</td>
<td>53.4 ± 2.6</td>
<td>51.2 ± 2.7</td>
<td>56.0 ± 1.4</td>
<td>59.0 ± 0.7</td>
</tr>
<tr>
<td>Concordants</td>
<td>35±10</td>
<td>52.5 ± 3.1</td>
<td>50.1 ± 3.5</td>
<td>55.7 ± 1.6</td>
<td>59.1 ± 0.7</td>
</tr>
<tr>
<td>Discordants</td>
<td>34±11</td>
<td>50.5 ± 2.9</td>
<td>47.7 ± 3.4</td>
<td>54.7 ± 1.9</td>
<td>58.9 ± 1.1</td>
</tr>
<tr>
<td>ANOVA</td>
<td>0.72</td>
<td>0.051</td>
<td>0.025</td>
<td>0.11</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Table 1: Mean and SD values of the average and percentiles of the MTR histograms obtained from white matter in controls, concordant and discordant patients.

O-360
11:26AM - 11:33AM

Early MRI Characteristics After MRI-guided Laser Assisted Cingulotomy For Intractable Pain Control.

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Purpose
Anterior cingulotomy is a well accepted stereotactic procedure in the treatment of both refractory OCD and debilitating pain syndromes. The procedure to this date has been done using a radiofrequency probe with or without MRI stereotaxis. At our institution, we recently have introduced the use of a 980-nm diode laser to perform this procedure: MR imaging (MRI)-guided Laser assisted cingulotomy (MRgLAC). The MRI characteristics after ablation of the cingulum with this technology have not been described. The purpose of this study is to report the early MRI changes associated with cingulotomy using a 980-nm diode laser.

Materials and Methods
Five bilateral procedures were performed in four patients with intractable pain secondary to metastatic disease under an approved IRB protocol. The patients were imaged at multiple time points within 60 hours of the procedure. We retrospectively analyzed the changes in MRI signal characteristics during that time frame. One patient had a four-month follow-up MRI. Imaging was performed on 1.5 T GE and Phillips MRIs.

Results
At 0-60 hours, a characteristic pattern of zonal architecture consisting of four concentric rings in an "owl eye" shape was noted in the cingulum on T1-weighted and T2-weighted imaging. We observed four areas of injury with distinct signal intensity characteristics created by the ablation. These have been labeled zones 1-4. The central zone (zone 1) represents a laser probe void filled with fluid, with appropriate signal intensity characteristics. Initially, zones 2 and 3 have signal characteristics that represent hemorrhage, which matures differentially into two distinct zones (zone 2 and 3) over our measured time interval. Zone 4 has a peripheral ring of infarction with restricted diffusion-weighted imaging (DWI), and enhances postgadolinium administration. The lesions enlarged over the 60-hour time frame. The patient with the 4-month follow-up MRI demonstrated persistent concentric rings but resolution of the surrounding edema. We believe these areas represent a continuum of injury created by the laser probe and have an almost linear relationship to the transmitted "energy".

Conclusions
MRgLAC is a newly introduced technique to perform bilateral anterior cingulotomies. The perioperative imaging changes seem similar to that described for laser ablation of tumor infiltrated tissue with a 1064-nm laser. This is the first study to characterize early MRI changes after MRgLAC using a 980-nm laser. As minimally invasive laser ablation cingulotomy re-emerges to treat intractable pain in these patients, it becomes important for the neuroradiologist to understand the expected imaging findings.

KEYWORDS: Laser, Pain
FIGURE: The above “owl eyes” appearing lesions are recorded post laser ablation of the cingulate gyri. Four discrete zones are arbitrarily labeled 1 through 4 from central to peripheral.

Zone 1 represents the CSF-filled cavity created post-thermal ablation; Zones 2 and 3 demonstrate varying T1-T2 signal with associated GRE blood products of varying age (T1 not included above). Zone 4 demonstrates restricted diffusion and enhancement, relating to peripheral swelling associated blood-brain barrier break down (T1 post and DWI not shown above). Surrounding edema is better seen on T2 imaging.

(O-361) Identification of Heschl's gyrus on phase difference enhanced imaging
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Purpose

Human primary auditory cortex locates on the superior surface of the temporal lobe in the region known as Heschl's gyrus (HG). A previous study at 7 T evaluated the T2* signal intensity of the HG cortex (1). However, no studies have analyzed the signal intensity of the white matter (WM) in the HG. The phase difference enhanced (PADRE) imaging was developed to enhance the contrast between the target tissue and surrounding tissue by choosing the appropriate phase difference. On PADRE images, the signal-intensity (SI) of a certain WM may reflect its myelin content. Our purpose is to evaluate relative SI of the WM in the HG on PADRE images in comparison with the susceptibility-weighted imaging (SWI)-like images.

Materials and Methods

The subjects comprised four healthy volunteers (8 sides, 2 women, 2 men: mean age 29.0 years: range 28-30 years). Coronal high spatial resolution PADRE images were acquired covering the entire HG and superior temporal gyrus (STG) using a 3 T MR system. By consensus of two observers, the HG and STG were identified based on previously established anatomical methods (2, 3). The SI of WM in the HG on the PADRE images and SWI-like images were divided into three grades in comparison with that of the STG; grade I: isointense, grade II: slightly hypointense, and grade III: markedly hypointense.

Results

For the SI of WM, the grade II and grade III appearances were found in three (38%) and five (62%) of eight HG (4 subjects) on PADRE images, respectively (Figure). On the other hand, all eight HG were rated as grade I on SWI-like images, suggesting that there was no difference of susceptibility between the HG and STG.

Conclusions

The WM in the HG shows hypointense on PADRE, which probably reflects the higher myelin content. PADRE may be useful for identification of the HG by assessing the SI of the WM.

KEYWORDS: Phase Contrast Imaging
Microarchitecture Of Hippocampus: How Much Can Be Resolved On Clinical 3T MRI?

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Purpose
Alterations of hippocampal volume and signal are the standard MR criteria in localization of temporal lobe epilepsy. In absence of the above, the internal architecture of hippocampus may become critical in seizure lateralization. Although the hippocampal microanatomy is well
understood, there is no literature investigating what extent of the microarchitecture detail is reproducible on clinical high resolution MR imaging (MRI). Hence, there are no consistent and objective criteria for evaluating hippocampal architecture on clinical MRI. This study attempts to assess the extent to which the microanatomy of hippocampus can be resolved on high resolution techniques at 3 T and thereby, establish clinical MR criteria of hippocampal architecture.

Materials and Methods
Ninety-five consecutive technically optimal 3 T MRI (Skyra, Siemens) scans of patients with seizures were viewed independently by two neuroradiologists experienced in epilepsy imaging. Hippocampal architecture was evaluated on high resolution coronal 3D SPACE True Inversion Recovery T1- and TSE T2-weighted sequences. A total of 154 hippocampi remote or contralateral to seizure onset, and appearing normal in volume and signal were included in the study. These hippocampi were scrutinized for morphologic details previously published in cadaveric ultra high field MR and histologic studies of hippocampal architecture.

Results
The following features of hippocampal microarchitecture were agreed upon by both observers in greater than 95% hippocampi: 1. Cornu ammonis (CA1-CA3): a. A dark outer stripe representing the strata oriens and pyramidale, tapering from CA1 to CA3, b. An inner bright stripe comprising of strata radiatum and lacunosum-moleculare, becoming thicker from CA1 to CA3. 2. Endfolium (CA4 and dentate gyrus): a. Dentate gyrus: an outer bright molecular layer, and inner dark band comprising of granular and polymorphic layers, b. CA4: seen as an intermediate signal zone enveloped by the dentate gyrus. In the hippocampal head digitations, the bright stripes of inner cornu ammonis and outer dentate merge into a single band; while in the body, these are separated by the hippocampal fissure.

Conclusions
Clinical high resolution 3T MRI can reliably replicate the above details of hippocampal microarchitecture previously described on cadaveric MR and histological studies. These can be used as objective criteria to evaluate and describe hippocampal architecture both in practice and clinical research.

KEYWORDS: Epilepsy, Hippocampus, MR Imaging Brain

O-363
11:47AM - 11:54AM

Pre-operative Imaging and Clinical Predictors of Post-operative Seizure, Development, and Motor Outcomes in Hemispherectomy Patients.

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Purpose
Hemispherectomy and modified hemispherotomy are surgical procedures that are indicated for intractable seizures of various congenital and acquired etiologies. These procedures can be highly effective methods of long term seizure control and allow consequent discontinuation of antiepileptic drugs in selected candidates. The use of hemispherectomy and comparable epilepsy surgery is becoming more widespread and patient outcomes continue to improve. For this reason,
further evaluation of this patient population is warranted. The purpose of this study is to correlate pre-operative imaging and clinical findings in hemispherectomy patients with postoperative seizure, development, and cognitive outcomes.

Materials and Methods
After obtaining IRB approval, a retrospective review of the University of California Los Angeles Neuroradiology PACS system was performed to identify 44 patients that underwent hemispherectomy from 2006-2013. After reviewing the available images and medical records of these patients, pre-operative imaging and clinical findings were documented. These included the regions of brain involved, presence of signal and morphologic abnormalities in the affected and contralateral hemispheres, age at seizure onset, age at time of surgery, gender, seizure type, congenital versus acquired etiology, pre-operative development quotient, and severity of any pre-operative motor or language deficits. Postoperative seizure, motor, language, and development quotient outcomes also were documented. Spearman's correlation coefficients with P values were calculated for every possible pairing of pre-operative and postoperative variables.

Results
Preliminary results show a positive correlation between the following variables: temporal lobectomy and seizure outcome, age at seizure onset and postoperative language outcome, pre-operative language development and postoperative language development, pre-operative cognitive development and postoperative cognitive development. Preliminary results also show a negative correlation between the following variables: number of lobes involved and postoperative seizure outcome, left hemispherectomy and postoperative language development, contralateral anomalies and postoperative seizure outcomes, hemimegalencephaly patients and postoperative seizure, development, and cognitive outcomes, age at time of surgery and postoperative seizure and motor outcomes.

Conclusions
Hemispherectomy and modified hemispherotomy are highly effective methods of long term seizure control. Better postoperative outcomes are seen in patients with younger age at seizure onset, younger age at time of surgery, temporal lobectomy, higher pre-operative language and cognitive development, fewer lobes involved, fewer contralateral brain anomalies, and acquired seizure etiology versus hemimegalencephaly.

KEYWORDS: Epilepsy, Hemimegalencephaly

O-364

MR Imaging in Pediatric Non-convulsive Status Epilepticus

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Purpose
Nonconvulsive status epilepticus (NCSE) is defined as prolonged seizure activity identified by electroencephalogram (EEG) with no obvious clinical symptoms other than encephalopathy (1). A high prevalence of NCSE has been reported in encephalopathic children in the ICU (1, 3, 5). Diagnosis of NCSE is made with continuous EEG (cEEG) monitoring which changes the management of these patients and affects prognosis. Acute imaging findings in convulsive status
epilepticus have been well described (2), however recent studies have suggested that MR imaging (MRI) may be abnormal in NCSE patients as well (4). We hypothesized that certain MR imaging features are prevalent in children with NCSE concordant to hemispheric lateralization of seizure onset that may suggest the diagnosis, leading to more rapid identification of this patient subset.

Materials and Methods
Study patients were identified retrospectively from search of the electronic medical record. Criteria for inclusion were an EEG demonstrating NCSE and a brain MRI performed within 14 days of the EEG (peri-ictal MRI). Information was obtained on pertinent clinical, EEG, and MRI variables via retrospective chart review. All peri-ictal MRI exams (including all previous and follow-up MRIs) were blindly assessed for several variables, including acute T2/FLAIR signal [increased signal with associated swelling or lack of volume loss, new from prior exams (when available)], diffusion restriction, and hippocampal volume loss (on the initial or follow-up exams). Hemispheric lateralization and lobar localization of findings was recorded. Electroencephalogram reports were blindly assessed by an experienced epileptologist. When reported findings were unclear regarding lateralization or localization, tracings were assessed and scored independently.

Results
Thirty-three children formed the study group (age range: 3 mos – 20 years). Seventeen children had a past history of epilepsy. Thirteen of thirty-three (39.3%) had a structural etiology identified on imaging, 20/33 (60.6%) had a metabolic, toxic, or infectious etiology. Thirty of thirty-three (90.9%) had abnormal peri-ictal MRI exams. Twenty of thirty-three (60.6%) exhibited diffusion restriction, 22/33 (66.7%) had acute T2/FLAIR signal, 8/33 (24.2%) had hippocampal signal abnormalities, and 10/33 (30.3%) had hippocampal volume loss on follow-up exams. Those with no history of epilepsy were more likely to have acute T2/FLAIR abnormalities on MRI (p = 0.035) and hippocampal volume loss on follow-up MRI (p = 0.05). Younger patients were more likely to show hippocampal volume loss on follow-up MRI (p = 0.039). Significant hemispheric concordance of MRI and EEG abnormalities was noted (p = 0.016).

Conclusions
MR imaging abnormalities are common in children with NCSE and may represent an important clue in the evaluation of encephalopathic children. Younger children with NCSE and those with no history of epilepsy were more likely to develop hippocampal atrophy on follow-up exams. MR imaging and EEG abnormality locations were correlated by hemisphere, a relationship that should be further evaluated by future studies.

KEYWORDS: Status Epilepticus

O-365

Brain FDG PET versus brain MRI in epilepsy patients: Diagnostic accuracy and correlation to post-surgical outcome.

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Purpose
A significant number of epilepsy patients do not respond fully to medical treatment, and become eligible for surgical treatment. In this group of patients, lesion localization is critical for pre-operative planning. The purpose of this study is to assess the MR imaging (MRI) and fluorodeoxyglucose positron emission tomography (FDG PET) findings in patients with epilepsy, in order to compare the sensitivity and specificity of each modality for lesion detection as well as the impact on the postsurgical outcome.

Materials and Methods
This is a descriptive retrospective analysis of cases diagnosed with epilepsy who underwent MRI and FDG PET of the brain no more than six months apart in the past five years at our institution, including a total of 106 patients. After the IRB approval, data concerning the epidemiologic distribution of the patients, the imaging findings on both modalities, the EEG results, and the surgical outcome were reviewed. The patients were divided into three subgroups: Patients having mesial temporal sclerosis (MTS) (pathologically proven or on MRI if surgery was not performed), lesional epilepsy, defined as parenchymal lesion other than MTS responsible for the epilepsy (pathologically proven or on MRI if surgery was not performed), and patients with negative MRI (this subgroup includes patients who had a negative MRI with no pathology available). Data were analyzed to compare both imaging modalities in terms of localization and impact on the surgical outcome. The EEG was considered the gold standard for seizure localization.

Results
Of 106 patients included, mean age ± SD was 33.97 years ± 16.71, and gender distribution was 54 females and 52 males. Thirty-nine patients underwent epilepsy surgery, of which 29 (74.4%) were seizure free or had a worthwhile improvement. Thirty-seven patients were diagnosed with MTS: PET and MRI were both positive and concordant in 91.9% of cases (34 patients), PET was positive with a negative MRI in 5.4% of cases (2 patients), and PET was negative with a positive MRI in 2.7% of cases (1 patient). Sensitivity was 94.6% for MRI and 97.3% for PET. Twenty-seven patients were diagnosed with lesional epilepsy, these patients were classified into two subgroups. The first included patients with MCD (16 patients), in this subgroup PET and MRI were both positive and concordant in 50% of cases (8 patients), PET was positive with a negative MRI in 31.2% of cases (5 patients), and PET was negative or nonconcordant with the EEG with a positive MRI in 18.8% of cases (3 patients). These data show that MRI has a sensitivity of 68.8%, and the PET has a sensitivity of 81.2%. The second subgroup included patients with lesional epilepsy other than MCD (11 patients), with the following diagnoses: encephalomalacia (5 patients), tumors (3 patients), tuberous sclerosis (2 patients) and cavernoma (1 patient). In this subgroup PET and MRI were both positive and concordant in 81.8% of cases (9 patients), and MRI showed the pathology with a negative PET in 18.2% of cases (2 patients). Thus, the sensitivity of MRI in this subgroup is 100% and 81.8% for PET. Finally, the negative MRI subgroup included forty-two patients. Positron emission tomography was positive in 66.7% (28 patients) and correlated with EEG in 85.7% of cases (24 patients) while it did not correlate with EEG in 14.3% (4 patients). Positron emission tomography was negative in the remainder 33.3% of cases (14 patients).

Conclusions
In patients with MTS, both FDG PET and MRI have very high and comparable sensitivity. In patients with MCD, PET is superior to MRI with a sensitivity of 81.8%, probably because the included MCDs were located mostly in the mesial temporal lobes corresponding to types I and
IIA in the 2011 ILAE classification, which have lower MRI detectability compared to IIB (with balloon cells). Regarding lesional epilepsy not related to MCD, we would like to point out the selection bias of our sample, since most of the patients diagnosed with an epileptogenic abnormality on MRI such as tumor or vascular malformation do not undergo FDG PET. Notwithstanding, our study still showed the expected higher sensitivity of MRI, approaching 100%. FDG PET shows high sensitivity in the negative MRI subgroup, and it correlated with the EEG in 85.7% of cases. However, only one patient in this subgroup underwent surgery with a good outcome, therefore, PET results did not have a high impact on the patients' care since no surgeries were done in the vast majority of MRI negative patients.

KEYWORDS: Epilepsy, MR Imaging Brain, PET

Tuesday
1:00PM - 2:30PM
Palais des congres de Montreal, 517bc

39 - ASHNR PROGRAMMING: HEAD AND NECK STAGING AND TREATMENT ASSESSMENT (SAM)
O-366

Imaging of Lymph Node Metastasis - Practical Approach

Aiken, A.
Emory University School of Medicine
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Abstract/Presentation Summary
Imaging of cervical lymph nodes is one of the greatest challenges for the head and neck radiologist. There is no perfect test, but an understanding of the anatomy and the clinical context is key to providing useful information to clinicians. The three most common clinical scenarios for nodal assessment include: 1) Nodal staging with a known head and neck squamous cell carcinoma (HNSCC) primary 2) SCCA nodes with an occult primary 3) palpable nodes without a pathologic diagnosis. HNSCC comprises the majority of head and neck malignancies. The presence of a single metastatic node decreases the five -year survival by 50%, bilateral lymphadenopathy reduces prognosis by another 50% and the presence of extracapsular spread by another 50%. Therefore, lymph node status one of the most important predictors of the prognosis in HNSCC.(1,2) The first step in assessing the neck for metastatic nodes is knowledge of the anatomic nodal classification defined by the American Joint Committee on Cancer Staging (AJCC) as level I through VII. (See Table below) Level I refers to submental and submandibular nodes, levels II-IV refers to jugular chain nodes, level V refers to posterior cervical space nodes, level VI refers to visceral nodes and finally level VII refers to superior mediastinal nodes. Additional important named nodal groups include parotid nodes, lateral retropharyngeal nodes of rouver, supraclavicular nodes (Virchow). Table 1: Imaging-based nodal classification (3) Level I Submental and submandibular nodes, located above the hyoid bone, below the mylohyoid muscle, and anterior to the back of the SMGs IA Submental nodes lie between the medial margins of the anterior bellies of the digastric muscles. IB Submandibular nodes lie lateral to the
anterior bellies of the digastric and anterior to the back of the SMGs. II Upper internal jugular nodes, lying from the skull base to the bottom of the body of the hyoid bone, posterior to the back of the SMG, and anterior to the back of the SCM. IIA Anterior, medial, lateral, and immediately posterior/ touching the IJV. IIB Posterior to the IJV & separated by a fat plane. III Mid-jugular nodes, located from the bottom of the body of the hyoid bone to the level of the bottom of the cricoid arch and anterior to the back of the SCM. IV Low jugular nodes, located from the bottom of the cricoid arch to the level of the clavicle and lie anterior to the back of the SCM. V Posterior triangle nodes, located posterior to the back of the SCM from the skull base to the level of the clavicles. VA Upper level V nodes from skull base to the bottom of the cricoid arch posterior to the SCM. VB Lower level V nodes from the bottom of the cricoid arch to the level of the clavicles as seen on axial images. VI Visceral nodes, located between the carotid arteries from the level of the bottom of the body of the hyoid bone to the top of the manubrium. VII Superior mediastinal nodes, located between the carotid arteries below the level of the manubrium and above the level of the innominate vein. SPN Supraclavicular nodes are located caudal to the level of the clavicle on axial images and lateral to the carotid arteries on each side of the neck. RPNI Retropharyngeal nodes are located within 2 cm of the skull base and medial to the internal carotid arteries. Most studies that have compared the accuracy of CT and MRI for assessment of lymph nodes in known HNSCC have found no difference. Several recent studies have demonstrated high sensitivity and specificity for PET-CT in the evaluation of nodal metastasis, but reactive or inflammatory nodes may cause false positives and false negatives may occur with largely necrotic nodes. At Emory, we recommend performing a fully diagnostic CECT for attenuation correction for PET and in general most HNSCC patients should undergo PET-CT for staging. Although size criteria for lymph nodes have been established, they are somewhat arbitrary and controversial. A commonly used size criterion is a maximal longitudinal diameter of 15mm for level I and II and 10mm for all other levels except retropharyngeal nodes which should have a maximum diameter of 8mm. (7,8) If minimal diameter is used, then the threshold of 11mm for level II nodes and 10 mm for all other levels have been used. The imaging assessment of cervical lymphadenopathy is complex and includes not only determination of size, but also evaluation of morphology, borders, density and number. Regardless of the size, central low density is indicative of central necrosis and a metastatic node. Other highly suspicious features include rounded morphology with loss of the fatty hilum, clustered nodes (>3 nodes measuring >8mm) and ill-defined margins suggesting extracapsular spread. (9) The most important question to keep in mind when staging the neck is, "how will the presence/ absence of a metastatic node change treatment, surgery or prognosis?" For example, many head and neck surgeons will perform an ipsilateral prophylactic neck dissection for the N0 neck in patients with oral cavity carcinoma because of the high risk of occult cervical metastasis (up to 35%), regardless of the radiographic N stage. So what is the role of imaging in this scenario? The major role would be to detect unexpected nodal metastases in the contralateral neck or in an unusual nodal chain. On the contrary, when treatment is nonsurgical as in many oropharyngeal cancers, radiographic N stage will affect radiation planning. Also, upfront surgical management with TORS (transoral robotic surgery) has gained momentum for select oropharyngeal cancers to avoid the toxic effects of radiation and chemotherapy. However, features such as extracapsular spread (which often means that chemotherapy is added to treatment) may sway the surgeon away from upfront surgery. Unfortunately, recent data has shown that although CT can be specific (97%) for detecting ECS (47%), it is not sensitive. Knowledge of the clinicians' practice at a particular institution will dictate when careful discrimination of nodes is most critical to plan
treatment and when it is not. Ultrasound guided FNA of a suspicious node may be helpful for the clinically N0 neck, if this would affect surgical management. For the remaining two clinical scenarios—SCC node with an occult primary and palpable nodes without a pathologic diagnosis—knowledge of typical imaging patterns and nodal drainage is key. For level II nodes, the diagnosis of exclusion is HNSCC in one of the following sites: oropharynx (90%, lingual and palatine tonsils), nasopharynx or hypopharynx. For an infrahyoid node without any upper neck nodes, systemic metastases (lung, breast and GI) should be considered, particularly with a "Virchow" node. The radiologist should suspect nasopharyngeal carcinoma, lymphoma, thyroid cancer or hypopharyngeal cancer in an adult with an abnormal retropharyngeal node. In a child, reactive retropharyngeal nodes can be seen or suppurative retropharyngeal adenitis. Skin cancers often present with parotid lymphadenopathy. Bilateral non-necrotic bulky lymph nodes involving unusual chains should suggest lymphoma. Papillary thyroid cancer should be suspected with lower jugular chain and paratracheal nodes, especially with cystic change or calcification.

O-367

Imaging of Post-Operative Neck - What Radiologists Should Know

Mukherji, S.
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Ann Arbor, MI

Abstract/Presentation Summary
This presentation will review the various options for treating lymph node metastases in the neck. The presentation will begin with reviewing the normal anatomy of the cervical lymph nodes. We will then review the standard neck dissection and their indications. The section of the talk will end by review the post-operative imaging appearance of each form of lymph node dissection. The next portion of the talk will review the expected and abnormal appearance of the neck following non-surgical organ preservation therapy. The content will focus on how to distinguish between expected changes versus recurrent tumor.

O-368

Inoperable Head and Neck Cancer - What to Look For

Anzai, Y.
Univ. Washington Medical Center
Seattle, WA

Abstract/Presentation Summary
Imaging plays a major role in the initial staging of head and neck aerodigestive tract cancers. In particular, the imaging assessment of the extent of a primary tumor is essential for determining the treatment choice. Despite the wide application of chemoradiotherapy for advanced head and neck cancer, toxicity associated with chemoradiotherapy is difficult for some patients to tolerate. Primary surgery remains a preferred treatment choice for patients with certain head and neck cancers. Head and neck surgeons rely heavily on imaging findings to determine if a neoplasm is
The American Joint Commission on Cancer (AJCC) revised the T staging classifications of head and neck cancers in 2002. One of the major changes of the T staging classification is to divide T4 lesions to T4a (resectable) and T4b (unresectable). In this review, we will discuss pertinent radiological findings that make head and neck cancer unresectable. These findings should be clearly communicated to head and neck surgeons in order to make an impact on patient care and treatment decision. There are three imaging findings that clearly define the lesion unresectable at all anatomical sub sites of the head and neck: 1) Vascular encasement and invasion 2) Prevertebral fascia invasion 3) Mediastinal invasion

1) Vascular encasement – Imaging findings to indicate vascular invasion include a) compression and deformation of the carotid artery, b) partial fat or fascia defect between tumor and artery, and c) involvement of 270° or more of the circumference of the carotid artery. Yousem et al found that single criterion using involvement of 270° or more of the circumference of the carotid artery was accurate in predicting inoperability to strip tumor off from the carotid artery.

2) Prevertebral fascia invasion – Clinically, prevertebral fascia invasion is suspected by fixation of the tumor to the prevertebral musculature. Surgical resection of tumor from the longus colli/capitis muscle complex has been shown to be challenging and does not improve patient's prognosis. Patients with prevertebral fascia invasion are often associated with retropharyngeal nodal metastasis, indicating a dismal prognosis. Loevner et al demonstrated that preservation of a retropharyngeal fat stripe on T1 weighted non-contrast images served as an excellent imaging indicator for absence of tumor invasion. The findings suggestive of the presence of prevertebral invasion include abnormal muscle concavity or T2 signal changes and contrast enhancement in the longus capitis or colli muscle.

3) Mediastinal invasion – It is commonly seen in patients with advanced laryngeal, hypopharyngeal, or thyroid cancer. When the lesion extends below the sternal notch, it requires participation of thoracic surgeons. Imaging findings include obliteration of mediastinal fat and encasement of supra-aortic vessels. The combination of abnormal signal intensity of tracheal cartilage, intraluminal mass and circumferential tracheal encasement more than 180 degree is suggestive of tracheal invasion. Additionally, the followings are generally considered unresectable findings. These include skull base invasion, dural/brain invasion, and perineural spread of tumor.

4) Skull base invasion – skull base invasion is most commonly seen in nasopharyngeal cancer, sinonasal cancer or salivary gland tumors. When skull base bone is grossly involved, the lesion is clearly inoperable. MR is far more sensitive to detect the skull base invasion than CT. Replacement of fatty marrow by tumor infiltration on non-contrast T1 weighted images, associated with contrast enhancement is highly suggestive of tumor invasion. A study based on 943 patients by Chen L, et al, with NPC demonstrates difference in prognosis based on the location of skull base invasion. Patients with invasion to the pterygoid process, base of sphenoid, petrous apex, clivus, and foramen lacerum had better prognosis than those with invasion in the pterygoid canal, great wing of sphenoid bone, pterygopalantine fossa, foramen rotundum, foramen ovale, jugular foramen, and hypoglossal canal.

5) Dural/brain invasion – Intracranial extension, often seen in the sinonasal cancer, is another critical finding to determine surgical resectability. Dural invasion is the first step toward intracranial extension of squamous cell carcinoma. Although linear dural thickening seen on post contrast MR imaging is suggestive of tumor infiltration, often thin dural enhancement can be reactive or inflammatory, as seen in "dural tail" sign for meningioma. Linear dural thickening greater than 5 mm and nodular dural thickening are highly suggestive of actual tumor infiltration. Once pial arachnoid enhancement or actual brain invasion with vasogenic edema is seen, the lesion is considered unresectable. Exception for this rule is esthesioneuroblastoma, where surgical resection is a reasonable option.
and provides good outcomes even with presence of brain invasion. 6) Perineural spread (PNS) – HNC often spread along the neural sheath, a phenomenon well known as perineural tumor spread. Imaging manifestation of PNS has been beautifully described by Ginsberg et al. It is critically important for radiologists to pay attention to subtle findings of PNS as this clearly impacts therapeutic decision. Adenoid cystic cancer is commonly present with PNS, though virtually any HNC may be associated with PNS. Salivary gland tumor, oral cavity cancer, sinonasal cancer are often present with PNS. Enlargement and enhancement of neural foramen with loss of perineural foraminal fat, as well as asymmetric enhancement of cranial nerve is highly suggestive of PNS. Although there are certain structures that are not technically unresectable, these require tremendous functional or cosmetic loss leading to substantial morbidity, thus considered not suitable for surgical treatment. These are considered "functional unresectability". These include orbital apex invasion and brachial plexus invasion. Currently, these cases will be treated with chemoradiation and surgery remains a salvage option. 7) Orbital invasion – Sinonasal cancer is often associated with orbital invasion. Invasion to orbital wall itself does not necessary require orbital exenteration, allowing orbital sparing without compromising overall survival. Periorbital soft tissue invasion (extra-ocular muscles, optic nerve, etc), which often requires orbital exenteration, is not technically inoperable, if a patient accepts the degree of morbidity. Orbital apex invasion as a result of PNS along pterygopalatine fossa and inferior orbital fissure is thus considered inoperable. Orbital fat infiltration and enhancement of extraocular muscles and/or intraconal fat are key findings to make the determination. 8) Brachial plexus invasion – although brachial plexus invasion is not listed under T4b description of AJCC staging classification, once tumor involves the brachial plexus, similar to PNS to cranial nerves, it is generally inoperable. This is often seen in large nodal metastases with extracapsular spread or advanced thyroid cancer. The useful imaging feature is loss of fat surrounding the anterior scalene muscle as well as enhancement of anterior scalene muscle. STIR or heavily T2 weighted images are particularly useful to delineate brachial plexus and tumor margin.

Questions and Answers

Tuesday
1:00PM - 2:30PM
Palais des congres de Montreal, 517d

40 - MINI SYMPOSIUM - TUMOR - PART III
O-369
1:00PM - 1:15PM

Integrative Informatics for Brain tumor Gene Expression: Correlation with Imaging
Gevaert, O.
Stanford
Stanford, CA

Abstract/Presentation Summary
Vast amounts of molecular data characterizing the genome, epi-genome and transcriptome are becoming available for a wide range of cancers. In addition, new computational tools for quantitatively analyzing medical and pathological images are creating new types of phenotypic data. Now we have the opportunity to integrate the data at molecular, cellular and tissue scale to create a more comprehensive view of key biological processes underlying cancer. Our goal is to develop computational methods to realize multi-scale biomedical data fusion. To accomplish this we develop computational methods to derive quantitative image features from MR images that characterize the radiographic phenotype of glioblastoma lesions. Based on these quantitative image features we create radiogenomic maps by associating the radiographic phenotype with various molecular data. These models can have profound contributions towards predicting diagnosis and treatment. Preliminary results show that radiogenomic approaches in glioblastoma have the potential to predict clinical and molecular characteristics of tumors non-invasively.

O-370
1:15PM - 1:21PM

Imaging Genomic Features are predictive of EGFR mutation status in Glioblastoma

R Colen¹, J Wang¹, G Thomas¹, Z Mahmood¹, M ElBanan¹, P Zinn¹
¹MD Anderson Cancer Center, Houston, TX

Purpose
To develop a imaging biomarker signature that predicts the epidermal growth factor receptor (EGFR) mutation status in glioblastoma (GBM). Epidermal growth factor receptor mutations (mostly commonly these are extracellular) occur in GBM and are more sensitive to type 2 EGFR kinase inhibitors; in patients with this mutation, clinical responses to EGFR kinase inhibitor therapy is demonstrated. Thus, a noninvasive imaging surrogate that predicts EGFR mutation status will help stratify patients into therapy and clinical trials.

Materials and Methods
Using The Cancer Genome Atlas (TCGA), we identified 99 treatment naive GBM patients for whom both gene-and miRNA expression profiles including the EGFR mutation status, and pretreatment MR neuroimaging from The Cancer Imaging Archive (TCIA) were available. The 3D Slicer software 3.6 (http://www.slicer.org) was used for image analysis and image review was done in consensus by two neuroradiologists. Fluid attenuated inversion recovery (FLAIR) was used for segmentation of the edema and postcontrast T1-weighted imaging (T1WI) for segmentation of enhancement (defined as tumor) and necrosis. Imaging parameters then were correlated with EGFR mutation status and gene expression profiles. Complex biomarker signatures based on profiling and survival were created.

Results
We created a imaging signature that predicted EGFR mutation status and correlated with patient overall and progression-free survival.
Conclusions
The development of an imaging biomarker signature that predicts EGFR mutation status is of significant clinical significance as it remains a therapeutic target. The ability to noninvasively identify the presence of the EGFR mutation can help stratify patients into clinical trials and can serve as an imaging endpoint.

KEYWORDS: Image Processing, Imaging Biomarker, Imaging Genomics

O-371
1:21PM - 1:27PM

Integrated Imageomic Analysis Identifies Clinically Relevant Imaging Subtypes of Glioblastoma

R Colen¹, A Chaddad¹, P Zinn¹
¹University of Texas MD Anderson Cancer Center, Houston, TX

Purpose
To develop a classification of glioblastoma based solely on imaging that are clinically relevant and meaningful. Verhaak et al (Cancer Cell 2010) published the molecular classification of glioblastoma based on its genomic characterization. We seek to do the same with imaging, which we term imaging-omics (radiomics).

Materials and Methods
We retrospectively identified 80 patients with pretreatment, pre-operative MR imaging (MRI) from the Cancer Genome Atlas (TCGA). Each image (T1 axial image both before and after gadolinium contrast administration, and axial T2/FLAIR image), we performed volumetric analysis using the 3-D Slicer platform to quantitatively measure actual volumes of each individual region. The flair-volume, contrast-enhancing region, and necrotic core were independently segmented and verified by a trained neuroradiologist experienced in tumor volumetry, as previously done in our lab. Feature extraction (contrast, correlation, homogeneity and entropy) of each of the three segmented regions were performed using GLCM.

Results
A total of 628 imaging features were extracted for each of the segmented regions. The top 10 imaging features of each of the segmented regions were calculated and demonstrated to be robust and clinically predictive and relevant.

Conclusions
A novel robust classification based solely on imaging features was developed.

KEYWORDS: Imaging Biomarker, Imaging Genomics

O-372
1:27PM - 1:33PM

Association between genomic analysis of mammalian target of rapamycin (mTOR) and quantitative dynamic susceptibility contrast (DSC)-MR perfusion imaging evaluation and their implication in prediction of survival time in patients with glioblastoma

X Liu¹, S Ekholm¹, R Mangla¹, W Tian¹
Purpose
Glioblastoma is the most common malignant primary brain tumor in adults. Phosphatidylinositol-3 kinases (PI3Ks) constitute a family of intracellular lipid kinases that frequently are hyperactivated in glioblastoma, mammalian target of rapamycin (mTOR), a key mediator of PI3K signaling, which has emerged as a compelling molecular target in glioblastoma patients. The purpose of this study is to evaluate association between the activation status of mTOR and relative blood volume (rCBV) value derived from dynamic susceptibility contrast (DSC) MR perfusion imaging in patients with glioblastoma, and their clinical implication in predicting survival outcome.

Materials and Methods
Thirty-one cases (mean age is 62.06±11.5) with new pathology confirmed glioblastomas were enrolled in this study. Mean and maximal rCBV ratio of the enhancing tumor (rCBVmean and rCBVmax), maximal rCBV ratio of peri-enhancing tumor area (rCBVperitumor) were measured as well as Ki-67, IDH, and mTOR. The correlations between rCBVmean, rCBVmax and rCBVperitumor and mTOR were assessed, the Cox regression was used to evaluate their implication on overall survival time (OS). The difference of age, rCBVmean, rCBVmax, rCBVperitumor and mTOR between the patients who survived less than 14 months and more than 14 months was compared.

Results
The rCBVmean, and rCBVperitumor had significant correlation with mTOR, (p value was 0.04 and 0.037 separately). The rCBVperitumor also showed significant correlation with OS (p <0.001). The Cox regression analysis showed that age and rCBVmax were the two strongest predictors of OS. There were 17 patients who survived less than 14 months after initial diagnosis, and 14 patients survived more than 14 months. There was significant difference of rCBVperitumor between these two groups (p value was 0.003), but combination of rCBVperitumor and mTOR had better predication of survival time (>14 months) than other parameters.

Conclusions
The quantitative rCBV measurement is useful in predicting survival time of patients with glioblastoma. The rCBVmean, and rCBVperitumor correlated with mTOR status in glioblastoma, which suggested that mTOR pathway may moderate increase of neoplastic vasculature within the tumor and vasculature infiltration in the peri-enhancing tumor area. The rCBVmax is an independent imaging biomarker to predict patient overall survival. The combination of rCBVperitumor and mTOR could provide additional predictive information regarding to survival time of 14 months.

KEYWORDS: Genomic Analysis, Glioblastoma, MR Perfusion-Weighted Imaging
Pope, W.
University of California Los Angeles
Los Angeles, CA

O-374
1:45PM - 1:51PM

MR imaging Based Analysis of Glioblastoma multiforme: Estimation of IDH1 Mutation Status

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1Kyushu University, Fukuoka, Japan

Purpose
Glioblastoma multiforme (GBM) is the most common and highly aggressive primary malignant brain tumor. Recently, glioma patients with isocitrate dehydrogenase (IDH) 1 mutations were found to have better clinical outcomes than those without. Therefore, the detection of IDH1 mutation is of great importance for GBM patients. Our purpose was to predict the IDH1 mutation status in GBM using MR imaging.

Materials and Methods
Eighty patients including 65 with IDH1 wild type and 15 with IDH1 mutant in GBM were studied retrospectively. Absolute tumor blood flow (aTBF) and a relative tumor blood flow (rTBF) within the enhancing portion of each tumor were measured using arterial spin labeling (ASL) data. In addition, the percentage of cross-sectional necrosis area inside the enhancing lesions (%necrosis) and the minimum apparent diffusion coefficient (ADCmin) were obtained from contrast-enhanced T1-weighted images and diffusion-weighted imaging (DWI) data, respectively. Each of the four parameters was compared between tumors with IDH1 mutation and those without using Kruskal-Wallis test. The performance in discriminating between the two groups was evaluated using the receiver operating characteristics analysis. Area under the curve (AUC) values were compared among the four parameters using a nonparametric method.

Results
The aTBF, rTBF and %necrosis were significantly higher in IDH1 wild type (mean aTBF±SD = 86.5±56.0 mL/100g/min, mean rTBF±SD = 2.43±1.34, mean %necrosis±SD =34.9±21.1 %) than in IDH1 mutant (mean aTBF±SD = 50.3±25.0 mL/100g/min, mean rTBF±SD =1.49±0.64, mean %necrosis±SD = 15.7±17.8 %) (p<0.05, respectively). In contrast, no significant difference was found in the ADCmin value. The AUC for %necrosis, aTBF and rTBF were 0.764, 0.741, and 0.759, respectively. Combined rTBF and %necrosis resulted in higher AUC value (0.818) than that for each parameter alone, although their difference was not statistically significant.

Conclusions
MR imaging is useful to predict IDH1 mutation status.

KEYWORDS: Glioblastoma, MR Imaging Brain

O-375
1:51PM - 1:57PM

Imaging Genomic Biomarker Signature predicts IDH-1 mutation in Glioblastoma Patients
Purpose
The IDH-1 (R132H) mutation is one of the strongest prognostic predictors and a diagnostic hallmark of gliomas that is independent of other known prognostic factors, including age, grade, and O6-methylguanine-DNA methyltransferase (MGMT) methylation status and thus has a major clinical relevance. Given the latter, it will likely be integrated into the new WHO classification for GBM. Currently used methods to determine the IDH-1 mutation status of GBM include immunohistochemical analysis and genotyping of the DNA extracted from the brain tumor specimens. Thus, we seek to identify an imaging signature associated with IDH-1 mutated tumors that can be considered as a noninvasive predictor of the IDH1 status in glioblastoma patients.

Materials and Methods
We identified 99 GBM patients from The Cancer Genome Atlas (TCGA) who had both genetic expression profiles of IDH-1 and mutation status and neuroimaging available at The Cancer Imaging Archive (TCIA). All morphological image analyses and segmentation were done using Slicer 3.6 (slicer.org) and reviewed in consensus by two neuroradiologists. Fluid attenuated inversion recovery (FLAIR) was used for segmentation of the edema and postcontrast T1-weighted imaging (T1WI) for segmentation of enhancement (defined as tumor) and necrosis. The nonenhancing perilesional FLAIR hyperintensity reflected a mixture of edema/tumor infiltration. Multiple quantitative imaging features were identified and combined to create the imaging biomarker signature predictive of IDH-1 mutation status.

Results
We created a complex imaging biomarker signature using quantitative MR imaging features to predict those GBM patients with IDH-1 mutation and furthermore that was predictive of patient survival.

Conclusions
Glioblastoma multiforme tumors with IDH-1 mutation hold a specific imaging biomarker signature that can be used as a predictive and prognostic biomarker and noninvasive surrogate for IDH-1 status detection.

KEYWORDS: Glioblastoma, Imaging Biomarker, Imaging Genomics

O-376

Biomarkers in Brain Tumor Imaging: Definition and Beyond

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Los Angeles, CA

Abstract/Presentation Summary
With recent emphasis on individualized cancer care, biomarkers have taken on a prominent role in cancer medicine. Biomarkers have been defined as "a characteristic that is objectively
measured and evaluated as an indicator of normal biological processes, pathogenic processes, or pharmacologic responses to a therapeutic intervention." There are 2 general categories of biomarkers: 1. Bio-specimen biomarkers (genetic/molecular/biochemical/histological, etc) and 2. Imaging biomarkers. Imaging biomarkers have been specifically defined as "anatomic, physiologic, biochemical or molecular parameters detectable with imaging methods used to establish the presence or severity of disease." In order to obtain bio-specimen biomarkers, biological material, such as tissue or fluid, is taken from a patient. On the other hand, imaging biomarkers have the advantage of being essentially non-invasive. Other appealing characteristics of imaging biomarkers are that they can be repeated and are also spatially resolved. The potential for a particular imaging biomarker to overcome limitations of traditional reference standards such as histological analysis from invasive biopsy are particularly desirable because biopsy is inherently risky, may be inconclusive and are subject to sampling error. Like other biomarkers, imaging biomarker development is a difficult process that proceeds in sequential steps similar to the process for a new drug (i.e. discovery, verification in multiple laboratories, validation and qualification) before it can be put into routine clinical use. Accuracy, reproducibility/repeatability, standardization and quality control are central to these efforts. In brain tumor imaging, advanced MRI methods such as spectroscopy, perfusion and diffusion techniques as well and PET imaging have played a central role to provide quantitative imaging biomarkers for a number of applications including: tumor diagnosis, tumor grading/prognosis, treatment planning, prediction/markers of treatment response and functioning as surrogate endpoints. Techniques such as molecular MRI and radiogenomics methods are emerging techniques which may provide novel biomarkers for brain tumor imaging in the future. However, despite their "added value", the evidence for these biomarkers is largely from small case series performed in single centers and, as such, their role as a complement to conventional anatomic imaging in clinical research and clinical care remains limited. While a prospective, multi-center imaging trial is complex and expensive, evaluation of a validated imaging biomarker in this context is critical to establish it as a part of "standard of care" and directly impact patient management and outcome.

O-377

Feasibility of Perfusion Fraction from Intravoxel Incoherent Motion as a Biomarker in Contrast-Enhanced Tumor: A Pilot Study in Glioblastoma Patients

J Puig1, J Sanchez-Gonzalez2, G Blasco1, J Daunis-i-Estadella3, M Essig4, R Jain5, S Pedraza1
1Girona Biomedical Research Institute (IDIBGI), Hospital Dr Josep Trueta, Girona, Spain, 2Philips Healthcare Ibérica, Madrid, Spain, 3University of Girona, Girona, Spain, 4University of Manitoba, Winnipeg, Manitoba, Canada, 5New York University Langone Medical Center, New York, NY

Purpose
Effective monitoring of antiangiogenic drugs in patients with glioblastoma requires accurate assessment of vascularization. Dynamic susceptibility contrast (DSC) echo-planar MR imaging (MRI) enables noninvasive assessment of tumor angiogenesis by estimating regional cerebral blood flow (CBF) and cerebral blood volume (CBV). Other perfusion techniques based on endogenous tracers, such intravoxel incoherent motion (IVIM) MRI, are potentially useful in
clinical protocols. Considering the vascular floor as a random network of vessels where blood freely flows, IVIM uses a single diffusion-weighted imaging (DWI) acquisition to distinguish pure molecular diffusion from water molecules moving in the capillary network. We compare perfusion fraction (f) measured by IVIM with CBV and CBF on DSC to determine whether f is useful in predicting survival in newly diagnosed glioblastoma.

Materials and Methods
Seventeen patients (14 men; mean age, 64 years) with histologically proven glioblastoma underwent MRI including echo-planar imaging with IVIM-encoding gradients using 13 b-values (0-1000 s/mm2). Diffusion-weighted imaging (DWI) were fitted to an IVIM biexponential model to elaborate diffusion-coefficient (D), pseudodiffusion-coefficient (D*), and perfusion-fraction (f) maps for contrast-enhancing region (CER) and nonenhancing region (NCER). Anatomical images were reviewed using Olea Sphere V.2.0 software (Olea Medical, La Ciotat, France). The measured tissue concentration-versus-time curve was deconvoluted with an arterial input function to generate CBV and CBF maps. Intravoxel incoherent motion imaging was analyzed with a program developed within the research group using Interactive Data Language 6.3 (Research Systems Inc.; Boulder, CO, USA). Statistical analysis included Pearson correlation, linear regression analysis, and intraclass correlation coefficients. Prognostic factors were evaluated by Kaplan-Meier survival and Cox proportional hazards analyses.

Results
We found significant linear correlations between fCER and both CBFCER and CBVCER (R=0.878 and R2=0.77 (P<0.001) and R=0.599, R2=0.36;(P=0.011), respectively) (Figure). The best cutoffs for 7-month survival were fCER > 15.37% and CBFCER > 223.01 ml/min/100g (44% sensitivity, 100% specificity, 100% PPV, and 61.5% NPV; AUC 0.722 and 0.694, respectively). fCER yielded the highest hazard ratio (1.579; 95% CI: 1.028, 2.424; P=0.036).

Conclusions
fCER correlated with CBFCER and CBVCER indexes in newly diagnosed glioblastoma and promises to be useful in predicting survival; IVIM using endogenous tracers can potentially obviate the need for contrast media in clinical imaging. Patients with high fCER may benefit from more aggressive and experimental treatments for newly diagnosed glioblastoma.

KEYWORDS: Diffusion MR Imaging, Glioblastoma, MR Perfusion-Weighted Imaging
Fractional Anisotropy as a Quantitative Imaging Biomarker for Prediction of Tumor Grade in Glioma: A Meta-analysis Research Study.

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¹Columbia University, New York, NY, ²Columbia University Medical Center, New York, NY
Purpose
Diffusion tensor metrics have been investigated as a potential in vivo quantitative neuroimaging biomarker for the characterization of brain tumor subtype and degree of invasion into the surrounding brain tissue. Fractional anisotropy is an indirect, quantitative measure of tissue microstructure. Multiple publications have evaluated the ability of fractional anisotropy (FA) to distinguish low grade from high grade glioma in the identifiable tumor core and the peripheral edematous/infiltrated region. This meta-analysis analyzes the statistical consensus of quantitative values in the published literature.

Materials and Methods
A meta-analysis of all published fractional anisotropy data for World Health Organization (WHO) low grade (I, II) and high grade (III, IV) gliomas was performed. Meta-regression, standardized mean difference, approximate back calculation of axial and radial diffusivity, and receiver operator characteristic curve (ROC) analysis was performed.

Results
The fractional anisotropy of the solid tumor component is larger in high grade gliomas than low grade gliomas (60 studies, 772 patients, p-value = 0.009). The difference in fractional anisotropy, or a combination of axial and radial diffusivity, in the peripheral region of signal abnormality (the region of T2-prolongation) is not statistically significant in the cohort of studies with respect to tumor grade. However, the fractional anisotropy difference between the tumor core and peritumoral region of signal abnormality is significantly smaller in high grade gliomas (27 studies, 335 patients, p-value = 0.001, optimal threshold ΔFA = 0.21) as compared to low grade gliomas.

Conclusions
High grade gliomas have larger fractional anisotropy values compared to low grade gliomas in the tumor core and have a smaller fractional anisotropy difference between the tumor core and peripheral region of signal abnormality. However, fractional anisotropy in the peripheral region of signal abnormality is not statistically significant with respect to tumor grade in the current literature. Considerable heterogeneity in the published literature may be addressed by use of standardization in image acquisition, processing, and analysis techniques as well as genomic histopathological differentiation of tumor subtypes in future studies.

KEYWORDS: DTI, Fractional Anisotropy, Glioma
FA (Edema – Tumor) vs Grade

AUC = 0.8 (0.55 – 0.97)

Tuesday
1:00PM - 2:30PM
Palais des congres de Montreal, 517a

41 - ASPNR PROGRAMMING: PEDIATRIC SPINE
O-379

Advanced Techniques in Spine Imaging
Thurnher, M.
Medical University Of Vienna
Vienna

Abstract/Presentation Summary
Challenging advanced MR imaging techniques have been successfully applied to the brain, and now could be applied on even more challenging part of the central nervous system, namely the spinal cord. Despite all difficulties several diffusion-weighted MR imaging (DWI) methods have been introduced and used for the evaluation of the spinal cord. DWI became a method of choice in detection of spinal cord ischemia. Diffusion tensor imaging (DTI) metrics and fiber tracking (FT) allowing more accurate characterization of intrinsic integrity of tissues including cellular density and architecture have been increasingly used in evaluation of spinal cord neoplasms. Perfusion MR imaging may be helpful in preoperative and postoperative evaluation of the spinal cord in patients with severe degenerative disease and cervical compression myelopathy.

Methodological challenges for MR spectroscopy (MRS) of the spinal cord such as anatomical tissue heterogeneity, small diameter of the spinal cord, pulsatile flow of the CSF and patients motion have been partly effectively solved. In this lecture the clinical impact of advanced MR imaging techniques in evaluation of the spine will be discussed.

O-380
1:30PM - 2:00PM

Developmental Spine

Huisman, T.
The Johns Hopkins University School of Medicine
Baltimore, MD

Abstract/Presentation Summary
The most common spinal dysraphias and malformations that may be encountered at birth or in the neonatal time period will be discussed and correlated with our current understanding of the normal and abnormal development/embryology of the spinal cord and canal. Pathologies to be covered include skin and non-skin covered myelomeningoceles, dorsal dermal sinus malformation, diastematomyelia, caudal regression syndrome, sacrococcygeal teratoma and various frequent pathologies that may involve the filum terminale.

O-381
2:00PM - 2:30PM

Acquired Pediatric Spine Abnormalities

Shroff, M.
The Hospital for Sick Children
Toronto, Ontario

Abstract/Presentation Summary
Imaging is critical in the diagnosis of acquired spinal diseases in children. Conventional
radiographs are often used as an initial screening study with more definitive evaluation with MRI and/or CT scan and sometimes with nuclear medicine studies. In this presentation, we will review imaging features of the following acquired conditions and will discuss features specific to the pediatric age group: 1) Infective and inflammatory conditions, 2) Tumors, 3) Trauma, 4) Discogenic disease, 5) Idiopathic & unusual conditions. The discussion will include spinal and intraspinal abnormalities. Cases that will be discussed for the spine will be inflammatory conditions of the craniovertebral region, CRMO of the spine, eosinophilic granulomas, osteoid osteoma / osteoblastoma, aneurysmal bone cyst, chordomas, trauma specific to children such as atlanto-axial dissociation and non-accidental injury, disc disease associated with posterior lumbar apophyseal ring fracture and unusual discogenic conditions like idiopathic intervertebral disc calcification. Intraspinal inflammatory (MS, transverse myelitis, GBM) and neoplastic conditions will also be briefly discussed. The presentation will be based on personal experience and review of literature. It will follow a case based format and where appropriate relevant differential diagnoses will be discussed.

Tuesday
1:00PM - 2:30PM
Palais des congres de Montreal, 520

42 - SOCIOECONOMIC PROGRAMMING: NEW PAYMENT AND PRACTICE MODELS
O-382

Obamacare's Impact on Radiology Payment

Silva, E.
South Texas Radiology Group
San Antonio, TX

Abstract/Presentation Summary
This presentation will discuss in depth the emergence, implementation and impact of the Patient Protection and Affordable Care Act, aka Obamacare. A perfect political storm allowed this legislation to pass and the long term implications of that political storm will be highlighted. Comments will be made regarding the internal debates which occurred during the crafting of this legislation and how that impacts policy today. Focus will be paid upon the impacts of Obamacare on the Medicare Physician Fee Schedule, including the most common means of physician payment: fee for service. A detailed discussion of the Health Insurance Marketplace roll out will take place with comments provided regarding the future status of insurance networks and Medicaid across the country. Reference to the Massachusetts experience will be included. New payment models will be discussed including the demonstration projects taking place as well as the status of ACOs around the country.

O-383

National Entrepreneurial Radiology Initiatives - Evolution of Corporate Radiology
Abstract/Presentation Summary
This presentation will discuss the emergence and evolution of national entrepreneurial radiology companies. The topic will cover what these companies offer to hospitals, what they deliver, why they may be appealing to hospital administrators, and how radiologists might respond to this non-traditional competitive challenge. Radiologists must understand that this is not "business as usual". Strategies for radiology groups to succeed in a changed environment will be covered.

QUESTIONS: 1) Which of the following statements about national entrepreneurial radiology companies is true: A) Joining them is always voluntary for a radiology practice and its members. B) A common goal of these companies is to "go public" or be acquired by a publicly traded company. C) Radiologists who join these entities usually have a major say in how the company is run. D) The emergence of these companies is a new phenomenon seen only in the past five years.
Chen, J.
San Diego VA / UCSD Med. Center
La Jolla, CA

Abstract/Presentation Summary
Is your practice ready? The Affordable Care Act is expected to increase the number of patients with health insurance. Many of them will need diagnostic imaging studies. All of them will have access to the internet. Are you ready to differentiate your practice to patients who all have access to the internet? Whether or not you are familiar with social media, social media can help with practice building and marketing. The concept of social media, social media mistakes, and selected content ideas will be introduced. The different metrics for effectiveness and return-on-investment compared to traditional marketing will be introduced.

O-386
1:30PM - 2:00PM

Using Social Media: Separating Your Personal Life from Your Professional Life

Patel, J.
Baltimore VA Medical Center
Baltimore, MD

Abstract/Presentation Summary
Social media has established itself as a powerful medium to connect people. Companies like Facebook, LinkedIn, Google, and Twitter have developed widely used communication tools and websites which facilitate networking, messaging, and sharing. "One to one" and "one to many" communication has never been easier. These tools have found applications across all disciplines including medicine. Social media can play a role in both the personal and professional lives of physicians. The session targets physicians who engage in or plan to engage in social media. The discussion will outline specific ethical, legal, and financial conflicts at the intersection of personal and professional social media. These conflicts will be described through representative case examples and analyzed from multiple perspectives. The session will conclude with strategies to minimize these conflicts and effectively integrate one's personal and professional online presence.

O-387
2:00PM - 2:30PM

Disruption Innovation: What Is It and What It Means for You

Chokshi, F.
Emory University School of Medicine
Marietta, GA

Abstract/Presentation Summary
Disruptive Innovation (DI) is all around us and many of us don't even know it. From your smartphone and tablet, to the PACS station you work on, to the diffusion weighted imaging that has revolutionized MR imaging, DI a phenomenon that upsets the status quo and breaks through
the dogmatic thinking and processes afflicting any industries and professions. Find out about the way DI affects both your personal and professional life, especially how it has revolutionized radiology (especially Neuroradiology). Moreover, find out why it's so important to you.

Background: Introduced by Clayton Christensen, Ph.D. (Harvard Business School) in 1997, Disruptive Innovation (DI) refers to a new technology or innovation that is rapidly adopted in an industry or profession, essentially replacing the "older", established status quo. Radiology is a field full of examples of DI, which may go unnoticed or under-appreciated by radiologists, possibly related a lack of exposure to the history behind DI and its implications to our field. From the advent of CT to the amazing power of MRI, and the workflow changing effect of PACS, DI has changed the face of radiology over the last half century.

Tuesday
3:00PM - 4:30PM
Palais des congres de Montreal, 517bc

44 - PARALLEL PAPERS: Head and Neck: Neoplasia
O-388

Osteoradionecrosis after Radiation Therapy for Head and Neck Cancer: Differentiation from Recurrent Disease with CT and PET-CT Imaging

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Purpose
To compare the CT and PET-CT imaging features of osteoradionecrosis (ORN) with those of recurrent disease after treatment of head and neck malignancy.

Materials and Methods
We retrospectively reviewed maxillofacial and neck CT scans performed for suspected ORN or tumor recurrence for the presence of 1) discrete solid mass, 2) cystic mass, 3) interruption of the bony cortex, 4) bony fragmentation, 5) bony trabecular loss, 6) intraosseous gas and 7) bony sclerosis. Trabecular bone loss was further categorized as permeative (<75% loss of trabecula) or lucent (>75% loss). Positron emission tomography (PET)-CT studies performed for suspected ORN or tumor recurrence were evaluated for SUVmean and SUVmax.

Results
Ten maxillofacial CT, 53 neck CT, and 23 PET/CT studies were performed in a total of 63 patients. Osteoradionecrosis was diagnosed by pathology or imaging stability in 46 patients, and tumor recurrence in 17 patients. Bony sclerosis was seen and found to be significantly more prevalent in ORN, and never seen with tumor recurrence (p=0.013). Patients with tumor recurrence were more likely to have a solid (p<0.001) or cystic mass (p=0.025), which was rare in ORN. While patients with tumor recurrence had significantly higher SUVmean and SUVmax, there was significant overlap in SUVmean and SUVmax between the two groups.

Conclusions
There is significant overlap of SUV values in patients with ORN and tumor recurrence. CT imaging findings provide more reliable diagnostic tools, with a solid or cystic mass strongly associated with tumor recurrence and bony sclerosis seen only with ORN.
Discordant Parathyroid 4DCT and Sestamibi Scintigraphy Results for Localization of Parathyroid Adenomas and Hyperplasia: What Factors Contribute to Missed Parathyroid Lesions?

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¹Duke University Medical Center, Durham, NC

Purpose
To determine the prevalence of discordant results for parathyroid four-dimensional (4D) computed tomography (CT) and sestamibi scintigraphy and describe factors leading to missed adenomas for both modalities.

Materials and Methods
This was a retrospective review of 40 patients with primary hyperparathyroidism with pathologically proven parathyroid lesions that underwent both sestamibi scintigraphy with SPECT and 4DCT prior to parathyroidectomy between July 2009 and October 2013. Ultrasound was performed in 14 patients. The original radiology reports were reviewed with knowledge of the surgical results. The parathyroid lesions were categorized into four groups based on the radiology reports: a) both modalities correctly identified the lesion; b) neither modality correctly identified the lesion; c) 4DCT was correct and scintigraphy was incorrect; and d) 4DCT was incorrect and scintigraphy was correct. Interpretation of imaging studies could have been biased by availability of the other study, but this does not significantly favor one modality over the other since 16 patients had both modalities performed on the same day and two patients had 4DCT before scintigraphy. Imaging studies of missed lesions were reviewed by three radiologists (fellowship-trained in neuroradiology and nuclear medicine) for whether the lesion was seen in retrospect and potential factors limiting the original interpretation.

Results
There were 51 lesions in 40 patients with six cases of multiglandular disease. The sensitivities of 4DCT and scintigraphy were 85% (29/34) and 50% (17/34), respectively, for single adenomas; and 53% (9/17) and 24% (4/17), respectively, for multiglandular disease. Overall sensitivities for detection of all lesions by 4DCT and scintigraphy were 71% (36/51) and 41% (21/51), respectively. The sensitivity of ultrasound was 21%. The four categories of results and factors contributing to missed lesions are summarized in Table 1. In 20 patients with discordant imaging results, 4DCT was correct in 90% and scintigraphy was correct in 10%. Both modalities missed at least one lesion in 18% of all patients (7/40). Of 13 lesions missed on 4DCT, 10 were not evident on retrospective review. Of 30 missed lesions on scintigraphy, 21 were not evident on retrospective review.

Conclusions
Detection rates of 4DCT and sestamibi scintigraphy are discordant in 39% of lesions, with 4DCT correctly identifying the lesion in the majority of these cases. If the institution has experience in both modalities, 4DCT has higher sensitivity than scintigraphy and could have a role as the first line imaging modality. However, additional imaging with scintigraphy may be helpful in patients...
with heterogeneous/nodular thyroid glands or large body habitus. Multiglandular disease is a challenge for both modalities but 4DCT is more likely than scintigraphy to detect multiple lesions.

KEYWORDS: CT, Parathyroid

Table 1. Radiology report result and factors contributing to missed parathyroid lesions

<table>
<thead>
<tr>
<th>Radiology report results</th>
<th>Number of lesions as % of total lesions (n=51 lesions, 40 patients)</th>
<th>Predominant reason for missed lesions (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct</td>
<td>Correct</td>
<td>4DCT</td>
</tr>
<tr>
<td>Correct</td>
<td>39% (n=20, 20 patients)</td>
<td>Multiglandular disease (7)</td>
</tr>
<tr>
<td>Correct</td>
<td>Incorrect</td>
<td>Heterogeneous thyroid (2)</td>
</tr>
<tr>
<td>Correct</td>
<td>Incorrect</td>
<td>Low dose protocol(a) (1)</td>
</tr>
<tr>
<td>Correct</td>
<td>Incorrect</td>
<td>Large body habitus (1)</td>
</tr>
<tr>
<td>Incorrect</td>
<td>Incorrect</td>
<td>Multiglandular disease (7)</td>
</tr>
<tr>
<td>Incorrect</td>
<td>22% (n=11, 7 patients)</td>
<td>Heterogeneous thyroid (2)</td>
</tr>
<tr>
<td>Incorrect</td>
<td>Incorrect</td>
<td>Small lesion adjacent to the thyroid (2)</td>
</tr>
<tr>
<td>Correct</td>
<td>Incorrect</td>
<td>Small lesion adjacent to thyroid (9)</td>
</tr>
<tr>
<td>Correct</td>
<td>35% (n=18, 16 patients)</td>
<td>Heterogeneous thyroid (3)</td>
</tr>
<tr>
<td>Incorrect</td>
<td>Incorrect</td>
<td>Retropharyngeal location (2)</td>
</tr>
<tr>
<td>Incorrect</td>
<td>Incorrect</td>
<td>High parapharyngeal space location (1)</td>
</tr>
<tr>
<td>Incorrect</td>
<td>4% (n=2, 2 patients)</td>
<td>Multiglandular disease (2)</td>
</tr>
<tr>
<td>Correct</td>
<td>Incorrect</td>
<td>Poor isotope uptake (1)</td>
</tr>
<tr>
<td>Incorrect</td>
<td>Correct</td>
<td></td>
</tr>
<tr>
<td>Incorrect</td>
<td>Correct</td>
<td>Heterogeneous thyroid (1)</td>
</tr>
<tr>
<td>Incorrect</td>
<td>Correct</td>
<td>Large body habitus (1)</td>
</tr>
</tbody>
</table>

\(a\) Low dose protocol with tube current modulation and maximum tube current of 500mA. Current protocol has a maximum tube current of 700 mA for the arterial phase.

O-390

Cystic lymph nodes as a predictor of prognosis in HPV-positive oropharyngeal squamous cell carcinoma.

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\(^1\)University of Pittsburgh Medical Center, Pittsburgh, PA
Purpose
Human papillomavirus (HPV) now is recognized to play an important role in oropharyngeal squamous cell carcinoma (OPSCC) pathogenesis. HPV-positive OPSCC is considered a distinct entity with better prognosis than HPV-negative cases. However, some patients with HPV-positive OPSCC have aggressive disease with higher recurrence and metastatic rates. The purpose of this study is to determine whether the presence of cystic lymph nodes on staging CT can act as an imaging bio-marker to predict prognosis in HPV-positive OPSCC.

Materials and Methods
This is an IRB approved HIPAA compliant retrospective study. Two hundred eighty-eight patients with HPV-positive OPSCC were identified from our tumor registry. Subjects were divided into two groups; those with and without recurrent disease. Staging CT was evaluated for patterns of nodal metastases. The presence of solid or cystic lymph nodes, size and cystic change of index LN and overall percent of cystic lymph nodes were calculated. Patients were categorized based on the overall fraction of cystic versus solid lymphadenopathy into one of the three categories: predominantly solid (<20% cystic change), mixed (20-80% cystic change) and predominantly cystic (>80% cystic change). Recurrence rates were tabulated for each group, and Kaplan-Meier curves were plotted for disease-free survival.

Results
Recurrence was identified in 28 of the 288 patients (10%). Patients with predominantly cystic lymph nodes at staging had a recurrence rate of 4% (1/26), while patients with mixed cystic and solid nodes had a rate of 8% (11/141), and patients with solid nodes recurred at a rate of 13% (16/121). Kaplan-Meier curves also reflected these differences in disease-free survival.

Conclusions
In patients with HPV-positive OPSCC, greater cystic change in lymph node metastases on staging CT predicts better prognosis. This imaging biomarker may help to identify patients who would be more appropriate candidates for treatment de-escalation.

KEYWORDS: Head And Neck, Oropharynx

O-391
How Do Radiologists Report Incidental Thyroid Nodules on CT and MRI? High Variability Across Subspecialties

A Grady¹, T Tanpitukpongse¹, K Choudhury¹, J Sosa¹, R Gupta¹, J Hoang¹
¹Duke University Medical Center, Durham, NC

Purpose
There are currently no widely accepted guidelines for reporting incidental thyroid nodules (ITNs) seen on computed tomography (CT) and MR imaging MRI), and lack of guidelines may lead to variable practices. The purpose of this study is to describe the reporting practices of radiologists for ITNs seen on CT and MRI and to determine the factors that influence reporting.

Materials and Methods
This is a retrospective review of 401 patients with ITNs reported on CT and MRI examinations between January and December 2011. Patients were identified by searching CT and MRI reports for the phrase "thyroid nodule". Patients were excluded if they had prior thyroid workup or a
history of thyroid cancer. Data obtained from the reports included characteristics of patients, nodules, and reading radiologists. Radiology report outcomes of interest were whether the ITN was reported in the impression section of the report and whether further workup was recommended. Analyses were performed to identify factors associated with these outcomes.

Results

Three hundred seventy-five patients met the inclusion criteria (Table 1). The reporting styles were as follows: impression with ultrasound recommendation (n=67, 18%), impression with no recommendation (n=71, 19%), body of report only with ultrasound recommendation (n=2, 0.5%), and body only with no recommendation (n=235, 63%). Three hundred fifty-three (94%) patients had ITNs reported on CT, and chest CT accounted for 62% (n=231) of all studies. Mean ITN size was 14.5 mm (range 3-56 mm) in those with reported sizes, but 185 (49%) reports did not provide nodule size. The factors that determined if an ITN was reported in the impression of the report were radiology division and nodule size on multivariate analysis (p<0.03, Table 1). Body division radiologists were least likely to report a nodule in the impression. Large ITNs were more likely to be reported in the impression (73% of nodules ≥20 mm). However, there was variability in reporting ITNs measuring 10-14 mm and 15-19 mm, which were reported in the impression in 61% and 50% of patients, respectively. The factors that determined if an ITN was recommended for ultrasound were radiology division and study indication on multivariate analysis (p<0.05, Table 1). Body division radiologists were least likely to recommend workup. Patients having imaging for another malignancy were least likely to have recommendation for workup.

Conclusions

Reporting styles and recommendations for ITNs seen on CT and MRI are variable. The predominant factor that influences how a nodule is reported is the subspecialty of the radiologist, and not nodule and patient characteristics. Ideally, size should be used to categorize nodules for workup, as is the case for ultrasound guidelines. Development of CT/MRI practice guidelines for reporting ITNs has the potential to standardize ITN reporting by radiologists and thereby improve quality of care.

KEYWORDS: Incidental Findings, Report Style, Thyroid

Table 1. Characteristics of incidental thyroid nodules reported on CT and MRI by reporting styles

<table>
<thead>
<tr>
<th>Study indication, n (%)</th>
<th>Reported in impression</th>
<th>Ultrasound recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All nodules</td>
<td>Nodules</td>
</tr>
<tr>
<td>n (%)</td>
<td>375 (100)</td>
<td>138 (37)</td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>250 (67)</td>
<td>93 (67)</td>
</tr>
<tr>
<td>Mean age, years (SD)</td>
<td>64 (14)</td>
<td>64 (15)</td>
</tr>
<tr>
<td>Malignancy</td>
<td>196 (52)</td>
<td>44 (32)</td>
</tr>
<tr>
<td>Vascular</td>
<td>63 (17)</td>
<td>30 (22)</td>
</tr>
<tr>
<td>Trauma</td>
<td>43 (11)</td>
<td>21 (15)</td>
</tr>
<tr>
<td>Inflammation/infection</td>
<td>24 (6)</td>
<td>15 (11)</td>
</tr>
<tr>
<td>Other</td>
<td>49 (13)</td>
<td>28 (20)</td>
</tr>
</tbody>
</table>
Radiologist experience, n (%)  
<table>
<thead>
<tr>
<th>Experience</th>
<th>n (%</th>
<th>p</th>
<th>n (%</th>
<th>p</th>
<th>n (%</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4 years</td>
<td>144 (38)</td>
<td>0.12</td>
<td>24 (35)</td>
<td>0.028</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>5-9 years</td>
<td>78 (21)</td>
<td></td>
<td>23 (17)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥10 years</td>
<td>153 (41)</td>
<td></td>
<td>65 (47)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Radiology division, n (%)  
<table>
<thead>
<tr>
<th>Division</th>
<th>n (%)</th>
<th>p</th>
<th>n (%)</th>
<th>p</th>
<th>n (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest imaging</td>
<td>92 (25)</td>
<td>&lt;0.0001</td>
<td>29 (42)</td>
<td>&lt;0.0001</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Neuroradiology</td>
<td>103 (27)</td>
<td></td>
<td>25 (36)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body imaging</td>
<td>172 (46)</td>
<td></td>
<td>10 (14)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>8 (2)</td>
<td></td>
<td>6 (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nodule size  
<table>
<thead>
<tr>
<th>Size</th>
<th>Mean size, mm (SD)</th>
<th>p</th>
<th>Mean size, mm (SD)</th>
<th>p</th>
<th>Mean size, mm (SD)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10 mm, n (%)</td>
<td>14.5 (8.8)</td>
<td>16.9 (9.8)</td>
<td>&lt;0.0001</td>
<td>15.4 (7.4)</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>10-14 mm, n (%)</td>
<td>71 (37)</td>
<td>21 (22)</td>
<td>11 (21)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-19 mm, n (%)</td>
<td>51 (27)</td>
<td>31 (32)</td>
<td>19 (37)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥20 mm, n (%)</td>
<td>24 (13)</td>
<td>12 (13)</td>
<td>7 (13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size not reported, n</td>
<td>185</td>
<td>42</td>
<td>17</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

O-392  

PET/CT in Head and Neck Squamous Cell Carcinoma: Should We Include the Head and the Abdomen?

U Yankevich¹, M Hughes¹, T Rath¹, S Fakhir², L Alhilali¹, J Grandis¹, S Kim², B Branstetter¹  
¹University of Pittsburgh Medical Center, Pittsburgh, PA, ²University of Pittsburgh School of Medicine, Pittsburgh, PA

Purpose  
Optimizing the utilization of positron emission tomography (PET)/computed tomography (CT) in patients with head and neck squamous cell carcinoma (HNSCC) is an important area of ongoing research. Although metastases from HNSCC to the head and to the abdomen are rare, these regions are often included in PET/CT protocols. These additional images create a financial burden on the health care system and require more time of the interpreting radiologist. The purpose of our study was to determine the diagnostic and therapeutic yield of the head and abdomen portions of PET/CT scans performed in patients with HNSCC to determine if these areas should be included routinely with PET/CT of the neck and chest.

Materials and Methods  
We evaluated patients with pathologically proven HNSCC who had PET/CT scans for staging, restaging or surveillance of HNSCC from January 2007 to December 2012. Medical records were extracted from a dedicated Head and Neck Oncologic Data Repository. Patients with intracranial and intra-abdominal metastases were identified. All metastatic lesions were confirmed via biopsy or clinical follow up. The fraction of patients with evidence of HNSCC to the head and abdomen was tallied. Medical records then were reviewed to determine whether the abdominal and head findings changed the management of the patients, above and beyond the findings in the neck and chest.
Results
Seven hundred and four patients (1881 PET/CT scans) were included in the study. Eight patients (1.1%) had cranial involvement by cancer: in six patients (0.85%), this was a result of local tumor extension; two patients (0.3%) had distant calvarial metastases. None of the calvarial metastases changed patient management. Fourteen patients (2.0%) had intra-abdominal metastases. In nine patients (1.3%) the intra-abdominal findings changed the patient's management (surgical intervention in two patients, external radiation in one patient, and chemotherapy modification in six patients). In both patients with distant calvarial metastases and in 10 out of 14 patients with intra-abdominal metastases, the cranial and abdominal lesions coexisted with chest metastases and were part of multifocal disease progression. In four patients (0.6%) the intra-abdominal metastases were the only evidence of distant metastases.

Conclusions
Routine extension of PET/CT scans to include the head and abdomen in patients with HNSCC is not indicated. If other signs of metastatic disease are present (radiologic evidence of chest metastases or clinical evidence of spinal or abdominal metastases), then extension to these regions may be warranted. In patients without evidence of systemic metastases, routine PET/CT examinations should include the neck and chest only.

KEYWORDS: Cancer, Head And Neck, PET/CT

O-393 3:35PM - 3:42PM

Localization of Parathyroid Adenomas by Tc99m Sestamibi SPECT-CT, Contrast-enhanced Multi-phase CT (4D-CT) and Combination of SPECT-CT and 4D-CT

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¹The University of Texas M.D. Anderson Cancer Center, Houston, TX, ²Methodist Hospital Research Institution in Houston, Houston, TX

Purpose
This study is designed to compare the abilities of Tc99m Sestamibi (MIBI) SPECT-CT, dynamic contrast-enhanced CT (4DCT) and combination of both modalities to identify parathyroid adenomas.

Materials and Methods
A retrospective study was conducted under an IRB-approved chart review for patients undergoing parathyroid adenoma resection in January 2010-June 2010. Parathyroid SPECT-CT was conducted after the patient received 20 mCi of Tc99m MIBI, 4DCT was conducted within two days from MIBI. All images were display in planar digital displays. Three teams of nuclear physicians and radiologist were assigned to interpret anonymized imaging studies without clinical or pathologic information. The surgical pathology is used as the gold standard. An A-F type location scheme was applied to identify the location of the lesions.

Results
A total of 41 evaluable patients were collected. Histopathology reported 46 lesions with 21 in the left and 25 in the right size. SPECT-CT correctly lateralized 36 lesion and identify 21 correct
surgical types; 4DCT also lateralized 36 lesions but correctly identify 18 lesion types while combination of both correctly lateral 37 lesions and identified 24 lesion types.

Conclusions
The combination of 4DCT and MIBI SPECT CT may have additional diagnostic values for identification of parathyroid adenomas.

KEYWORDS: Parathyroid

O-394

Diffuse metastases to the Thyroid Gland.

N Guha-Thakurta1, (Debnam1
1The University of Texas M.D. Anderson Cancer Center, Houston, TX

Purpose
Metastases to the thyroid gland are rare and account for 2-3% of all malignant tumors of the thyroid. The most common primary malignancy is renal cell carcinoma, but thyroid metastases also have been reported from primary cancers in the gastrointestinal tract, lung, breast, and sarcoma. Metastases can be discovered incidentally or present with clinical complaints such as a new thyroid nodule, enlarged thyroid gland, neck swelling, dysphonia, dysphagia or cough. Rarely they can present in a dramatic fashion with respiratory compromise requiring emergent tracheostomy. While previous reports have stated that thyroid metastases can occur as single or multiple masses, diffuse infiltration of the thyroid gland by metastases has not been described and characterized.

Materials and Methods
The patient demographics, clinical history, and multidetector computed tomography (MDCT) imaging findings of patients who demonstrated diffuse metastases to the thyroid gland from nonthyroid primary cancers were reviewed retrospectively.

Results
Diffuse thyroid metastases were identified in 15 patients (10 men and 5 women), age range 33-71 years (median 58 years). The primary malignancies included prostate (n=1), renal (n=1), melanoma (n=1), breast (n=3), lung (n=4), and head and neck cancer (n=5). The median time of detection of metastatic disease within the thyroid was two years after the initial diagnosis of the primary nonthyroid cancer. The imaging patterns include, diffuse hypodensity, or multiple coalescent nodules. Metastases to the thyroid either remained confined to the gland, or extended beyond the thyroid capsule to encase the adjacent vessels and structures.

Conclusions
Metastases to the thyroid gland should be considered following development of a new, diffuse enlargement of the thyroid gland in the context of a known primary elsewhere in the body irrespective of the remoteness of the history of prior malignancy. Diffuse infiltration of the gland by metastases can mimic primary thyroid cancer, lymphoma or thyroiditis. The diagnosis of metastases to the thyroid gland can be a challenge and a high index of suspicion is warranted especially in cases with an atypical infiltrative appearance.

KEYWORDS: Metastases, Thyroid
Needle in a haystack: Diagnosing metastatic papillary thyroid carcinoma in patients with concurrent cervical nodal involvement by lymphoma.

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1The University of Texas M.D. Anderson Cancer Center, Houston, TX, 2The University of Texas Health Science Center at Houston, Houston, TX

Purpose
Ultrasound (US)-guided fine needle aspiration (FNA) biopsy is performed to document the presence or absence of lateral compartment metastasis to determine the need for neck dissection at the time of thyroidectomy. Pre-operative evaluation, including nodal selection for FNA, in the lateral compartments of the neck for metastatic papillary thyroid carcinoma (PTC) is challenging in patients with concurrent active lymphoma. The purpose of this study was to evaluate the nodal imaging characteristics of concurrent lymphoma and PTC, and to describe differentiating features of adenopathy from each disease.

Materials and Methods
Hospital databases were queried for FNA diagnoses of PTC and lymphoma since 2004, yielding 53 patients with both diagnoses. Selection criteria included biopsy proven cervical lymphomatous involvement and co-existing PTC. Demographic and pathology data were obtained through retrospective chart review. Computed tomography (CT) and US examinations were evaluated retrospectively. Lymph nodes, status-post FNA, were identified on CT and US examinations, and nodal characteristics including morphology, echogenicity, calcification, and cystic change were recorded.

Results
Eleven patients, seven male and four female ranging in age from 38 to 75 years (median = 60 years) were included in the study. Total of 18 lymph nodes were evaluated preoperatively by US-guided FNA biopsy. Fourteen of 18 nodes demonstrated lymphoma and four demonstrated metastatic PTC. The 14 nodes demonstrating lymphoma showed the following characteristics: solid (n=14), cystic change (n=0), hypoechoic to muscle (n=12), isoechoic to muscle (n=2), calcification (n=0). The four nodes demonstrating PTC showed the following characteristics: solid (n=2), partially cystic (n=1), completely cystic (n=1). One of the solid nodes was hypoechoic with calcification, and the other was hyperechoic. The entirely cystic node biopsy initially yielded a nondiagnostic sample, and thyroglobulin washout assay was performed on the cystic fluid contents to confirm metastasis.

Conclusions
Calcification and cystic change of lateral compartment nodes suggest involvement by metastatic PTC in patients with active lymphoma (p=0.0049). These features can be used for nodal FNA selection to ensure that the correct diagnosis is made and the appropriate therapy is instituted. Thyroglobulin washout assay of the aspirate can be used to establish a diagnosis of PTC when the sample is acellular. Nodes with lymphomatous involvement are more likely to be solid and hypoechoic, whereas hyperechogenicity raises the concern for metastatic PTC.

KEYWORDS: Biopsies, Lymphoma, Thyroid
Intra-tympanic contrast enhanced MRI evaluation of Meniere's Disease

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¹University of California San Diego Health System, La Jolla, CA, ²University of California San Francisco, San Francisco, CA, ³University of California San Diego Health System, San Diego, CA

Purpose
Dilute gadolinium-based MR contrast has been used in an off-label manner for the delineation of membranous labyrinthine structures, and studies propose that the extent of endolymphatic hydrops in patients with Meniere's disease can be assessed with this technique. Our aim was to optimize a protocol for 3T MR imaging (MRI) after intratympanic contrast injection for the clinical setting, improving resolution and reducing the time for sequence acquisition.

Materials and Methods
FDA IND #115,342 was obtained for intratympanic injection of 1:7 v/v diluted Gd-DTPA (Magnevist) contrast. With IRB approval, five consenting adults with Meniere's symptoms refractory to medical therapy underwent 3T MR imaging 20-28 hours after intratympanic injection of dilute contrast into their more severely affected ear. Series were acquired with a standard head coil and a three-inch surface coil with sequences including high resolution heavily T2-weighted (FIESTA), T2 FLAIR, and T1 spin echo imaging pre- and postintravenous contrast administration. The area of the endolymphatic space (FLAIR signal void) and the perilymphatic space (contrast enhancement) were segmented manually for comparison. Mean signal intensity of an ROI placed in the basal turn of the cochlea of the injected ear was compared to that in the cochlear basal turn of the noninjected ear, and to that of a vertical segment of AICA for determination of relative signal intensity (rSI) ratios.

Results
In-plane resolution of 0.23 x 0.23 mm was achieved on FIESTA imaging, without resolution of Reissner's membrane. On FIESTA, the signal intensity of the perilymphatic space could not be distinguished from that of the endolymphatic space (Figure A). On FLAIR imaging, contrast was evident in the perilymphatic space of the vestibule, semicircular canals and cochlea of the injected ear in all patients after 20-28 hour delay (Figure B). Signal void corresponding to the endolymphatic space represented 34-50% of the vestibule in three participants and >50% in two participants, corresponding to mild and significant hydrops respectively per the proposed grading scale of Nakashima et al (1). By using the surface coil, in-plane resolution of 0.375 x 0.375 mm was achieved on FLAIR with a scan time of 4 min 12 sec. Contrast was detectable in the labyrinth on T1 images, however less visually conspicuous than on FLAIR sequences.

Comparing the mean signal intensity of the cochlear basal turn in the injected versus noninjected ear yielded rSI ratios of 1.2 – 5.1 (average 2.8 +/-1.6). T1 signal intensity in the injected cochlear basal turn was 0.5 – 0.8 (average 0.6 +/-0.1) that of the vascular enhancement of AICA.

Conclusions
Evaluation of the endolymphatic volume in patients with Meniere's symptoms can be accomplished using high resolution FLAIR with minimal additional time added on to a standard internal auditory canal MR protocol. Contrast within the labyrinth on T1 sequences was not
sufficiently intense that it should obscure an enhancing intralabyrinthine mass such as schwannoma, if present; however correlation for any filling defect on a heavily T2-weighted sequence is recommended. Performing the MR exam 20-28 hours after intratympanic diluted contrast injection allows for optimal contrast penetration of the perilymphatic spaces and facilitates patient scheduling.

KEYWORDS: Meniere, MR Contrast Agents

CT Findings of the EAC in Patients After Middle Ear Surgery

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Purpose
Middle ear surgery performed through the external auditory canal (EAC) often involves drilling of a portion of the bony canal wall. On computed tomography (CT), such postoperative changes can mimic bony changes typically associated with neoplasms or aggressive infections of the EAC. The objective of this study was to evaluate and describe the CT appearance of the EAC after transcanal surgery so that erroneous diagnoses can be avoided.

Materials and Methods
We retrospectively reviewed the CT examinations of 15 patients with a history of transcanal surgery who underwent postoperative multidetector CT (MDCT) or cone beam CT (CBCT) between July 2008 and January 2013. Two experienced neuroradiologists, reviewed the images for findings in the EAC including bony change, wall defects and soft tissue thickening.

Demographic and operative data were subsequently collected.

Results
Time since operative intervention ranged from 10 months to 30 years. All 15 patients had osseous changes along the inferior wall (floor) of the EAC. The bony changes observed included thinning and flattening of the EAC floor resulting in loss of the normal tympanic sulcus (Figure
1). Similar osseous changes were seen in the anterior and superior walls of the EAC in seven out of 15 patients. The inferior wall was the most common site for bony defects (5 out of 15 patients), with the defects ranging in size from 2.0 – 8.1 mm. Soft tissue thickening also was seen most commonly along the floor of the EAC. The posterior wall was the least often involved, with osseous changes in four of 15 patients and a bony defect in a single patient. No patient was found to have a superimposed pathologic process of the EAC. Figure 1, coronal reformatted CT images demonstrate the typical convexity of the EAC floor in a normal right temporal bone (1A), with a well formed tympanic sulcus (arrow); compared to flattening of the EAC floor in the postoperative left ear (1B).

Conclusions
Computed tomography findings in the EAC after transcanal surgery include thinning, irregularity and/or flattening of the bone, soft tissue thickening and bony wall defects. The most common findings include involvement of the inferior wall with loss of the normal tympanic sulcus and flattening of the anterior wall of the EAC, as seen on axial images. Bony defects and soft tissue thickening also can be seen and should not prompt concern for a pathologic process. Knowledge of this normal postoperative appearance is useful to avoid misdiagnosis of external canal disease.

KEYWORDS: CT, Head And Neck, Temporal Bone

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O-398

4:10PM - 4:17PM

Combined Contrast Enhanced CT of the Neck with PET/CT in the Baseline Assessment of Oral Cavity Cancer Post Treatment.

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Purpose
The National Cancer Comprehensive Network (NCCN) guidelines for surveillance imaging in oral cavity cancer recommend imaging of the head and neck within six months of completion of therapy (surgery with or without radiation/chemotherapy). At our institution, there has been a transition towards a combined positron emission tomography (PET) and contrast-enhanced neck computed tomography (CECT) to serve as this baseline assessment. The purpose of this study was to assess the performance of both components alone and together in the assessment of local, regional and metastatic disease. We hypothesize that PET alone may lead to a higher number of false positives for local recurrence due to recognized pitfalls in the post-treatment oral cavity.

Materials and Methods
A database inquiry of all patients who received a PET/CECT between 2009 and 2012 and an ICD 9 code for oral cavity cancer was performed. This identified 348 studies involving 287 patients. Of this group, 37 patients met the following inclusion criteria: 1. Primary squamous cell carcinoma (SCCA) of the oral cavity, 2. First staging study post-treatment was a PET/CECT, 3. At least three months imaging and clinical follow up. The PET/CT portion of the study (without the diagnostic CECT Neck) was reviewed independently and retrospectively by a nuclear medicine physician. The CECT of the neck was reviewed retrospectively by a consensus of two neuroradiologists specializing in head and neck imaging. Finally, the initial reports generated by a consensus read between nuclear medicine and head and neck radiology were reviewed. Both modalities were assessed for local, regional and distant metastasis. Findings were categorized as positive, negative and indeterminate for recurrent or metastatic disease. Clinical and imaging follow up, with biopsy results where available served as the gold standard for imaging performance.

Results
Of the 37 patients, four patients had local recurrence and five patients had regional recurrence on the initial post-treatment scan, one of which with both local and regional disease. Both CECT and PET/CT correctly identified local recurrence in three cases (Sens 75%). PET/CT had a higher number of false positives (3, PPV 50%) for local recurrence than CECT (0, PPV 100%). CECT had a higher number of indeterminate classifications (6) than PET/CT (2). Of the CECT indeterminate findings, PET/CT helped to correctly downgrade to a negative read in five of the six cases, but incorrectly upgrade to a positive read in one case (false positive). However, in four of those cases (66%), the area of imaging concern localized to the mucosal surface, which could be assessed clinically. The remaining two cases had imaging concerns in the deep tissues of the surgical site. For regional disease, CECT correctly identified four of five cases of regional recurrence, while the fifth recurrence had been assigned an indeterminate value. PET/CT correctly identified five of five cases of regional recurrence. For distant metastasis, PET/CT identified four of four patients and CECT neck identified three of four patients (as disease was localized to upper mediastinum) The fourth case of distant disease manifested as pulmonary nodules, included only on the CT portion of the PET/CT.

Conclusions
This initial study suggests that combined PET/CECT may not be cost-effective as a routine screening tool in the baseline post-treatment assessment for all oral cavity cancers. While PET imaging was helpful in downgrading the indeterminate findings on CECT for local disease recurrence, in four of six of those cases, the abnormality was on the mucosal surface and could be assessed clinically. This was countered by a significantly higher false positive rate on PET/CT, with such pitfalls as muscle fasciculations, mucositis, and physiological asymmetry.
contributing to this finding. CECT of the neck may suffice as a baseline study in the post-treatment setting of oral cavity cancer, with PET/CECT reserved for cases where there is a concern for deep recurrence or patients at high risk for regional and distant metastasis. A larger study of cost-effectiveness and patient outcomes would be needed to determine which oral cavity cancers should undergo upfront surveillance with PET/CECT.

KEYWORDS: Contrast-Enhanced CT, Oral Cavity, PET/CT

O-399

Errors in Radiology Reports for Head and Neck Cancer: Types and Frequencies for Cases Stratified by History, Primary Site, Cancer Stage, and Imaging Center

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Purpose
Patients with head and neck cancer often present to academic tertiary referral centers with imaging studies that have been performed and interpreted elsewhere (1). Prior studies show that formal review of these outside imaging studies by an academic neuroradiologist with expertise in head and neck imaging frequently leads to clinically meaningful changes in the cancer stage and treatment plan (2-4). We hypothesize that subspecialty radiologist second opinions may be of greater value in particular subsets of these cases. The purpose of this study was to determine the radiology error rates for groups of cases stratified by history, primary site, cancer stage, and imaging center.

Materials and Methods
Our institutional review board approved the retrospective review of electronic medical records, including original and second opinion radiology reports, for 100 consecutive cases of biopsy proven or clinically suspected head and neck cancer referred to our academic tertiary cancer center. The presence or absence of "misses" and "misinterpretations", with regard to the primary tumor and lymph node metastases, was determined for each original radiology report. A "miss" was defined as the absence of a reported finding in the original report that would correspond to clinically significant pathology when it was identified correctly in the second opinion report. A "misinterpretation" was defined as a finding that was interpreted incorrectly as benign versus malignant or was described insufficiently to allow for local tumor staging in the original radiology report when it was interpreted correctly and sufficiently described in the second opinion report. Correct identifications and interpretations were defined as those corresponding to the recorded TNM cancer staging as had been determined by the multidisciplinary cancer care team as part of routine clinical practice. The 100 cases were stratified by: (1) history (initial staging for known cancer versus imaging investigation for nonspecific symptoms – e.g., "lump in neck"), (2) primary site (oral cavity, oropharynx, larynx, other), (3) cancer stage (high stage versus low stage), and (4) imaging center (urban versus rural). The error rates for the entire cohort and for the stratified groups were calculated, and Fisher's exact test using a threshold for statistical significance of P<.05 was used to reject the null hypothesis that the error rate for each group was the same.
Results
At least one clinically significant error was present in 66.0% of the original radiology reports (95% CI: 56.3-74.6%). There was at least one "miss" in 33.0% of reports (95% CI: 24.5-42.7%) and at least one "misinterpretation" in 41.0% of reports (95% CI: 31.9-50.8%). The primary tumor was missed in 20.0% of cases (95% CI: 13.3-29.0%) and was misinterpreted in another 35.0% of cases (95% CI: 26.4-44.8%). Metastatic lymphadenopathy was missed 19.0% of the time (95% CI: 12.4-27.9%) and was misinterpreted 11.0% of the time (95% CI: 6.1-18.8%). There was a trend toward fewer primary tumors being missed when the scan was done for a known history of cancer than when the scan was done for nonspecific symptoms, but this was not statistically significant (15.9% versus 38.9%; P=0.128). Even when the specific primary site was known, the primary tumor was missed 17.0% of the time (95% CI: 9.0-29.5%). Oral cavity primaries were missed more often than other primaries (40.0% versus 13.3%; P=0.033). There was no significant difference in error rates for high stage (69.1%) versus low stage (52.6%) cancers or for rural (67.5%) versus urban (65.0%) imaging centers.

Conclusions
Clinically significant errors occur in the majority of outside radiology reports for patients presenting to an academic tertiary referral center with a known or suspected head and neck cancer. Risk stratification based on history, primary site, cancer stage, and imaging center location did not reveal a low risk group. Outside imaging for all patients with head and neck cancer should be reviewed by a neuroradiologist with expertise in head and neck imaging as part of a multidisciplinary team.

KEYWORDS: Head And Neck, Quality Improvement, Report Content

O-400

Pediatric Parotid Neoplasms: A 10-Year Retrospective Review of These Rare Tumors

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Purpose
Most adult primary parotid gland neoplasms are benign and are pleomorphic adenomas. We aimed to identify the types and distribution of pediatric parotid gland neoplastic masses, and to determine imaging or presenting clinical features that might suggest malignancy.

Materials and Methods
Institutional review board approval was obtained. Hospital electronic medical records were reviewed for all patients younger than 18 years with pathology proven parotid neoplasms presenting to our tertiary referral center over the 10-year period from 2003 to 2013. Infantile hemangiomas and neurofibromas secondarily involving the parotid gland in patients with known neurofibromatosis type 1 were excluded from evaluation. Imaging features of all lesions were analyzed, and the presenting clinical features were reviewed.

Results
Eighteen patients (10 boys, 8 girls; age range: 2-17 years) were identified with neoplastic parotid masses; 11 were malignant and seven were benign. The malignant tumors consisted of three acinic cell carcinomas, two mucoepidermoid carcinomas, one alveolar rhabdomyosarcoma, one
poorly differentiated carcinoma, one low-grade adenocarcinoma, and three nodal metastases (2 melanoma, 1 orbital medulloepithelioma). The seven benign tumors consisted of six pleomorphic adenomas and one schwannoma. Radiologic imaging was available in 14/18 patients; 13 MR imaging (MRI) and three computed tomography (CT). Imaging features that were highly suggestive of malignancy included: low T2 signal, reduced diffusion, and ill-defined borders. Pleomorphic adenomas had similar characteristics to those in adults in two of four of the patients with available imaging appearing well circumscribed with homogeneously hyperintense T2 signal and heterogeneous enhancement. Two patients, one with acinic cell carcinoma and the other with alveolar rhabdomyosarcoma, had imaging features indistinguishable from this despite their malignant histology. The two patients with confirmed pleomorphic adenoma and nontypical imaging findings had low T2 signal and focal internal hemorrhage in one and multifocal nodular recurrent disease presenting as a mass in the other. A painless enlarging mass was the most common symptom in 10 patients (5 benign, 5 malignant), followed by asymptomatic in four patients (all malignant), and painful enlarging mass in one patient with a pleomorphic adenoma. Conclusions While pediatric primary parotid neoplasms are rare, even at a tertiary referral hospital, there is a greater likelihood that a new parotid mass is malignant. This is in distinction to adult parotid tumors, which are statistically likely to be benign. MR imaging features that should raise concern for malignancy include: ill-defined borders, low T2 signal, and reduced diffusion; however, some malignant tumors in our patient group had imaging appearances identical to classic pleomorphic adenomas. Clinical presenting symptoms did not differ between the benign and malignant tumors. It is thus important when evaluating pediatric parotid masses to have a high degree of suspicion of malignancy, and recommend FNA in order to enable timely correct clinical management.

KEYWORDS: Masses, Parotid Gland, Pediatric Head And Neck

Tuesday
3:00PM - 4:30PM
Palais des congres de Montreal, 517d

45 - MINI SYMPOSIUM TUMOR - PART IV:
O-401

DSC-MRI and the Identification of Tumor Recurrence in the Setting of Pseudoprogression and Pseudoresponse

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Abstract/Presentation Summary
Increased enhancement on post-treatment MRI of high-grade gliomas can represent treatment-related effects, including early-delayed pseudoprogression (PsP) and late-delayed radionecrosis, or true progressive disease (PD). Whereas conventional MRI has proved unreliable for prospectively distinguishing PsP and radionecrosis from PD, DSC-MRI with measures of
Relative cerebral blood volume (rCBV) has shown promise. Although rCBV is generally higher in PD compared with radionecrosis, its ability to distinguish PsP from PD is more controversial, with some studies concluding that specific thresholds are helpful, and others asserting the opposite. Overlapping rCBV measurements in PsP and PD are common, and fractional tumor burden maps of enhancing lesions reveal rCBV patterns consistent with mixtures of PsP and PD, emphasizing the limitations of single-mean rCBV values for discrimination. PsP appears to lie somewhere between radionecrosis and active tumor in a histopathological spectrum, and coexistent viable irradiated tumor and necrosis present wide-ranging vascular morphologies that likely explain overlapping mean rCBV between PsP and PD at initial progressive enhancement. Measures of spatial (histogram analysis, parametric perfusion maps) and temporal (longitudinal trends) rCBV variation are therefore likely to be more useful than mean rCBV for predicting lesion destiny because over time, tumor-to-PsP ratios increase when PD dominates, with correspondingly increased rCBV, and the converse should be true for PsP domination. Pseudoresponse (improved contrast enhancement not necessarily reflecting true anti-tumor effect) is commonly seen with anti-angiogenic drugs interfering with VEGF signaling and reducing blood-brain barrier permeability. Whereas progressive enhancement of recurrent GBM treated with anti-angiogenic therapy correlates significantly with poor overall survival (OS), decreased enhancement does not (responsive and non-progressive/non-responsive enhancement have similar OS). Although progression of non-enhancing disease (FLAIR) may occur following anti-angiogenic therapy, evidence that FLAIR progression correlates with OS is controversial. However, recent data suggest that decreased rCBV shortly after treatment predicts longer PFS and OS in bevacizumab-treated tumors, and that rCBV can prognosticate patients with non-progressive enhancement and select patients with greater likelihood of response to bevacizumab treatment. DSC-MRI parameters, including pulse sequence (GE versus SE, TE, flip angle, field strength), contrast agent (relaxivity, pre-load dose and incubation time, bolus dose and injection rate), and post-processing (leakage correction, integration methodology) can substantially impact quantitative rCBV estimates, as can inter-reader variability in segmentation of tumor and reference brain. Intra- and inter-subject comparisons of rCBV therefore require consistent methodology. Because contrast agent leakage confounds Gd-based rCBV measures, ferumoxytrol-based rCBV measures have been proposed as a better alternative for assessing treatment response. Vessel size index and percent signal recovery are additional computed DSC-MRI parameters that may provide complimentary information about treatment response.

O-402

**Prediction of response to concurrent chemoradiotherapy with temozolomide in glioblastoma: application of immediate post-operative dynamic susceptibility contrast and diffusion-weighted imaging**

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Purpose

Even though the immediate postoperative MR imaging (MRI) can be used to evaluate the presence of residual tumor or operation-related complications in glioblastoma patients, there have been no reports regarding its application for the prediction of response to concurrent...
chemoradiotherapy (CCRT) with temozolomide using dynamic susceptibility contrast (DSC) and diffusion-weighted imaging (DWI). The purpose of this study was to determine whether histogram analysis of apparent diffusion coefficient (ADC) and normalized cerebral blood volume (nCBV) maps of enhancing lesions detected by immediate postoperative MR images could predict the response to CCRT with temozolomide, and to correlate parameters from histogram analysis of ADC and nCBV maps with the progression-free survival (PFS).

Materials and Methods
We enrolled 24 patients with glioblastoma, who showed measurable contrast enhancement on immediate postoperative MRI. In all patients, DSC perfusion imaging and DWI (b = 0, 1000 sec/mm²) were obtained. The corresponding nCBV and ADC maps were calculated for the measurable enhancing lesions. Among them, 11 patients showed progression after 2–6 cycles of adjuvant TMZ (progression group), while complete response or stable status was observed in 13 patients (nonprogression group). The histogram parameters from nCBV and ADC maps between the two groups were compared using an unpaired Student's T-test. Receiver operating characteristics (ROC) analysis was used to find the best cutoff value of each parameter for the prediction of progression after CCRT. One year progression-free survival was determined by using the Kaplan-Meier method with log-rank test.

Results
The 99th percentile of the cumulative nCBV histogram (nCBV C99) on immediate postoperative MR imaging was a significant predictor for true progression after CCRT (P = 0.033). However, we could not find significant differences of mean nCBV, mean ADC, and other histogram values from nCBV and ADC maps between two groups. Receiver operating characteristics analysis showed that the best cutoff value was 5.537 for the prediction of progression after CCRT, and sensitivity and specificity was 72.7% (8 of 11 patients) and 76.9% (10 of 13), respectively.

Conclusions
The nCBV C99 of the cumulative histogram analysis of nCBV from immediate postoperative MRI can be a useful method for the prediction of progression and PFS after CCRT in glioblastoma.

KEYWORDS: DSC MR Imaging, Glioblastoma, Radiation Therapy
Purpose
Dynamic susceptibility contrast (DSC) MR and positron emission tomography (PET) using carbon-11 methionine (MET) are both used in the follow up of patients with brain gliomas for the early detection of tumor recurrence as well as for the distinction between tumor recurrence and post-treatment effects (1-3). The access to MET is restricted in many sites because of the short half-life of carbon-11 methionine, whereas DSC MR imaging and CBV measurements now are performed routinely in most centers with no additional cost during the follow-up imaging of
brain tumors. The purpose of this study is to compare quantitatively the information provided by cerebral blood volume (CBV) based on DSC-MR and by maximum carbon-11 methionine uptake based on PET performed during the follow-up imaging work up of brain gliomas.

Materials and Methods
Thirty-three patients with histologically proven primary brain gliomas were included in the study. In addition to conventional MR sequences, dynamic contrast-enhanced MR and PET study using MET, were acquired on the same day during their follow up. Fifteen patients had low grade gliomas and eighteen patients had high grade gliomas. Patients with low grade gliomas had been treated by surgery only, whereas those with high grade tumors had been treated by surgery and radiation and/or chemotherapy. Maximum CBV as well as maximum MET uptake values were recorded and normalized to normal brain values. The sites of CBV measurements were based on FLAIR/T2 abnormality and/or enhancement on T1-weighted with contrast. Cerebral blood volume values also were measured at the site of maximum PET-MET uptake measurements for a local comparison. Cerebral blood volume ratios and MET-uptake ratios were compared using Spearman rank order correlation test.

Results
Maximum CBV ratios ranged from 0.35 to 5.27 (n= 33, Mean= 2.27, SD=1.46) and maximum MET uptake ratios ranged between 0.79 and 1.50 (n= 33, Mean= 1.02, SD= 0.16). Cerebral blood volume ratios measured at the same region as maximum MET uptake ranged between 0.28 and 6.15 (Mean= 2.11, SD= 1.51). A positive significant correlation was found between maximum MET uptake ratios and maximum CBV ratios (Spearman rank order correlation: \( r = 0.53, p < 0.01 \)) (Figure 1). The correlation was stronger when MET values were correlated to CBV values measured at the site of PET measurement (Spearman rank order correlation: \( r = 0.58, p < 0.001 \)).

Conclusions
During the follow up of treated brain gliomas, we found a relation between metabolic information provided by PET-MET studies and vascularity information provided by DSC MR studies.

KEYWORDS: Cerebral Blood Volume, Glioma, PET
Various imaging techniques have been employed to evaluate blood-brain-barrier leakiness in brain tumors as higher tumor vascular leakiness is known to be associated with higher grade and malignant potential of the tumor, and hence can help provide additional diagnostic and prognostic information. These imaging techniques range from routine post-contrast T1-weighted images that highlight degree of contrast enhancement to absolute measurement of quantitative metrics of vascular leakiness employing pharmacokinetic modeling methods (1-3). Brain tumor patients undergo various combination therapies, which can lead to complex and confusing imaging appearance on follow-up MRI. Therefore, the differentiation of recurrent or progressive tumor from treatment-induced necrosis (4) or effects has always been a challenge in neuro-oncologic imaging. The purpose of this presentation is to discuss the clinical utility of dynamic contrast-enhanced T1-weighted MR imaging (DCE-MRI) to differentiate tumor recurrence from treatment-induced changes.
Complimentary Role of Brain Dynamic Contrast-Enhanced MR Perfusion for Posttreatment Evaluation of Brain Tumors: Use of ‘Stack-of-Stars’ Scheme and k-Space Weighted Image Contrast

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Purpose
In comparison to dynamic susceptibility contrast (DSC), dynamic contrast-enhanced (DCE) is technically a more demanding technique but provides a different prospective of blood-brain barrier and tumor angiogenesis and may be of additional value, where DSC could be affected by susceptibility artifacts. Introduction of imaging tools such as radial k-space sampling 1 and echo-sharing techniques such as k-space weighted image contrast (KWIC) 2 have improved the efficiency of dynamic contrast imaging in terms of coverage, spatial and temporal resolutions. The purpose of this study was to prospectively assess the added value of an improved DCE perfusion technique in evaluation of post-treated brain tumors and compare the result to DSC perfusion and surgical pathology in a subset of patients.

Materials and Methods
In this prospective study, 20 consecutive patients (12 males, age range: 36-72 years old) who were being treated for brain tumors underwent MR imaging (MRI) on a 3.0 T MR scanner (Siemens Skyra) including DCE and DSC perfusion. The DCE perfusion was acquired by a 3D radial VIBE (volumetric interpolated examination) sequence (TR/TE: 3.6/1.7 ms, voxel size 1.4 x 1.4 x 3mm). A total of 328 radial views were acquired in eight rotations (42 views/rotation) with 'stack-of-stars' scheme. Three measurements were obtained each divided to eight subframes by applying KWIC, resulting in whole brain coverage with three minutes acquisition time and a four sec temporal resolution. Subsequently DSC perfusion was performed using a gradient-EPI sequence (TR/TE: 1450/22 ms, voxel size 1.7 x 1.7 x 4 mm³). A total of 0.2 mmol/kg of gadolinium was used to accomplish both DCE and DSC. The DCE image quality was evaluated independently by two neuroradiologists using a 1-4 grading scale in respect to motion and pulsation artifact, brain edge sharpness and vascular conspicuity. Perfusion datasets were processed using a commercially available FDA approved software (Olea Medical, La Ciotat, France). The arterial input function was selected automatically and multiparametric perfusion maps were calculated using an extended toft model for DCE and block-circulant singular value decomposition technique for DSC. The perfusion maps, FLAIR and T1 postcontrast images for each patient were coregistered using the Olea software. K-trans (minutes⁻¹) and rCBV values were calculated from the region of interests for each patient.

Results
All DCE studies were rated with diagnostic image quality (median: 3, range: 3-4) by both observers and with excellent interobserver agreement (k=0.82). In 11 patients the k-trans values and perfusion permeability curve pattern were suggestive of tumor recurrence and concordant with rCBV values >1.5 3-4. In six patients the k-trans values and perfusion permeability curve pattern were suggestive of radiation necrosis and concordant with rCBV < 1. In three patients (15%), DSC maps were nondiagnostic due to blood-product susceptibility artifact within the surgical bed, in whom DCE was able to predict tumor recurrence. In seven patients (35%) the perfusion findings were confirmed subsequently by surgical pathology.
Conclusions
The described DCE perfusion technique is feasible with acceptable result in comparison to DSC perfusion and can provide additional diagnostic value in a subset of patients with brain tumor in whom DSC may be limited by susceptibility artifact related to post-treatment surgical bed. Radial k-space sampling provides several advantages including lower motion sensitivity, benign undersampling behavior and lack of aliasing artifact, while KWIC helps to maintain the temporal resolution.

KEYWORDS: Brain Neoplasms, DCE MR Imaging, Radiation Necrosis

O-406

Differentiation of True Progression and Pseudoprogression by Use of Quantitative Dynamic Contrast-Enhanced MR Imaging in Glioblastoma Treated with Radiation Therapy and Concomitant Temozolomide

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Purpose
To assess the ability of dynamic contrast-enhanced (DCE) MR imaging (MRI) to discriminate true progression from pseudoprogression in glioblastoma treated with concurrent chemoradiotherapy.

Materials and Methods
We conducted a prospective study in 33 patients with histopathologically proven glioblastoma, who had undergone concurrent chemoradiotherapy. Dynamic contrast-enhanced-derived pharmacokinetic parameters including Ktrans, Ve, and Vp were calculated from the newly developed or enlarged enhancing lesions. The pharmacokinetic parameters between true progression (n=17) and pseudoprogression groups (n=16) were compared using unpaired t-tests, which also were compared using multivariable analysis.

Results
The mean Ktrans value was higher in the true progression group than that in the pseudoprogression group (0.44 ± 0.25 and 0.23 ± 0.10 min⁻¹, retrospectively, p = .004). In terms of the cumulative Ktrans histograms, 5th, 10th, and 50th percentile points also were significantly higher in the true progression group than those in the pseudoprogression group (p ≤ .020). We also observed the higher mean Ve value in the true progression group than in the pseudoprogression group (1.26 ± 0.78 and 0.75 ± 0.49, retrospectively, p = .034). With regards to the cumulative Ve histograms, we found the higher 5th and 10th percentile points in the true progression group than those in the pseudoprogression group (p ≤ .015). Multivariable analysis showed that mean Ktrans value was the only independently differentiating variable (p = .004).

Conclusions
The mean Ktrans parameter is the most promising parameter in the differentiation of true progression from pseudoprogression among the useful Ktrans and Ve values of the DCE MR imaging.

KEYWORDS: DCE MR Imaging, Glioblastoma, Radiation Therapy
O-407

RANO Criteria: How it Evolved and Where it Currently Stands

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Abstract/Presentation Summary
Discussion will include: 1. Evolution in the "standard of care" treatment strategies in patients with high-grade gliomas. 2. Understanding the terms tumor progression, pseudoprogression, and pseudoresponse, and the underlying pathophysiology. 3. Evolution of imaging based-response assessment from MacDonald to RECIST to PERCIST to currently accepted RANO criteria to keep up with the change in treatment strategies. 4. Comparison of these various response assessment criteria in high-grade gliomas. 5. Are the currently accepted RANO criteria sufficient? 6. Role played by advanced imaging and the different contrast agents in assessing treatment response. 7. Future directions for monitoring treatment response in high-grade gliomas.

O-408
Differentiation of Pseudoprogression and Real Progression in Glioblastoma using ADC Parametric Response Maps

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Purpose
Pseudoprogression describes the radiologic phenomenon that patients with high grade glioma undergoing their first or second radiation MR imaging (MRI) show increased contrast enhancement that eventually subsides without any change in treatment. Currently it is not possible to differentiate real progression and pseudoprogression using conventional T1- and T2-weighted images. Here we tested if a voxelwise analysis of apparent diffusion coefficient (ADC) values can differentiate between true progression and pseudoprogression using the parametric response map, a new postprocessing procedure.

Materials and Methods
Twenty-nine patients with proven progression and seven patients with pseudoprogression were identified in a retrospective case study. For all patients ADC baseline and follow-up maps were available. The ADC baseline map and the ADC follow-up map were coregistered on the contrast-enhanced T1-weighted follow-up images. Subsequently the enhancement in the follow-up contrast-enhanced [Dotarem (Gadoterate meglumine)] T1-weighted image was delineated manually and a reference region of interest (ROI) was drawn in the contralateral white matter. Both ROIs were transferred to the ADC images. Relative ADC (rADC) (baseline)/reference ROI (baseline) values and ADC (follow up)/reference ROI (follow up) values were calculated for each voxel within the ROI. The corresponding voxels of rADC (follow up) and rADC (baseline) were subtracted and the percentage of all voxels within the ROI that exceeded the threshold of 0.25 was quantified.

Results
Relative ADC voxels showed an increase of 21.9 +/- 26.3% above 0.25 in patients with real progression and in 55.7 +/- 28.3% in patients with pseudoprogression. Receiver operating characteristic (ROC) analysis revealed a very good diagnostic performance (AUC = 0.82).

Conclusions
The introduced parametric response map for rADC maps provides a potential tool for the differentiation between pseudoprogression and real progression. Generally an ADC increase is supposed to be correlated with a decrease of cellularity and hence with therapy response. Therefore our findings of an increased number of voxels with increased ADC values in patients with pseudoprogression are in line with these basic pathophysiologic considerations.

KEYWORDS: Glioblastoma, Pseudoprogression

Tuesday
3:00PM - 4:30PM
Palais des congres de Montreal, 517a

46 - PARALLEL PAPERS: Brain: Functional Imaging II
MEG Graph Theoretic Connectivity Analysis

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Purpose
Interhemispheric connectivity with resting state magnetoencephalographic (MEG) has been elusive, and demonstration of the default mode network (DMN) yet more challenging. Recent seed-based MEG analyses have shown interhemispheric connectivity using power envelope correlations. The purpose of this study is to compare graph theoretic maps of brain connectivity generated using MEG with and without signal leakage correction to evaluate for the presence of interhemispheric connectivity.

Materials and Methods
Eight minutes of resting state eyes-open MEG data were obtained in 22 normal male subjects enrolled in a larger IRB-approved study (ages 16-18 years). Data were processed using an in-house automated MEG processing pipeline including synthetic third-order gradient balancing, DC filtering (60 Hz), automated artifact rejection, baseline correction, high and low-pass filtering at 0.5 and 100 Hz for environmental noise, frequency filtering at 13-30Hz (β band) and projection into standard (MNI) source space at 5 mm resolution using a scalar beamformer. Mean beta band amplitude was sampled at 2.5 second epochs from the 4D source space time series. Leakage correction was performed in the time domain of the source space beam-formed signal prior to amplitude transformation as a 0-phase lag regressor. Graph theoretic voxel-wise source space correlation connectivity analysis was performed (~20K gray matter nodes) for corrected and uncorrected data. Degree maps were thresholded across subjects for the top 20% of connected nodes to identify hubs. Log-log plots of the complementary cumulative degree distribution were generated to determine scale-free behavior. Additional degree maps for visual, motor, and temporal regions were generated to identify interhemispheric connectivity using laterality indices.

Results
Hubs for the uncorrected MEG networks were predominantly symmetric and midline, bearing some resemblance to functional MRI (fMRI) networks. These included the cingulate cortex, bilateral inferior frontal lobes, bilateral hippocampal formations and bilateral cerebellar hemispheres. These uncorrected networks however, demonstrated little to no interhemispheric connectivity using the region of interest (ROI)-based degree maps. Leakage-corrected MEG data identified the DMN, with hubs in the posterior cingulate and biparietal areas. These corrected networks demonstrated symmetric interhemispheric connectivity for the ROI-based degree maps. Degree distributions for corrected and noncorrected MEG networks followed a truncated exponential power law.

Conclusions
Graph theoretic analysis of MEG resting state data without signal leakage correction can demonstrate symmetric networks with some resemblance to fMRI networks. These networks however, are an artifact of high local correlation from signal leakage and lack interhemispheric connectivity. Following signal leakage correction, MEG hubs emerge in the DMN, with strong interhemispheric connectivity.
O-412

Subject Based Registration: Patient-Centered Analysis Of Diffusion Tensor MRI (dtMRI)

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Purpose
Detection of patient specific pathological changes in diffusion MRI requires comparison of individual patients to a control group (1 versus many analysis). The typical approach to this problem entails coregistration of the imaging of the patient and a set of controls to a canonical brain atlas in order to facilitate comparisons. Although appropriately registered brains more closely resemble the template brain, morphological variations still can be readily verified by visual inspection. Thus, a voxelwise comparison of a set of coregistered brains for the purpose of identifying salient differences will incorporate a systematic limitation of the registration process as a confounding factor. In addition to this systematic error, an additional error is introduced due to differences between the template, the target of the registration process, and the patient's brain, the target of the analysis. In this study, we propose a novel approach where the patient of interest is the target of the registration process as well as the analysis. Using this approach, systematic
registration errors of the control brains, although present, will be distributed across the subject rather than an alternate target, such as a brain atlas. The result is elimination of registration error for the patient of interest.

Materials and Methods
3 T diffusion tensor MR imaging (MRI) (2mm³, 32 directions, b=800) was performed on 20 acute TBI patients and 48 normal individuals using a Philips Achieva scanner and 32 channel head coil. Fractional anisotropy (FA) images were derived and registration and segmentation procedures applied as described previously (1). A voxelwise ANCOVA then was performed comparing the white matter of the patient to the controls to identify clusters of abnormally low FA defined as at least 100 contiguous voxels with p<0.01. Three distinct analyses were performed: (1) all subjects and controls were transformed to the Johns Hopkins University (JHU) T1-weighted atlas, (2) all subjects and controls were transformed to the Montreal Neurological Institute (MNI) T1-weighted atlas, (3) all controls were transformed to the patient's T1-weighted volume, which we term the patient-centered approach.

Results
We found a significant reduction in the total volume of abnormally low FA values in analyses carried out in the patient's anatomical space compared to either atlas-based analysis. More that 50% of the patients (11/20) demonstrated no abnormally low FA clusters in the patient space analysis. This is in contrast to registrations to a brain atlas which demonstrated near ubiquitous presence of abnormally low FA clusters, seen in 95% to 100% of patients. The nine patients that did demonstrate low FA clusters using the subject-based registration method showed average increases of approximately 400% in total number of abnormally low FA voxels detected when using the atlas-based analyses. Furthermore, atlas-based analysis demonstrated an average range of 9.8% to 13.3% overlap of gray matter/CSF voxels of the coregistered patient volume and the white matter of the atlas template, which may contribute to the excess number of low FA voxels detected in atlas-based analyses. Without careful evaluation, such misregistrations could be misinterpreted as pathology. Since subject-based registrations does not involve any manipulation of patient data, these misregistrations cannot occur.

Conclusions
Brain templates facilitate comparison across subjects and can be used as a basis for delineating regions of abnormal diffusion in individual patients. However, systematic limitations of the registration process as well as morphological differences between template and subject brains can introduce error in identification of diffusion abnormalities. Through a simple change in the registration process, we eliminate inaccuracies due to differences between a brain template and the patient's anatomy. Although registration errors still persist, these errors are distributed across the subject rather than a brain atlas and therefore are less problematic. Although expert assessment can identify misregistration in atlas-based analyses, the patient-centered analysis can provide more accurate identification of diffusion abnormalities. An additional benefit of our patient-centered approach is that diffusion abnormalities now can be visualized directly in the patient's anatomical space, rather than interpolating results from a brain atlas registration, thereby enhancing clinical correlation across image series within an exam and facilitating MR tractography using regions of diffusion abnormality as seed regions of interest (ROI).

KEYWORDS: DTI, Fractional Anisotropy, Postprocessing

O-413
Regional Brain T1 and T2 Relaxometry in Healthy Adults using Magnetic Resonance Fingerprinting

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Purpose
To quantify T1 and T2 relaxation times of different brain regions in normal adults by using the novel magnetic resonance fingerprinting (MRF) technique and to analyze differences in relaxometry measurements based on gender and age.

Materials and Methods
We scanned 12 healthy volunteers (M:F 1:1; 7 between age 18 to 30 years, 5 between age 40-60 years) on a 3 T MR imaging (MRI) scanner using the already described MR fingerprinting protocol (1). Imaging was acquired through the representative areas of brain and quantitative T1 and T2 maps were generated. Multiple regions of interest (ROIs) were manually outlined at predetermined locations and T1 and T2 relaxation values at these sites were extracted. Each slice acquisition was less than 15 seconds in duration. The ROIs included representative white matter regions in all lobes, centrum semiovale, corpus callosum, internal capsule and cerebral peduncles, deep nuclei, thalami, cerebellar structures and pons. A total of 38 ROIs were drawn in each subject. Independent sample t-tests were used to determine differences between males and females, and age groups 18-30 and 40-60 years.

Results
Normal T1 and T2 values of selected brain ROIs were established. The T2 relaxometry values in right superior frontal white matter (SFWM) were higher (p<0.03) in the older age group (Figure 1). Similar trend also was seen in T1 values of right centrum semiovale (p<0.06). The T2 values of several posterior fossa structures were significantly lower in the older age group (all p<0.05) (Figure 1). Similar trend also was seen with T1 of left dentate nucleus (p<0.06). The T2 values of different regions and age-related changes were comparable to the published data in literature (2). There was a trend for higher T1 values in rostrum and right cerebellar hemisphere in males as compared to females (p<0.07).

Conclusions
Magnetic resonance fingerprinting allows simultaneous, rapid, in vivo quantification of relaxation parameters of brain. Normal T1 and T2 relaxometry values in different brain regions provide baseline measurements for comparison with different disease-related states. Age-based analysis shows significant differences in relaxation parameters of certain brain regions in concurrence with published literature.

KEYWORDS: Brain Aging, Brain Mapping, Relaxivity
Correlation of Size of Primary Motor Hand Region or “Hand knob” to Individual Handedness

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Purpose
MR imaging (MRI) evaluation of individual handedness may be a noninvasive way to identify
the dominant cerebral hemisphere, especially in seizure patients. By measuring the dimensions of the primary motor hand region, or "hand knob," we hope to establish asymmetry between the two cerebral hemispheres, and thus improve predictive value of handedness.

Materials and Methods
Twenty-one subjects (16 right handed, 3 left handed, and 2 ambidextrous) were identified retrospectively after a search for individuals who had both MRI with 3D isotropic imaging and a clinical note from neurology assessing handedness. Only subjects ranging in age from 10-50 were included. Subjects were excluded from analysis if there was no documentation of handedness, or a confounding disability was identified, including congenital abnormalities, hemiplegia, quadriplegia, cerebral palsy, traumatic brain injury, brain tumor, and infection. From axial T1 3D spoiled gradient echo sequences, types of "hand knob" morphology were identified as omega, epsilon, null, or medially or laterally asymmetric epsilon. Length and height of the "hand knob" were measured in the axial plane (see Figure A). Length and height dimensions of the "hand knob" then were added together as a sum for both dominant and nondominant hemispheres. Paired two-tail method T test was used to compare the dominant versus nondominant hemisphere summed height and length measurement total in the axial plane for both right, left and ambidextrous patients.

Results
The left hand knob taken as the sum of the length plus height measured in the axial plane, was larger than the right in 16 right handed subjects (p < 0.001) (Graph B). Statistical significance in the size of the hand knobs in the three left-handed subjects (p = 0.19) and the two ambidextrous subjects (p = 0.5) could not be established given the small sample size. Combining both right and left handed patients, the dominant versus nondominant primary motor hand cortex summed measurements of the length and height were taken and compared and also yielded statistic significant, p<0.01.

Conclusions
This pilot study suggests that there is a direct correlation between dominant hemisphere primary motor cortex size and handedness. The study is limited by the small number of subjects, particularly in the left handed and ambidextrous groups. Ongoing data collection will increase sample size, and along with future volumetric analysis of the primary motor hand regions (which will be made with Free Surfer software application, developed at the Martinos center for Biomedical Imaging) of the primary motor hand region, may support the conclusion of a statistically significant difference in size of dominant versus nondominant "hand knob" region.

KEYWORDS: Motor Cortex
In Vivo Assessment of White Matter Damage in Neuromyelitis Optica Patients: a Diffusion Tensor and Diffusion Kurtosis MR Imaging Study

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¹CDPI-Clinica de Diagnostico por Imagem, Rio de Janeiro, Brazil

Purpose
In patients with neuromyelitis optica (NMO), damage to extensive regions of normal-appearing white matter (WM) has been observed. To investigate the possibility that microstructural alterations are present in these WM tracts, diffusion tensor imaging (DTI) and diffusion kurtosis imaging (DKI) techniques were applied and compared.

Materials and Methods
Thirteen patients with NMO and 13 demographically and gender-matched controls underwent MR imaging (MRI) using a 3 T MR scanner, with both DTI and DKI sequences acquired. Parametric fractional anisotropy maps were derived from diffusion tensor (FADTI) values using...
b values of 0 s/mm² and 1000 s/mm². Parametric fractional anisotropy maps derived from diffusion kurtosis tensor (FADKI) values also were acquired using b-values of 0, 1000, and 2000 s/mm². Mean FADTI and FADKI values also were calculated. A region of interest (ROI) analysis of the genu and splenium of the corpus callosum (CC), cerebral peduncle (CP), and optic radiation (OR) also were performed. Student's T-test and corrections for multiple comparisons were used to evaluate the data obtained.

Results
In the present study, a ROI-driven DTI and DKI analysis of WM tracts previously found to have altered FA values in NMO patients were performed. Both the splenium of the CC and the left OR of NMO patients were found to have significantly reduced FADTI values compared to controls (p < 0.05). The FADKI ROI values of NMO patients also were slightly lower than those of the controls for the same WM tracts, demonstrating only a positive trend (0.1 > p > 0.05). The other WM tracts analyzed in this study did not display significant decrease in the FA values obtained for NMO patients versus controls for both the DTI and DKI techniques. Diffusion tensor imaging employs a water diffusion displacement probability function that obeys Gaussian distribution. However, while Gaussian diffusion of water is observed in homogeneous solutions, diffusion of water in biological tissues, such as the brain, often do not show Gaussian behavior. This is consistent with the presence of cell membranes and organelles in the brain, which create differing extents of water diffusion, thereby resulting in a non-Gaussian probability of distribution. Therefore, theoretically, DKI is better able to characterize the microstructure of brain tissue. However, differently of DTI technique, the DKI technique could not assess the microstructure alterations of the brain in patients with NMO.

Conclusions
To our knowledge, this is the first study to analyze WM tracts of NMO patients using DTI and DKI. These data indicate that DKI could not be used to evaluate WM integrity in NMO patients. Furthermore, the results obtained with FADTI are consistent with the hypothesis that diffuse brain involvement characterizes NMO.

KEYWORDS: Diffusion Kurtosis Imaging, Diffusion Tensor Image, Neuromyelitis Optica

<table>
<thead>
<tr>
<th></th>
<th>FADTI Patients</th>
<th>FADTI Controls</th>
<th>FADKI Patients</th>
<th>FADKI Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Splenium of corpus callosum</td>
<td>0.66 +/-0.11</td>
<td>0.75 +/-0.09</td>
<td>0.66 +/-0.12</td>
<td>0.75 +/-0.09</td>
</tr>
<tr>
<td>Left optic radiation</td>
<td>0.43 +/-0.08</td>
<td>0.50 +/-0.06</td>
<td>0.47 +/-0.08</td>
<td>0.53 +/-0.05</td>
</tr>
</tbody>
</table>
Cortical Atrophy and Relative Increase of Interhemispheric Connections in Relapsing Remitting Multiple Sclerosis With Low Scores of Disability

C Rimkus¹, M Otaduy¹, D Callegaro², C Leite¹
¹Laboratory of Medical Investigation (LIM-44), University of São Paulo, São Paulo, Brazil, ²University of São Paulo, São Paulo, Brazil

Purpose
The chronic inflammation in multiple sclerosis (MS) leads to axon and myelin damage, which can induce functional and anatomical reorganization of brain connections. Studies have reported increases in cortical activity in the initial stages of MS (1, 2), as a possible compensatory response to the beginning process of tissue degeneration. We propose to study the white matter (WM) connections in areas of cortical atrophy in relapsing remitting MS (RRMS) patients with low Expanded Disability Status Scale (EDSS) scores by diffusion tensor imaging (DTI), in an attempt to observe adaptive changes in the WM pathways associated to the early cortical degeneration.

Materials and Methods
Fifteen RRMS patients (12 female, mean age 30.3 years ± 8.3, mean EDSS 1.3 ± 0.9) and 15 healthy controls (HC) (13 female, mean age 32.5 years ± 5.4) underwent brain exams with a 3 T MR scanner. The MRI exam included acquisition of 3DT1-weighted images (time of echo (TE)/time of repetition (TR)= 2.7/6.2 ms; time of inversion (TI)= 700 ms; 1mm³ isotropic voxel) and DTI (b-values= 0 and 1000 s/mm²; 32 encoding directions; 2mm³ isometric voxel). Cortical segmentation was obtained with FreeSurfer v5.1.0. Group analysis based on General Linear Modeling was performed searching for areas of significant cortical atrophy (p< 0.05) and using

Figure 2. Box-and-whisker plots show the distribution of diffusion tensor imaging fractional anisotropy (FADTI) for the genu of CC (antiCC), splenium of CC (splCC), right OR (Orr), left OR (ORI), right cerebral peduncle (CPR), and left cerebral peduncle (CPI) for healthy controls (white boxes) and NMO patients (gray boxes).

Figure 3. Box-and-whisker plots show the distribution of diffusion kurtosis imaging fractional anisotropy (FADKI) for the genu of the CC (antiCC), splenium of the CC (splCC), right OR (ORr), left OR (ORI), right cerebral peduncle (CPR), and left cerebral peduncle (CPI) for healthy controls (white boxes) and NMO patients (gray boxes).
age as a cofactor. The resulting labels of cortical atrophy were coregistered to each individual DTI space. From the labeled areas of cortical atrophy we extracted the regional fiber tracts (Figure 1), fractional anisotropy (FA), mean diffusivity (MD), the total number of cortical fibers and the number of connections to the corpus callosum (CC).

Results
The main results are shown in Table 1, showing a greater ratio of cortical fibers connecting to the CC in RRMS patients, associated to an increase in MD. The increase of interhemispheric fibers was derived predominantly from the right hemisphere, which also showed a greater extension of cortical atrophy (Figure 1).

Conclusions
Cortical degeneration has been reported previously from the earlier stages of MS. Some patients may compensate the initial neurological dysfunction by adaptive changes in cortical activity and connectivity (1, 2). The DTI results of our study show that the cortical degeneration also may be followed by microstructural reorganization of WM tracts, resulting in an increase of interhemispheric connections.

KEYWORDS: Degenerative, Diffusion Tensor Image, Multiple Sclerosis

<table>
<thead>
<tr>
<th>FA</th>
<th>MD ($10^{-3} \text{mm}^2/\text{s}$)</th>
<th>Total cortical fibers (CF)</th>
<th>Connections to the CC (CCF)</th>
<th>Ratio CCF/CF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>RRMS</td>
<td>0.36 ±0.02</td>
<td>0.37 ±0.02</td>
<td>0.83 ±0.04</td>
<td>0.83 ±0.03</td>
</tr>
<tr>
<td>HC</td>
<td>0.36 ±0.02</td>
<td>0.37 ±0.02</td>
<td>0.8 ±0.02</td>
<td>0.81 ±0.03</td>
</tr>
<tr>
<td>p value</td>
<td>0.8</td>
<td>0.8</td>
<td>0.03*</td>
<td>0.08**</td>
</tr>
</tbody>
</table>

The cells show the mean results ± standard deviation of each measurement for the right and left hemispheres in the RRMS and HC groups. The bottom row contains the p value of the t-test showing the differences between the groups, being significant $p \leq 0.05$ (*) and the p-values between 0.05 and 0.1 were considered trends (**).
Quantitative MR and Histopathologic Features of CNS Remyelination Correlate with Functional Recovery in Felines: The Role of Vitamin B12 As An Independent Promoter of Myelination.

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Purpose
In this study we investigate the outcome of various quantitative MR parameters – obtained from quantitative magnetization transfer (MT), diffusion tensor (DTI), q-space, and myelin water fraction imaging - during sequential stages of central nervous system (CNS) demyelination and remyelination in felines, as corroborated by functional assessments and histopathologic correlation.

Materials and Methods
This is a case-control study that enrolled a total of 13 cats, 11 of which were placed on a diet of irradiated food, which induces global CNS demyelination. A subset of the diseased group was supplemented with vitamin B12 while others were either maintained on the irradiated diet or
switched to nonirradiated food. Quantitative MR imaging (MRI) of the whole brain, spinal cord, and optic nerves were obtained at baseline, during partial disease onset, at peak disease, and during recovery; MRI data were obtained on a 3 T clinical scanner with a standard knee coil. Subjects from each representative group were euthanized at different stages for the purpose of histologic analysis and comparison.

Results
The diseased group demonstrated decreased MT ratio and MT saturation values, in comparison to the non-diseased subjects. However, MT parameters were seen to rebound during the recovery phase, which correlated with functional outcomes and histologic confirmation of remyelination. A similar relationship was observed with diffusion parameters, with a decrease in fractional anisotropy, axial diffusivity, and mean diffusivity – and accordingly an increase in radial diffusivity – when comparing the diseased state to the baseline and recovery phases. Myelin water fraction values correlate with the degree of myelination at various disease stages.

Conclusions
The unique phenomenon of nonimmune mediated CNS demyelination in felines that are fed irradiated food offers a powerful large animal model with which to study "pure" demyelination and subsequent recovery, without the confounding factors of inflammatory changes and axonal degeneration that are encountered in other animal models. Recovery from the peak disease state is observed in both cats that are switched to a nonirradiated diet, or cats supplemented with vitamin B12 regardless of diet. The latter effect is observed irrespective of serum levels or other markers of vitamin B12 status, which suggests that vitamin B12 supplementation may independently promote remyelination. We confirm this with functional outcomes, histologic analysis, and multiparametric quantitative MRI. Quantitative MRI values are shown to correlate with various degrees of myelination in this model, which confirms that these sequences potentially offer a noninvasive, clinically feasible means for assessing this facet of white matter disease. Furthermore, the feline model may translate to subacute combined degeneration (SCD), observed in vitamin B12-deficient humans, or can be treated as a reductionist model of multiple sclerosis in which demyelination and remyelination can be studied in isolation from confounding effects.

KEYWORDS: Animal Model, Demyelination, FMRI
Evaluation of the Brain Gray Matter Structures in Adults Perinatally-infected with HIV Using DKI

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\textsuperscript{1}Jackson Memorial Hospital/University of Miami, Miami, FL, \textsuperscript{2}University of Miami, Miami, FL

Purpose
To evaluate the long term impact of persistent reservoirs of HIV in the central nervous system (CNS) and the potential effects of long term use of some of its antiretroviral therapeutics on the tissue structural integrity of the brain subcortical and deep gray matter (GM) regions in people living with HIV infection. In this study, a whole-brain diffusion kurtosis imaging (DKI) method is used to obtain mean diffusivity (MD) and mean kurtosis (MK) metric maps in adults perinatally infected with HIV and a matched community control group for comparisons.

Materials and Methods
MR imaging (MRI) data were acquired from 24 adults perinatally infected with HIV (mean±SD: 20±1.9 years) and nine control subjects (mean±SD: 22±1.4 years) using a 3 T scanner. The MR
protocol included diffusion-weighted imaging (DWI) (b: 0, 1000, 2000 s/mm²; number of diffusion gradient directions: 30; TR: 6100 ms; TE: 101 ms; slices: 45; resolution: 2.7 mm isotropic; 2 ave) and T2 (for distortion correction) sequences. Data were processed using DKE1 and DtiStudio (www.mristudio.org). The DKE-processed maps of MD and MK were transformed spatially to a template in MNI space at 1 mm resolution. To obtain data from GM regions in these maps, we used a brain atlas2 with 130 regions of interest (ROI). Furthermore, to avoid inclusion of voxels with predominantly CSF or white matter (WM) in the ROIs, a GM mask was created for each subject by setting appropriate thresholds in their MD and FA images, respectively. Finally, data were selected only from 60 predominantly GM ROIs for analysis. Between group analysis of MD and MK metrics of the ROIs was carried out using ANCOVA with age and sex as covariates. A p value of <0.05 was considered significant.

Results
In Figure 1A are shown the mean MD values of nine GM ROIs that showed significant changes in the HIV group. The nine ROIs comprised of cuneus - left (Cu_L) and right (Cu_R), inferior occipital gyrus right (IOG_R), middle occipital gyrus - left (MOG_L) and right (MOG_R), pre-cuneus right (PrCu_R), putamen right (Put_R), and superior occipital gyrus - left (SOG_L) and right (SOG_R). In Figure 1B are shown ten GM ROIs with significant mean MK changes in the HIV group. The ten ROIs included caudate nucleus - left (Caud_L) and right (Caud_R), globus pallidus left (GP_L), middle frontal gyrus right (MFG_R), precentral gyrus right (PrCG_R), putamen left (Put_L), superior frontal gyrus right (SFG_R), superior temporal gyrus - left (STG_L) and right (STG_R), and thalamus left (Thal_L). In the HIV group compared to controls, the MD values were lower across the ROIs, except in Put_R, and the MK values were consistently higher in all the ROIs.

Conclusions
The significant changes observed in the MD and MK metrics of the subcortical and deep GM brain regions in individuals with HIV infection indicate that these regions also are affected in addition to previously known WM regions. There was no overlap of the ROIs found with significant MD and MK changes; this result indicates that the tissue water in these ROIs experiences different degrees of Gaussian and non-Gaussian diffusion effects. The significantly reduced MD values and increased MK values in the GM ROIs indicate that tissue structural and cellular compositional changes occur in the intra- and extra-cellular environments of the brain of individuals with HIV infection. In conclusion, microstructural changes occur in the subcortical and deep GM brain regions of adults infected with HIV. These changes indicate underlying cellular pathologies that may be responsible for HIV-associated neurocognitive disorders (HAND) prevalent in people living with HIV infection. The neuroimaging methodology described here will be useful in developing biomarkers for evaluating the impact of HIV infection and its therapeutics on the brain. Acknowledgements: This work is supported by a pilot grant from the Center for AIDS Research, University of Miami.

KEYWORDS: Brain Abnormalities, Diffusional Kurtosis Imaging, HIV
White Matter Microstructure Abnormalities in Pediatric Migraine Patients: In-Vivo Measures of Brain Hyperexcitability?

R Messina¹, M Rocca¹, B Colombo¹, E Pagani¹, G Comi¹, A Falini¹, M Filippi¹
¹San Raffaele Scientific Institute, Vita-Salute San Raffaele University, Milan, Italy

Purpose
By exploiting diffusion characteristics of water molecules in the central nervous system, diffusion tensor (DT) magnetic resonance imaging (MRI) provides several quantities with the potential to disclose white matter (WM) microstructure abnormalities. Among these, fractional anisotropy (FA) reflects axonal integrity and fiber organization, mean diffusivity (MD) measures the overall magnitude of diffusion, axial diffusivity ($\lambda_\parallel$) is associated with fiber density and axon intrinsic characteristics, whereas radial diffusivity ($\lambda_\perp$) reflects the degree of myelination (1). In this study, we explored abnormalities of WM microstructure in pediatric patients with migraine using DT MRI and two different methods of analysis.

Materials and Methods
Using a 3.0 T scanner, dual-echo and DT scans were acquired from 15 pediatric migraine patients (8 girls, mean age = 14.1 years, mean disease duration = 3 years, mean attack frequency = 21 attacks per year, 8 with visual aura and 7 without aura) and 15 age-matched controls. Tract-based spatial statistics (TBSS) analysis (2) was performed using FMRIB’s Diffusion Toolbox. In order to confirm TBSS results, we also performed a DT probabilistic tractography of the major brain WM tracts (3).

Results
Both TBSS and DT tractography analysis showed that compared to controls, pediatric migraine patients had significant lower MD, $\lambda_\parallel$ and $\lambda_\perp$ in the brainstem, thalamus, fronto-temporo-occipital lobes, including the right cingulum, corpus callosum, optic radiation, fronto-occipital fasciculus and corticospinal tract, bilaterally. They also experienced increased FA of the left optic radiation. No correlation was found between WM abnormalities and disease duration and frequency of attacks.
Conclusions
Pediatric migraine patients present diffuse WM microstructural abnormalities. Higher FA and lower MD, $\lambda_{||}$ and $\lambda_{\perp}$ might be explained by repeated neuronal activation, that is likely to lead to cells swelling and might stimulate the activity-dependent myelo-modulation, or by the presence of higher neuronal and synaptic densities in migraine patients compared to controls (4, 5). Both these mechanisms would reflect an hyperexcitability of the brain in migraine patients.

KEYWORDS: Migraine, MR Imaging/Diffusion, White Matter Disease

O-421
4:10PM - 4:17PM

Using Quantitative Imaging to Evaluate Correlation Between Diffusion MRI and DCE MRI in Intracranial Human Gliomas, Meningiomas, Metastases, and Cerebral Lymphomas

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1University of Southern California, Los Angeles, CA, 2Keck School of Medicine, Los Angeles, CA, 3iCAD, Nashua, NH, 4LAC/University of Southern California Medical Center, Los Angeles, CA, 5Keck Medical Center of University of Southern California, Los Angeles, CA

Purpose
Quantitative imaging biomarkers are needed to better characterize tumor cell number, cell size, and cell packing (1). Determination of the relationship between diffusivity metrics derived from diffusion MRI and dynamic contrast-enhanced (DCE) MR imaging (MRI) metrics such as extravascular-extracellular space (EES) volume fraction (ve) may help develop new imaging biomarkers of brain tumor cellularity. Monitoring of cellular proliferation and cell death is needed in neuro-oncology practice to monitor tumor response to novel therapeutics. Apparent diffusion coefficient (ADC) determined from diffusion weighted imaging (DWI) MRI and the equivalent concept of mean diffusivity (MD) determined from diffusion tensor imaging (DTI) can both give an impression of the EES and have been shown to be inversely correlated with tumor cell density. Upon successful treatment, the tumor cellularity, with its associated barriers, would be expected to decrease, therefore increasing diffusivity. Likewise, EES would be expected to increase upon successful treatment due to tumor necrosis. As such, one would expect diffusivity and ve to be positively correlated. The purpose of this study was to determine the correlation between DCE metrics such as ve, blood-brain barrier transfer constant (Ktrans), Kep (Ktrans/ve), and fractional plasma volume (vp), and diffusivity, as characterized by ADC in the case of DWI MRI, and axial diffusivity (DA) and MD in the case of DTI MRI, focusing on gliomas, lymphomas, metastases, and meningiomas.

Materials and Methods
Fifty intracranial tumors (21 gliomas (grade I-IV), 13 metastases, 7 lymphomas and 9 meningiomas) were evaluated retrospectively. Diffusion tensor imaging/DWI and DCE images were acquired during the same MRI exam on a GE 3T HDxT scanner. Dynamic contrast-enhanced MRI images were postprocessed in CADvue. Metrics extracted from DCE MRI were: ve, vp, Ktrans, and Kep. Metrics for diffusivity were calculated using custom Matlab software. Dynamic contrast-enhanced and diffusion images were coregistered and 3-dimensional (3D)
regions of interest were drawn on parametric maps using the area of enhancement on postcontrast imaging. Mean and median values were extracted using Pearson correlation.

Results

When all the tumors were considered together, no statistically significant correlation was observed between DCE parameters and diffusion parameters either with DTI or DWI, although for cases imaged with DWI the negative correlation observed between mean ADC and mean Kep (r=-0.51, p = 0.05) as well as the negative correlation observed between mean ADC and median Kep (r=-0.51, p = 0.05) did both approach statistical significance (see Table). These negative correlations are suggestive of positive correlation between ADC and ve as Kep = Ktrans/ve.

However, when analyzing by specific tumor type (see Table), a strong positive correlation was observed for gliomas between mean MD and mean ve (r=0.60, p = 0.01) as well as between mean AD and mean ve (r=0.66, p <0.01). No statistically significant correlation was observed between measures of diffusivity and mean ve for the other tumor types in the study.

Conclusions

Our results showed a strong positive correlation between DTI measures of diffusivity, MD and AD, and ve for gliomas, while no statistically significant correlation was observed for the other tumor types. A prior study performed in breast cancer (2) found a negative correlation while another study in breast cancer (3) as well as one in glioblastoma (1) found no correlation between measures of diffusivity and DCE parameters. Multiple factors contribute to measures of diffusivity other than extravascular extracellular space volume. For example, different geometries of the available extravascular extracellular space may impact diffusivity, while the overall volume remains unchanged (2). Likewise, diffusivity is affected by the spatial configuration of the EES, intracellular diffusion coefficients, and membrane permeability (1).

Yankeelov et al. (2) also suggested interstitial fluid pressure may decrease in tumors following treatment, which in turn aids elimination of cellular debris and increases diffusivity, while the overall volume of extravascular extracellular space may decrease as a result of this decreased interstitial fluid pressure. To conclude, our results suggest that the way these multiple factors impact diffusivity, and its relationship to DCE parameters such as ve, is tumor type specific, and that meaningful combination of these different MRI sequences to build predictive models should be tumor type specific.

KEYWORDS: DCE MR Imaging, Diffusion MR Imaging, Postprocessing

| Pearson Correlation Coefficients and (p-values), all tumors combined, DTI vs. DCE, N = 35 |
|---------------------------------|--------|--------|--------|--------|
| Mean ve                        | Mean Kep | Median Kep | Median Ktrans |
| Mean MD                        | 0.2599 (0.132) | -0.2046 (0.240) | -0.1203 (0.491) | -0.0284 (0.871) |
| Mean AD                        | 0.3134 (0.067) | 0.2435 (0.159) | -0.1162 (0.506) | -0.0006 (0.997) |

Table: Correlation coefficients between Diffusion MRI parameters and DCE MRI parameters - both for all tumors combined as well as for specific tumor types

| Pearson Correlation Coefficients and (p-values), all tumors combined, DWI vs. DCE, N = 15 |
### Pearson Correlation Coefficients and (p-values), by tumor type, DTI vs. DCE

<table>
<thead>
<tr>
<th>Tumor Type</th>
<th>N</th>
<th>Mean ADC</th>
<th>MEAN MD</th>
<th>Median ADC</th>
<th>MEAN MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glioma</td>
<td>17</td>
<td>0.1668 (0.552)</td>
<td>-0.5141 (0.050)</td>
<td>0.0374 (0.895)</td>
<td>-0.3632 (0.183)</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>5</td>
<td>-0.5102 (0.052)</td>
<td>-0.3961 (0.144)</td>
<td>-0.4659 (0.080)</td>
<td>-0.4050 (0.134)</td>
</tr>
<tr>
<td>Meningioma</td>
<td>5</td>
<td>-0.5102 (0.052)</td>
<td>-0.3961 (0.144)</td>
<td>-0.4659 (0.080)</td>
<td>-0.4050 (0.134)</td>
</tr>
<tr>
<td>Metastases</td>
<td>8</td>
<td>-0.5102 (0.052)</td>
<td>-0.3961 (0.144)</td>
<td>-0.4659 (0.080)</td>
<td>-0.4050 (0.134)</td>
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</tbody>
</table>

### O-422

**Glioblastoma: Evaluation of the nonenhancing peritumoral region using resting state BOLD MRI**

D Chow, C Horenstein, M Kozberg, A Lignelli, C Filippi, J Grinband

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**Purpose**

Glioblastoma (GBM) is an invasive primary brain malignancy, which may infiltrate the peritumoral edema with malignant cells. Identification of this nonenhancing disease remains a radiographic challenge. Given that GBMs may disrupt cerebral blood flow modulation through a variety of mechanisms (i.e., vascular compression, invasion, shunting), imaging focused at identifying regions of vascular deregulation may represent a possible biomarker for nonenhancing disease. One possible means of objectively quantifying disruptions in blood flow modulation is resting state BOLD MR imaging (MRI). In this study, we aim to objectively measure the BOLD blood flow correlations as a potential marker for tumor-impaired neural tissue. We hypothesize that regions of dysfunction in the vascular regulation will display lower correlative values.

**Materials and Methods**

This was a retrospective review of 15 patients with pathology proven GBMs that had resting state BOLD functional MR imaging (fMRI) at 3 T prior to tumor resection. Motion correction and slice timing correction was performed on the raw datasets. Global functional connectivity (FC) maps were generated to obtain an objective measure for correlative blood flow. Each voxel time series was correlated to the time series of a set of Talairach-identified regions of interest (ROIs) to derive a measure of global functional connectivity. Patterns of functional connectivity...
within the tumor and peritumoral edema (defined by the peritumoral FLAIR abnormality) were characterized qualitatively and quantitatively.

Results
The contrast-enhancing tumor had significantly lower correlative blood flow measures compared to the contralateral normal white matter (p<0.05). The nonenhancing peritumoral edema region also displayed significantly lower correlative blood flow measures compared to the contralateral normal white matter (p<0.05).

Conclusions
These findings suggest that objective assessment of the correlative blood flow using resting state BOLD MRI may provide a potential biomarker for tumor invasion in the nonenhancing peritumoral edema. Further study is required to determine whether different signatures on these BOLD connectivity maps relate to tumor subtype and/or prognosis.

KEYWORDS: Biomarkers, Functional Connectivity MR, Glioblastoma
Automatic lesion detection on C-arm CT CBV-maps in a canine model of ischemic stroke

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Purpose
Perfusion imaging may identify viable brain tissue in ischemic stroke that critically guides patient and treatment selection for endovascular therapy. Tissue viability may change rapidly after stroke onset, suggesting the need for accurate perfusion imaging immediately prior to intraarterial treatment. In pursuit of bringing cerebral blood flow (CBF) and volume (CBV) measurements to the angiography suite, recent studies have focused on perfusion imaging using C-arm cone-beam CT (CBCT) systems (1, 2). The purpose of this study was to explore the potential of a machine learning algorithm to automatically identify voxels belonging to the ischemic lesion on CBCT-based CBV maps.

Materials and Methods
Adult beagle dogs (n=4) received stroke by injection of an autologous blood clot unilaterally in the internal carotid artery (ICA) inducing an M1-occlusion which was confirmed by digital subtraction angiography (DSA). Subsequently, animals were imaged on an x-ray angiographic C-arm system and a 3 T whole-body MR imaging MRI) scanner (Philips Healthcare) as described before (1). Four and on half hours after stroke onset, CBV maps were calculated from CBCT images obtained during a 20-second 220°-sweep, before and after intravenous contrast agent injection (1). Diffusion weighted imaging (DWI) for calculation of apparent diffusion coefficient (ADC) maps and anatomical MRI was performed within 10 minutes after CBV assessment. True infarct volumes were measured on post mortem TTC-stained coronal brain sections (1). After coregistration, voxel-wise analysis was performed. The ischemic lesion was determined on the ADC map by thresholding (1) and a mirrored control region was obtained in the contralateral hemisphere. A nonlinear support vector machine (SVM) classifier (3) was trained (C = 1, σ = 40, 15000 samples) to discriminate between lesion and control voxels in the combined control and lesion area, based on CBV values that were normalized with respect to the average control CBV. Classification performance was assessed with leave-one-out cross-validation.

Results
The left panel of the figure shows the anatomical MRI (top row), ADC map (second row; values between 0 and 3.0*10^-3 mm²/s), and CBV map (bottom row; a.u.) for each of the four animals (A-D). The ischemic lesion is clearly identified on the ADC map at a threshold of 5.3*10^-4 mm²/s, which yields lesion volume estimates that are in agreement with TTC-based lesion volumes (1). Support vector machines were trained in a leave-one-out cross-validation on a limited set of voxels that encompassed the lesion and contralateral control areas. The performances of the SVMs are depicted in the right panel of the figure. The receiver operating characteristic (ROC) curve indicates reasonable performance of the classifier in each case, with the area under the ROC curve (AUC) between 0.75-0.85 (see Table). The AUC of the combined predictions was 0.78.

Conclusions
The current approach shows that nonlinear machine learning algorithms are capable of detecting ischemic lesion voxels with reasonable sensitivity and specificity. As the current training and
evaluation was confined to a restricted area of the brain that encompassed ischemic and unaffected contralesional tissue, its performance on whole-brain CBV maps remains to be evaluated.

KEYWORDS: Acute Ischemic Stroke, C-Arm CT CBV, Image Processing

Prediction performance on CBV-maps in comparison to TTC- and ADC-based lesion volumes.

<table>
<thead>
<tr>
<th>Subject</th>
<th>TTC volume (ml)</th>
<th>ADC volume (ml)</th>
<th>CBV volume (ml)</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9.6</td>
<td>13.8</td>
<td>15.2</td>
<td>0.85</td>
</tr>
<tr>
<td>B</td>
<td>5.6</td>
<td>6.2</td>
<td>6.0</td>
<td>0.79</td>
</tr>
<tr>
<td>C</td>
<td>13.4</td>
<td>12.2</td>
<td>8.1</td>
<td>0.75</td>
</tr>
<tr>
<td>D</td>
<td>3.6</td>
<td>3.4</td>
<td>2.8</td>
<td>0.77</td>
</tr>
</tbody>
</table>

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Tuesday
3:00PM - 4:30PM
Palais des congrès de Montreal, 520

47 - PARALLEL PAPERS: Adult Brain: Degenerative Disease
O-424

Hypertrophic Olivary Degeneration Resulting from Posterior Fossa Masses and Their Treatments

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Purpose
The purpose of this study was to characterize hypertrophic olivary degeneration (HOD) that develops from posterior fossa masses and their treatments.

Materials and Methods
We retrospectively queried a departmental database from January 1997 to June 2013 to find patients with posterior fossa masses and HOD. Total 10 patients had MR imaging and other clinical data available for review. HOD was defined as abnormal T2 hyperintensity and/or enlargement of the inferior olive by MR imaging (MRI) with an inciting lesion in an afferent limb of the Guillain-Mollaret triangle. Four patients also had diffusion tensor imaging (DTI) available for analysis and streamline tractography.

Results
Patients had unilateral cerebellar lesions (n=4, developed contralateral HOD), midline cerebellar lesions (n=4, bilateral HOD) or unilateral pontine lesions (n=2, ipsilateral HOD). These consisted of tumors (n=8), demyelination (n=1) and nonspecific necrosis (n=1). Eight patients had dysphagia and/or nystagmus, including four patients a median 87 days before HOD. MR imaging showed T2 hyperintense signal in the inferior olive median 86 days (range, 0-363) after the diagnosis of a posterior fossa lesion. Hypertrophic olivary degeneration presented prior to surgery (n=2), after surgery (n=3), after surgery and radiation therapy (n=4), or without any treatment (n=1). Diffusion tensor imaging in four patients revealed decreased anisotropy and fiber tracts in the central tegmental tract (n=2, ipsilateral HOD) or the superior cerebellar peduncle (n=2, contralateral HOD).

Conclusions
Hypertrophic olivary degeneration may develop from posterior fossa masses and surgical and/or radiation therapy treatments. Proper recognition of the characteristic features of HOD is necessary to avoid misdiagnosis of a recurrent tumor in cancer patients.

KEYWORDS: Anatomy, Brain Neoplasms, Hypertrophic Olivary Degeneration
Axial T2-weighted image (left) shows HOD in the right medulla after resection of a left paramedian hemangioblastoma (not shown). Coronal directionally encoded color fractional anisotropy map (right) reveals thinning of the left superior cerebellar peduncle (arrow) injured at surgery.
Estrogen and Brain Structure in a Community Cohort of Elderly Women

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Purpose
Alzheimer disease (AD) is the most common cause of dementia, and women are at higher risk than men (1). Prior studies suggest that estrogen may reduce the risk of Alzheimer dementia (2). Such risk modifying influence may occur by estrogen strengthening brain structural integrity with neurotrophic effects. Here we aimed to understand how estrogen use influences brain structure in a cohort of elderly women.

Materials and Methods
Female participants were recruited from the multisite Cardiovascular Health Study (n = 560). Of

(Filename: TCT_O-424_AbstractFig.jpg)
In this cohort, 100 subjects were actively taking estrogen at the time of assessment with 3D volumetric spoiled gradient echo T1-weighted MR imaging (MRI). The average age of this group was 78.1 years (range: 69-93); 137 subjects had either AD or mild cognitive impairment (MCI). Women using estrogen were more likely to be better educated [(557) = 2.71, p = .007] and younger [(557) = -2.64, p = .008] compared to the nonestrogen group. There were no statistically significant differences in BMI, physical activity, type II diabetes, alcohol use, smoking, MRI infarcts, white matter lesions, or cognitive impairment (p < .05). The relationship between estrogen use and brain structure was quantified with tensor-based morphometry. Multivariable regression modeled this relationship and controlled for multiple comparisons, age, site, education, physical activity, BMI, cognitive impairment, and white matter lesions.

**Results**

Women taking estrogen had greater gray and white matter volumes in the frontal, temporal, and parietal lobes, compared to the nonestrogen group (Figure 1). A darker shade of blue on the color scale denotes a stronger effect size in the frontal lobes. The positive influences of estrogen use on brain structure remained statistically significant after adjusting for potential confounders.

**Conclusions**

History of estrogen use in older women of the CHS was related to greater gray and white matter volumes in the frontal, temporal, and parietal lobes. Stronger main effects were observed in the frontal cortex; these results persisted even when controlling for multiple potential confounding variables. These results may reflect the underlying neurotrophic influence of estrogen known from prior work (3, 4).

**KEYWORDS:** Aging, Brain Mapping
Cerebral Microbleeds and White Matter Hyperintensity in Alzheimer’s Disease, Significance and Incidence in Australian Population and its effect on Cognition

S Bhuta¹, M Bilska¹, C Hsu¹, R Jones², G Kwan¹
¹Gold Coast University Hospital, Gold Coast, Australia, ²James Cook University, Townsville, Australia

Purpose
The aim of the study was to determine the incidence and distribution of lobar microbleeds in probable Alzheimer disease (AD) and mild cognitive impairment (MCI) patients and to assess its association with white matter hyperintensities (WMH) and its effect on cognition and higher executive function.
Materials and Methods
Patients with presumed clinical diagnosis of AD and MCI (n=38) referred from Specialist Dementia Clinic were included in the study and healthy age-matched controls (n=26) also were used. Retrospective review of MR imaging (MRI) was performed by two independent readers (CC-TH and SB). Susceptibility-weighted imaging (SWI) and phase sequences and T2/FLAIR were included in dementia imaging protocol. Location and number of microbleeds as lobar or basal ganglia was discerned with SWI and phase sequences. White matter hyperintensity was rated on T2-weighted images using a modified Age-Related White Matter Changes Rating Scale (ARWMC). Mini mental score examination (MMSE) was used as an index to assess patients cognitive status. To evaluate the association and effect of proposed variables, the data were modelled as negative binomial regression. SPlus 8.2 (Tibco Software) or R 3.0.1 (R Foundation for Statistical Computing) was used for statistical analysis.

Results
The average number of microbleeds was 4.7 times higher in the AD and MCI group versus the control group (p = 0.043). Microbleeds increased progressively with age in the 70+ age group (p = 0.010) at a rate of 11% per year. There was occipital predominance of lobar microbleeds in AD and MCI compared to control group (p = 0.007). Basal ganglia microbleeds were less frequent and demonstrated no significant difference between groups. Increase in modified ARWMC scores was associated with higher number of lobar microbleeds from score 0 to 2 but not between score 2 to 3. There was no consistent relationship between number of lobar microbleeds and MMSE in the AD and MCI group, similarly no consistent relationship was seen with Superficial Siderosis(SS) and AD although sample size of SS was small.

Conclusions
Alzheimer disease and MCI patients have higher incidence and number of microbleeds with an occipital predominance compared to normal aging subjects, this may implies vasculopathy in AD and possible vascular basis for neuronal damage and neurodegeneration. Microbleeds number increases with higher modified ARWMC score 0-2 but not so from 2-3. Numerical value of lobar microbleeds is not a reliable marker of cognition (MMSE). A larger patient cohort may be required to elucidate the complexity of microbleeds in AD and MCI patients.

KEYWORDS: Microbleeds
Effect of Age and Gender on Cerebral Microbleeds of Alzheimer’s Disease on 3T Susceptibility-Weighted Images - A University Hospital-Based Dementia Study

H Uetani1, Y Ando1, M Azuma1, M Hashimoto1, M Ikeda1, M Kitajima1, T Hirai1, Y Yamashita1

1Kumamoto University, Kumamoto, Japan

Purpose
The aim of this study was to investigate the effect of age and gender on cerebral microbleeds (MBs) on 3 T susceptibility-weighted images (SWI) in Alzheimer disease (AD) patients seen at our memory clinic.

Materials and Methods
We studied 299 consecutive AD patients (89 men, 210 women, mean age 76 ± 8.5 years) who attended our memory clinic and were diagnosed on the basis of the criteria for probable AD of the National Institute of Neurologic Disorders and Stroke/Alzheimer Disease and Related Disorders Association by two neuropsychiatrists. All underwent dementia screening, neurologic and comprehensive neuropsychiatric assessments, and 3 T MR imaging (MRI) including susceptibility-weighted imaging (SWI) studies of the brain. For each patient, two neuroradiologists independently evaluated MBs defined as small (<10 mm diameter) round foci of low signal intensity on SWI. Statistical analyses were performed to evaluate the difference between male and female on the prevalence of MBs.
Results
Of the 299 patients, at least one MBs was exhibited in 163 (55%) on whole brain and 128 (43%) on the cortex or subcortical white matter (C/S). There were no MBs on the whole brain and the C/S in female AD patients in their fifties. The prevalence of MBs on the whole brain increased with age in both male and female groups; it was higher for male than female at any age group. Male patients in their sixties had a significantly higher prevalence of MBs on the C/S than female (58% versus 24%; odds ratio adjusted by hypertension, 4.53; P = 0.041). In the prevalence of MBs on the C/S, no significant difference between the male and female groups was found in their seventies (42% versus 51%, adjusted odds ratio was 0.69, P = 0.395) and in their eighties (51% versus 43%, adjusted odds ratio was 1.47, P = 0.345).

Conclusions
On 3 T SWI in AD patients, the prevalence of cerebral MBs increased with age in both male and female groups. The appearance of MBs was later for female than male.

KEYWORDS: Alzheimer Disease, Microbleeds, Susceptibility-Weighted Imaging

O-428

Quantitative MRI discrimination of Alzheimer’s dementia, mild cognitive impairment, and other memory disorders using volumetric MRI

S Jones1, Z Berman2, S Mahmoud1, A Rae-Grant1

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Purpose
Alzheimer disease (AD) is a debilitating neurodegenerative process, and a core part of the clinical investigation is qualitative brain MR imaging (MRI). Recently quantitative MRI is being applied, with FDA-approved commercialized software yielding detailed brain volumes. Due to considerable overlap of these volumes compared with normal brains, the most useful clinical parameter is a statistical comparison of a given patient compared with a normal control distribution. We extend this concept except to compare a given patient against a distribution of patients with known AD, in addition to a set of patients with mild cognitive impairment (MCI), and those with age-related memory loss. Lastly to measure the clinical impact of these volumetric MRI reports, we measure the impact of a report during a weekly interdisciplinary degenerative disease conference using a survey method, with clinical decisions recorded both before and after the introduction of a quantitative report.

Materials and Methods
The clinical records were reviewed of 663 consecutive patients at the Lou Ruvo Center for Brain Health who underwent quantitative MRI using commercially available NeuroQuant (Cortech Inc., La Jolla, CA), which computes the brain volumes of 48 parenchymal and extraparenchymal regions. These numbers were compared with the presence and type of dementia, whose gold standard was the clinical diagnosis. This cohort was randomized to a group of 496 patients for a "training set" and 167 patients for a "test set." The training set volumetric data and clinical diagnosis were used to form a library and three models to evaluate the ability to correctly place the test set's patient into their correct clinical diagnosis. The model yielded three probabilities, for any new patient, that their volumetric numbers could belong to each of the library sets of AD,
MCI, or age-related memory loss. The second portion of this project evaluated the effect of these probabilities on clinical decision-making during a weekly conference, during which clinical diagnoses and treatment plans were recorded both before and after introduction of the three probabilities.

Results
Of the 663 patients scanned with volumetric MRI: 322 were with Alzheimer dementia, 262 with mild cognitive impairment, and 79 with age-related nonneurodegenerative memory loss (AR-ML). After randomization, three probability models using multinomial logistic regression were derived from the training group. A statistical, a clinical, and a hybrid model were created. The accuracy of correctly placing the test set was 0.691, 0.740, and 0.744, respectively. The hybrid model achieved 0.753, 0.625, and 0.444 positive predictive values for correctly assigning patients to AD, MCI, or AR-ML, respectively. To date, 12 patients have been discussed during weekly conferences, with inclusion of probabilities that a given patient could belong to each of the three disease groups. Two of the 12 patients have had their clinical decisions affected by the volumetric report. This activity is ongoing and we will present further data during conference.

Conclusions
A center specific library of quantitative brain measures may be useful in generating probabilistic models to categorize patients with cognitive disorders. Preliminary data suggest that inclusion of these volumetric results affect a given patient's clinical decision-making during a weekly conference about 10% of the time.

KEYWORDS: Alzheimer Disease, Degenerative, MR Imaging Brain

O-429
3:35PM - 3:42PM

Functional Neuroimaging: Trends in Utilization of PET in Alzheimer’s Disease as Analyzed from a NonDenial Approach to Radiology Benefit Management

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Purpose
Analyze utilization trends over a 36-month period for functional neuroimaging of PET scan for clinical indication of Alzheimer disease assessment in a nondenial approach to radiology benefit management.

Materials and Methods
Request for neuroimaging positron emission tomography (PET) pre-authorization by an Radiology Benefit Management (RBM) using a nondenial system, retrospectively reviewed over a 36-months trend for CPT codes 78608 and 78609 for commercial provider (Humana) as to three categories. 1. Total studies ordered by provider two. 2. Total number withdrawn by provider three. 3. Total number changed by consensus/nonconsensus.

Results
Over a 36-month analysis the total number of studies ordered were 1196 with total approved of 922 (77%), withdrawn by the provider 257 (21.5%) and procedure changed 17 (1.7%). The trend broken down per year were: Year 1 Year 2 Year 3 Total 3 Years Withdrawn PET 57 83 117 257
Approved PET 260 305 357 922
Conclusions
In an RBM environment with increasing utilization demand for functional neuroimaging using PET a non-denial RBM system with providers working in a collaborative environment (in which result of disagreement = defer to treating clinician) was not associated with a greater utilization with the upward trend of utilization being offset by upward trend of provider withdrawal allowing for appropriateness criteria and collaborative environment to "bend the cost curve" without a confrontational atmosphere with a patient safety achievement of decreasing radiation exposure (equivalent of 179,900 CXRs for 257 withdrawn PET studies).

KEYWORDS: Alzheimer Disease, PET

Comparison of Automated Brain Segmentation to Subjective Assessment in Discriminating Shunt-Responsive Normal Pressure Hydrocephalus, Alzheimer Disease and Normal Elderly

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Purpose
Normal pressure hydrocephalus (NPH) is increasingly recognized as a treatable disorder characterized by motor deficits, urinary incontinence and cognitive impairment. Differentiating NPH from cerebral atrophy associated with neurodegenerative diseases such as Alzheimer disease (AD) is often a challenge due to their overlapping clinical features and similar age groups they affect. Using clinically validated ground truth cases we assessed the subjective diagnostic performance of three experienced radiologists in discriminating shunt-responsive NPH from AD and age-matched healthy controls. We compared the subjective radiologic assessments with a multivariate predictive model based on brain tissue volumetry.

Materials and Methods
The study involved high resolution 3D T1-weighted MRI examinations of 15 NPH patients who showed subsequent positive response to shunt, 21 AD patients and 18 healthy controls. The groups were matched on age and gender. Subjective assessment: Three radiologists (with 3-18 years of experience in the interpretation of brain MR images) independently and in a blinded fashion rated each case as NPH, AD or healthy elderly. Automated model: Images were segmented into gray and white matter and intra and extraventricular CSF using automated software. A multivariate prediction model was generated based on tissue volumes and gender. The model was compared to the radiologists' subjective assessments in regards of diagnostic accuracy.

Results
Subjective assessments: The diagnostic accuracy for the three readers was 75.9%, 70.4% and 64.8% (Table 1). There was a 'fair agreement' across the readers with an intraclass correlation coefficient of 0.49 (95% confidence interval 0.33 - 0.64). There were 12 (22%) discordant diagnoses between readers one and two, and 16 (29%) between readers one and three and readers two and three. Automated model: A binary logistic regression model that includes gender (to account for larger head size in male subjects), gray matter volume and ventricular volume, had
accuracy of 96.3%, significantly (P<0.005) higher than each reader (Table 1). Receiver operating characteristic (ROC) analysis demonstrated higher sensitivity and specificity for the regression model compared to the readers (area under the curve 0.965) (Figure 1).

Conclusions
Automated brain segmentation differentiates shunt-responsive NPH from Alzheimer disease and healthy elderly with higher accuracy than subjective assessment.

KEYWORDS: Alzheimer Disease, Neurodegenerative, Normal Pressure Hydrocephalus

Diagnostic accuracy (%) for the three readers and the model based on brain segmentation

<table>
<thead>
<tr>
<th></th>
<th>Overall</th>
<th>Normal elderly</th>
<th>NPH</th>
<th>AD</th>
</tr>
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<tbody>
<tr>
<td>Reader 1</td>
<td>75.9</td>
<td>72.2</td>
<td>73.3</td>
<td>81</td>
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<tr>
<td>Reader 2</td>
<td>70.4</td>
<td>94.4</td>
<td>60.0</td>
<td>57.1</td>
</tr>
<tr>
<td>Reader 3</td>
<td>64.8</td>
<td>94.4</td>
<td>60.0</td>
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<td>Model</td>
<td>96.3</td>
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<td>86.7</td>
<td>100</td>
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</table>
Using Structural Connectivity Graph Analysis to Predict Cognitive Decline in Patients After Carotid Endarterectomy

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Purpose
While carotid endarterectomy or stenting has been noted to reduce the risk of future stroke in patients with high grade carotid stenosis, many patients still experience postoperative neurocognitive decline. We sought to apply structural connectivity metrics to identify patients at increased risk for postoperative decline.

Materials and Methods
Twenty-eight patients underwent presurgical evaluation under an IRB approved protocol that included T1 structural and 30 direction diffusion tensor imaging (DTI) MRI and a battery of neuropsychological tests both before and one month after surgery. Patients were classified as decliners based on decreased performance on the Rey-AVLT on one month follow up. The T1 images were processed using FreeSurfer, with resulting segmentations being reviewed and edited as needed under the supervision of a neuroradiologist. Whole brain tractography was performed using Diffusion Toolkit and visually inspected. Connectivity matrices then were generated from the FreeSurfer segmentation and DTK fiber tracking using Matlab, and graph metrics were computed using the Brain Connectivity Toolbox.

Results
Controlling for age, classifiers using the graph analysis metrics "weighted optimal community structure" and "binary component sizes" were able to identify patients that would experience cognitive decline with 81% sensitivity 83% and specificity (p>.05, false discovery rate .05). These two measures were computed at 10 proportion edge thresholds from .1 to 1 at intervals of .1 in weighted and binary networks respectively.

Conclusions
Applying structural connectivity analysis may be capable of identifying patients at increased risk for postoperative cognitive decline, and may help guide therapy and provide patients' families guidance regarding prognosis.

KEYWORDS: Carotid Artery, Carotid Artery Stenting, Connectivity
DTI Evidence of Asymmetric Progression in Parkinson's Disease

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Purpose
Parkinson's disease (PD), a common neurodegenerative disease, may be differentially affected between sides (left & right). There is limited data on side differences in PD and to our knowledge no studies that have examined the rate of change of diffusion tensor imaging (DTI) parameters on MRI between the right and left side over time. Utilizing a longitudinal follow-up methodology, we investigated the rate of change in DTI-metrics between the right and left side in PD patients.

Materials and Methods
Subjects diagnosed with PD using standardized clinical criteria were prospectively recruited. All subjects underwent DTI MR brain imaging at baseline and about 5 years later using identical MR
protocol. We measured the FA and ADC values in the right and left caudate, putamen, thalamus and substantia nigra. We evaluated the FA, ADC and their rate of change in the right and left sides of the ROIs in all subjects. Statistical significance is defined at \( p < 0.5 \).

Results

Forty-six PD patients (average age 70 years, 22 men) were included. There was a significant difference in the FA value between the right and left SN at baseline (0.45 vs 0.43, \( p = 0.001 \)) and the second time point (0.48 vs 0.47, \( p = 0.047 \)). The FA was not significantly different between right and left putamen at baseline (0.28 vs 0.28, \( p = 0.49 \)), but this became significant at the second time point (0.36 vs 0.32, \( p = 0.001 \)). Similar findings were found in the thalamus at baseline (0.37 vs 0.37, \( p = 0.59 \)) and the second time point (0.39 vs 0.42, \( p = 0.003 \)). The rate of change of change in some brain regions appears to be different between the right and left at baseline and the second time point.

Conclusions

We demonstrated significant right - left differences in FA values in the SN, putamen and thalamus in PD. These side differences became more significant for some brain regions 5 years later, suggesting asymmetric progression of neurodegeneration. These observations would be pertinent to consider in the long-term evaluation of clinical progression in PD patients using DTI.

KEYWORDS: Degenerative, Diffusion Tensor Image, Parkinson Disease

O-433

Comparison of subcortical tissue distortion in MR images at 3T and 1.5T for deep brain stimulation patients

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Purpose

MR-based presurgical stereotactic planning for deep-brain stimulation (DBS) surgery for placing electrodes within subcortical targets is a widely used and reliable method. However, potential MR distortion has been much debated (1) as a confounding factor toward estimating presurgical target coordinates leading to errors in electrode placement particularly for small targets like subthalamic nucleus (STN) or globus pallidus interna (GPI). Duchin et al. (2) compared several anatomical landmarks from MR images at 7 T and 1.5 T to show that 7 T images of the central brain regions have comparable while the distal brain regions have higher distortions than images obtained at 1.5 T, and hence concluded that targeting of central structures such as the STN are reliable at 7 T. In this work we analyzed the difference in various distance and size measurements for common subcortical tissues for six patients scanned first at 3 T for identifying and estimating presurgical target coordinates followed by imaging at 1.5 T after DBS implantation in order to assess lead placement accuracy. Our assumption, along with those of many practitioners, is that 1.5 T being the lower field strength would produce less geometric distortion and should be considered the preferred tool. However, often the MR-based surgical planning for various subcortical nuclei has been unsatisfactory due to the variability in
anatomical position and size of these structures at lower field strengths (3) although inadequate surgical atlas and mechanical variation involving brain shifts also have played significant roles in DBS targeting errors (4, 5).

Materials and Methods
Six patients (age 59-76, 3 males) with medically refractory Parkinson's disease were scanned using an axial T1-weighted MPRAGE and a coronal T2-weighted sequence in a 3 T GE MR scanner with Leksell frame and fiducials for presurgical stereotactic planning for DBS surgery for placing quadripolar electrodes (Medtronic Inc., Minneapolis, MN) in the subthalamic nuclei. After DBS placement the patients were re-imaged in a GE 1.5 T MR system with identical software and MR sequences appropriately modified to maintain SAR and other hardware conditional guidelines of FDA and DBS manufacturer. Qualitative and quantitative assessments of global and regional distortion were evaluated by a physicist and a neurosurgeon based on the dimensions and distances of the following: the AC-PC length, the diagonal distance between the outer fiducials of the Leksell frame, the length of the caudate head (CN) and the hippocampus body (Hb) as well as the diameter of bilateral red nuclei (RN) along the frequency encode direction in which the geometric distortion is maximum.

Results
Mean variation in the measured dimensions for various tissues between the two field strengths were less than one percent for AC-PC and fiducial distances as well as for dimensions of CN and Hb. However, the dimension of RN varied by 3-7% in our patient group when compared between 3 T and 1.5 T (Figure 1 below shows coronal T2-weighted images for a typical DBS candidate). Note in this case the RN dimension is 7.3 mm at 3 T prior to surgery (A, arrows) and 7.7 mm at 1.5 T 24 hours after surgery (B). Subthalamic nucleous and GPi boundaries were not equally identifiable at both fields and were not analyzed for distortion at this time.

Conclusions
The larger variation observed only for the dimension for RN indicates a greater geometric distortion perhaps due to the higher susceptibility at the iron-rich RN. Similar effects are expected for other iron-rich nuclei including STN and GPi and currently are being studied. This may be an important contributor to the lead placement errors in addition to ones caused by the brain shift (4, 5) in MR-based stereotactic DBS surgery.

KEYWORDS: Deep Brain Stimulator, High Field, Subthalamic Nucleus
Patterns of Chronic Venous Insufficiency in the Dural Sinuses and Extracranial Draining Veins and Their Relationship with White Matter Hyperintensities for Patients with Parkinson's Disease

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Purpose

Idiopathic Parkinson's disease (IPD) remains one of those neurodegenerative diseases where the cause remains unknown. Many clinically diagnosed cases of IPD are associated with cerebrovascular disease and white matter hyperintensities (WMH) (1). The purpose of this study was to investigate the presence of transverse sinus and extracranial venous abnormalities in IPD patients and their relationship with brain WMH.

Materials and Methods

Twenty-three IPD patients and 23 age-matched normal controls were recruited from the same site in this study. They had conventional neurological MR structural and angiographic scans. In addition, blood flow in the extracranial vessels were quantified with 2D phase contrast (PC) including the internal jugular veins (IJVs), vertebral veins, common carotid arteries, vertebral
arteries. The IJV flow was normalized by the total arterial flow. Venous structures were evaluated with 2D-time-of-flight (TOF); and WMH volume was quantified with T2-weighted fluid attenuated inversion recovery (FLAIR). The ratio of the flow in the dominant IJV (which carries the most flow) and the subdominant IJV (Fd/Fsd) was calculated for each case (Figure 1A). The IPD and normal subjects were classified using both the MR TOF and PC images into four categories: 1) complete missing transverse sinus and partially missing IJVs on the TOF images with high Fd/Fsd (Figure 1B); 2) missing transverse sinus and stenotic IJVs with high Fd/Fsd; 3) reduced flow in the subdominant IJV with high Fd/Fsd; and 4) normal flow and no stenosis.

Results
When broken into the above four categories with categories one through three combined, a significant difference in the distribution of the IPD patients and normal controls ($\chi^2=7.7$, $p<0.01$) was observed. Venous abnormalities (categories 1, 2 and 3) were seen in 57% of IPD subjects and only in 30% of controls. Patients with venous abnormalities tended to show higher volume WMH. In IPD subjects, category type correlated with both flow abnormalities and WMH.

Conclusions
A major fraction of IPD patients appear to have abnormal venous anatomy and flow on the left side of the brain and neck and the flow abnormalities in particular appear to correlate with WMH volume.

KEYWORDS: Parkinson Disease, Venous Drainage, Venous Stenosis

Normalized Dominant IJV flow vs. sub-dominant IJV flow

(Filename: TCT_O-434_Figure.jpg)

Hypertrophic Olivary Degeneration and Cerebellar Atrophy

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Purpose
It is well acknowledge that the primary (ischemia, hemorrhage, mass, trauma) or secondary (surgical treatment) injury of the dentato-rubro-olivary pathway may generate a unique pathological and imaging condition representing the phenomenon of hypertrophic olivary degeneration (HOD). The hallmarks include, depending on the level of injury, ipsilateral or bilateral increased T2 signal intensity and hypertrophy of the olive, and may be associated variably with dentatorubral tremor or palatal, cervical or ocular myoclonus. The purpose is to present two cases with classical acquired features of HOD associated with progressive cerebellar atrophy in the very late period. The progressive global cerebellar atrophy has not been considered previously in the definition of the HOD.

Materials and Methods
The first patient (50-year-old male) suffered symptomatic pontine hemorrhage due to cavernoma. He was followed up for up to 10 years after surgery. The second patient (32-year-old female) had history of systemic lupus erythematosus (SLE) and developed vasculitis with lacunar insults of the brain stem. The patient was followed up to five year after the first onset. The patients were evaluated by imaging studies (CT, MRI, MRA, catheter angiography).

Results
The first case was found to have - 10 months after surgery for pontine cavernoma with symptomatic hemorrhage - an abnormal T2 symmetrical signal in the olives of medulla oblongata bilateral, which persisted over the following three years. Two years after the surgery the patient developed progressive diplopia, numbness, poor coordination, dysarthria and intractable tremor. The patient was considered to be treated by deep brain stimulators. Repeated imaging in the following 10 years after surgery showed progressive general cerebellar atrophy. The second case suffered SLE and developed lacunar ischemic lesions of pons and thalamus. Three weeks later repeated MRI revealed abnormal T2 hyperintensity of olives involving the entire medulla oblongata. Repeated MRIs in the following four years showed persistent abnormal T2 signal of olives, shrinking of the superior medulla, and impressive progressive atrophy of pons and cerebellum. The chronological development of HOD in both cases showed initial T2 abnormality 10 months/3 weeks after ictus, with persistent increased T2 signal and mild olivary hypertrophy for three years/four years followed by continued signal decrease and olivary shrinking and impressive cerebellar atrophy.

Conclusions
The pathological changes within the olivary nucleus had been considered neuronal cell enlargement, cytoplasmatic vacuolation, fibrillary gliosis, demyelination, and astrocytic proliferation. The progressive involvement of the cerebellum in our cases may suggest similarities with the primary autosomal-inherited cerebello-olivary degeneration of Holmes, in which the olivary changes has been suggested to be secondary to transynaptic degeneration from the primary cortical degeneration. Some neuronal loss may be encountered in the dentate nucleus, but usually the afferent and efferent connections are uninvolved as are the motor and sensory tracts of the spinal canal. The evolution of the acquired HOD may suggest that the primary injury of dentato-rubro-olivary pathway may have the same impact on the cerebellum.

KEYWORDS: Hypertrophic Olivary Degeneration

O-436
Schizophrenia, Exercise and Hippocampal and Frontal Cortex Plasticity Assessed By High-Field Structural Imaging in MR

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Purpose

Previous imaging studies have suggested that reduced hippocampal volumes and frontal cortical thickness in schizophrenia are part of the underlying mechanism that gives rise to components of both psychiatric and cognitive impairment. Antipsychotic medications provide some alleviation of psychiatric deficits, but offer little to no amelioration of cortical or hippocampal deficits. Additionally, antipsychotic medications have deleterious metabolic and cardiovascular sequelae. In contrast, regular exercise is associated with improved cardiovascular health, enhanced mood state, weight loss, and increased hippocampal volumes in the normal population. We examined the effects of exercise on cortical thickness and hippocampal volume in a cohort of chronic hospitalized schizophrenia patients to determine if exercise could increase hippocampal volumes or frontal cortical thickness in chronically medicated patients.

Materials and Methods

a). Study Design: Measures of clinical symptoms and imaging were conducted at baseline, and at six weeks and 12 weeks following an exercise intervention. b). Subjects: 26 chronic refractory DSM-IV schizophrenia in-patients (10 female, 16 male) were recruited from the BC Psychosis Ward, UBC Hospital, and enrolled in a progressive 12-week supervised exercise program. Fourteen of 26 had completed all imaging research protocols at the time of this submission. c). Imaging: Standard whole brain 3D IR-weighted SPGR were collected at 3 T (Philips Achieva). Volumetric segmentation of hippocampal volumes and gray matter thicknesses were ascertained with FSL versus 4.1 and FreeSurfer 5.1 tools. d) Analysis: All repeated measures comparisons were based on baseline and 12 week follow-up scores. Preliminary repeated measures t-tests were used to investigate left-right differences. ANCOVAs with gender and total brain volume entered as covariates were used to test baseline versus follow-up differences in hippocampal volume or frontal gray matter thickness. Relationships between hippocampal volume and frontal thickness were explored with Pearson's linear correlations.

Results

All subjects were receiving antipsychotic treatment during the course of the study. Subjects were a mean age of 30.2 years and had been ill an average of 9.7 years at study entry. No significant left-right differences in any volumes were observed (all p-values >.10). Subsequent analyses used total left + right volumes. Total hippocampal volumes increased significantly after 12 weeks exercise (F(1,11)=9.4, p.=.01, particularly on the left (1,27)=6.2, p.=.03, but not the right (F(1,27)=.12, p>.50). Mean frontal lobe gray matter thickness did not increase after exercise (F(1,27)=.60, p. > .40), nor were hippocampal volumes and mean frontal lobe gray matter thicknesses correlated at baseline or follow up (all p-values > .10).

Conclusions

Twelve weeks of regular exercise was associated with increased hippocampal volume in chronically medicated schizophrenia patients, particularly on the left side. Exercise was not associated with overall frontal cortex thickness increases; however, a more focused assessment
of the frontal subregions may be more fruitful in determining potential benefits. These observations indicate that regular exercise is a potentially effective method of addressing the brain volume deficits associated with chronic schizophrenia and may result in improved cognitive functionality.

KEYWORDS: Cognitive Deficit, Cortical Thickness, Hippocampus

Tuesday
3:00PM - 4:30PM
Palais des congres de Montreal, 524

48 - PARALLEL PAPERS: Congenital Malformations and Seizures
O-437

Prenatal MR morphology of occipital encephaloceles

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Purpose
Meningoencephaloceles are congenital malformations of the central nervous system, characterized by the protrusion of meninges and cerebral tissue through a bony defect of the skull. When encephaloceles are detected prenatally, there is a need for detailed diagnostic assessment and characterization of a possible underlying syndrome. However, systematic studies on the prenatal MR appearance of encephaloceles are limited. This retrospective fetal MR study aims to systematically characterize cerebral MR morphology in cases with occipital and parietal meningoencephaloceles.

Materials and Methods
The 1.5-Tesla MR examinations (T2w, T1w, EPI, DWI) of 14 fetuses (mean gestational age: 26±3 gestational weeks (GW)) with occipital/parietal meningoencephaloceles were retrospectively analyzed for classification of anatomic characteristics. In five cases, a diffusion tensor sequence (16 gradient encoding directions, TR/TE = 2189/60 ms. FOV 230 x 230 x 72, resolution: 2mm x 2mm x 4mm, b = 0, 700 s/mm², scan time = 1 min 12 sec.) was performed.

Results
Displaced structures involved the occipital poles (3/14), occipital lobes (bilaterally 2/14, unilaterally 1/14), parietal and occipital lobes (bilaterally 1/14, unilaterally 2/14), and the parietal lobe only (1/14). In 2/14 cases, parts of the brainstem, the cerebellum, temporal and occipital lobes bilaterally were exteriorized. The typical features of Chiari III malformation were seen in 6/14 cases, no skull deformity with or without external CSF spaces in 3/14 cases. The encephalocele appeared grossly disorganized in 6/14 with hemorrhage in 3/14 and polymicrogyria in 2/14. In 3/14 the brainstem displayed abnormal kinking/rotation, a Z shape (1/14), and/or a molar tooth like configuration of the midbrain (3/14). Tractography revealed the presence and position of sensorimotor tracts in 5/5 and parts of the corpus callosum in 3/4. The displaced brain tissue showed diffusion restriction in 8/9 with massive frontooccipitally oriented tracts on DTI (3/5, Figure).
Conclusions
Fetal MRI allows prenatal characterization of the macro- and micro- structural heterogeneity of occipital encephaloceles and may provide important information in the genetic workup and counseling of affected pregnancies.

KEYWORDS: Fetal Brain Development, Fetal Brain Injury
Corpus callosum anomalies in Joubert syndrome: low prevalence and weak phenotype-genotype correlation

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Purpose
The molar tooth sign (MTS) is the neuroimaging hallmark of Joubert syndrome (JS) and results from a midbrain-hindbrain malformation characterized by vermian hypoplasia, thickened, elongated and horizontally orientated superior cerebellar peduncles and an abnormally deep interpeduncular fossa. Recently, we reported supratentorial neuroimaging findings including hippocampal malrotation, callosal dysgenesis, migration abnormalities, cephaloceles and ventriculomegaly in about 30% of JS patients. Mutations in KIF7, one of the 23 genes associated so far with JS, have been reported recently in patients with acrocallosal syndrome (ACS), a disease characterized by callosal agenesis and polydactyly. Additionally, the MTS have been reported in few children with a phenotype reminiscent of ACS. This suggests that there may be some overlap between JS and ACS. We aimed to 1) estimate the prevalence of anomalies of the corpus callosum in JS and 2) evaluate whether KIF7 is a major gene causative of this specific phenotype.

Materials and Methods
The inclusion criterion was neuroimaging findings consistent with JS (unequivocal presence of MTS). The evaluation included qualitative assessment of the corpus callosum. Genetic analysis performed in a subset of patients included sequencing of 21 JS genes (including KIF7).

Results
Neuroimaging studies of 533 patients with confirmed diagnosis of JS were included in this study. Complete agenesis of the corpus callosum was found in five patients. Other morphological abnormalities of the corpus callosum were found in eight additional patients and included partial agenesis (absence of the splenium and hypoplasia in three patients, respectively), and dysplasia (abnormal shape) in two. Screening for mutations in 21 genes associated with JS (including KIF7) was performed in 280 of 533 JS patients including four patients with complete callosal agenesis and three patients with other callosal abnormalities. Genetic analysis revealed causative mutations in KIF7 in one patient with complete callosal agenesis and another patient with a dysplastic corpus callosum. Mutations in KIF7 were excluded in 273 JS patients without callosal abnormalities.

Conclusions
Abnormalities of the corpus callosum are rare in JS and were found in 2.4% of JS patients. In our series, KIF7 mutations were rare and always associated with corpus callosum abnormalities. In the literature, however, mutations in KIF7 have been reported in JS patients with a normal corpus callosum, weakening the genotype-phenotype correlation between KIF7 mutations and
the occurrence of callosal anomalies. Neuroimaging findings are mandatory for the diagnosis of JS, but remain of limited value in classifying patients into specific subtypes.

KEYWORDS: Cerebellum, Corpus Callosum, Joubert Syndrome

O-439

Anatomical Connectome Reveals Abnormal Connectivity in Complete Corpus Callosum Agenesis

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Purpose
The corpus callosum (CC) is the major commissure in the human brain. In complete CC agenesis, the fibers of the CC are not missing, but heterotopic and form abnormal white matter tracts. Investigating the anatomical brain connectivity is crucial for understanding the structural reorganization of white matter circuits in children with CC agenesis. The structural connectome is an innovative technique suitable for the study of large-scale white matter connectivity of the human brain and the cerebral organization. Here, we apply a multiscale structural connectomics analysis to investigate white matter connectivity in children with complete CC agenesis. In more detail, we aim to 1) investigate connected/disconnected subnetworks, 2) characterize the topological network measures and 3) search for aberrant circuits in children with CC agenesis.

Materials and Methods
Patients were selected from our pediatric neuroradiology database based on 1) complete CC agenesis by conventional MR imaging (MRI) and 2) availability of diffusion tensor imaging (DTI) data without artifacts enabling high quality postprocessing. Age- and gender-matched controls also were selected. Diffusion tensor imaging data were acquired using a 1.5 T scanner. Postprocessing was performed using TORTOISE software. After nonlinear registration to MNI space, the cerebral and cerebellar cortex were parcellated into 108 regions using the AAL template. Probabilistic tractography was used to define connections between any pair of gray matter regions and an association matrix of structural connectivity was created for every subject. Structural connectomes for controls were created after excluding the CC (virtual callosotomy). Further analysis included 1) network-based statistics (NBS) to detect interconnected subnetworks as a whole and 2) topological network measures analysis to perform quantitative analysis of network metrics across different densities.

Results
Eleven patients (6 males, mean age 11.7 years) and 11 healthy controls were included in this study. One patient with two aberrant interhemispheric tracks was excluded from network analysis. Network-based statistics revealed three highly connected subnetworks (two intrahemispheric, one interhemispheric) in patients compared to controls. Topological network measure analysis showed higher clustering coefficient, smaller characteristic path length, higher global efficiency, slightly higher local efficiency (at higher density level), smaller assortativity and higher transitivity values across the range of densities in patients compared to controls. Network hubs were found in both insular and the left and right insula, and precuneus gyri and
right lingual gyrus in patients and in the right postcentral gyrus and cerebellar 8th lobule and bilateral precuneus gyri in controls.

Conclusions
In patients with CC agenesis, the structural network is more segregated and less integrated compared to controls. This represents more local (between neighboring anatomical regions) rather than global interactions. In patients, the absence of hubs in the cerebellum may reflect compensatory mechanisms to maintain local efficiency at the cost of global connectivity. Highly interconnected subnetworks in patients also suggest effective local connectivity and may reflect compensatory rewiring mechanism in CC agenesis. Connectome analysis provides new information about abnormal connectivity and potential reorganization of white matter tracts in CC agenesis.

KEYWORDS: Connectivity, Corpus Callosum, Diffusion Tensor Image

O-440
3:21PM - 3:28PM

Correlation of Prenatal and Postnatal MRI Findings in Schizencephaly

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Purpose
Schizencephaly is a rare malformation of the central nervous system characterized by a gray matter lined defect extending from the pial surface to the lateral ventricles. Previously it has been reported that the prenatal and postnatal appearances of schizencephaly are identical. The purpose of this study was to correlate imaging findings of schizencephaly and associated anomalies on fetal and postnatal MR imaging (MRI) and assess possible changes which may occur from the prenatal to postnatal state.

Materials and Methods
A retrospective review of 32 fetal subjects diagnosed with schizencephaly on prenatal MRI at our institution was performed. Those without postnatal MRI follow up at our institution were excluded. Subject age, cleft type, number, location, status of cortex lining the defect, presence or absence of a covering membrane (thin linear membrane along the surface or depth of the cleft), presence of signs of hemorrhage, and presence of other anomalies were assessed. Normalized dimensions of the defect at three levels and normalized width of the ipsilateral ventricle were measured on pre and postnatal imaging. These features and measurements were compared statistically and correlated to changes in the clefts between pre and postnatal imaging in order to assess whether these factors play a role in the observed changes in the schizencephalic clefts.

Results
Ten subjects with 18 clefts (8 bilateral) were included. The majority of defects (83%) were open on prenatal MRI, but 47% of those were found to subsequently have closed on postnatal imaging. Evidence of prior hemorrhage was seen in 83%. Prenatal MRI detected all cases of absent septum pellucidum, but detected a fraction of gross polymicrogyria and missed all cases of optic nerve hypoplasia. A covering membrane was detected in 10 defects prenatally, but only persisted in two defects postnatally. The normalized ipsilateral ventricular and inner and middle
width dimensions of the defects were significantly decreased at postnatal imaging (P<0.05). The widths of the defects, ventricular width, presence of a cleft membrane, and presence of hemorrhage were not predictors of closure of prenatally diagnosed open defects (P>0.05).

Conclusions
In our series, nearly half of prenatally diagnosed open schizencephaly defects had closed on postnatal imaging. Prenatal MRI was only able to demonstrate some of the associated anomalies. Our analysis could not predict which prenatally diagnosed open schizencephalic clefts will close.

KEYWORDS: Fetal, Fetal Brain Development, Schizencephaly

O-441

What is different in the acallosal fetal brain?

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Purpose
Complete agenesis of the corpus callosum (CCA) is a rather common developmental brain defect, with a reported incidence of 0.05-1% (1, 2) in the general population and 2-3% in patients with mental retardation (2). In cases of CCA, accompanied by associated brain or body malformations, severe psychomotor deficits and intractable epileptic seizures frequently are encountered (3). In contrast, the isolated finding of CCA leads more frequently (>80%) to a close to normal postnatal intellectual development (4). This study aims to detect and describe abnormalities and differences in cortical folding patterns of fetuses with CCA.

Materials and Methods
Three orthogonal T2-w sequences (1.5 T, slice thickness 4.4 mm, FOV 230 mm, TE=140 ms) of 15 fetuses with isolated and 15 cases with associated forms of CCA were compared to 15 age-matched normal fetuses. For 3D modeling axial, coronal and sagittal sequences were combined into isotropic volumes (resolution 0.78-1.02 mm) using intraslice motion correction and super-resolution reconstruction. The program ITK snap was used for manual segmentation of the surface of the fetal brain and the ventricles. In these, the shape of the manually delineated cortical contour was described using a 3D Gaussian model.

Results
Three-dimensional modeling could readily visualize the dynamic cortical folding patterns in CCA fetuses. Super-resolution datasets allowed the identification of subtle differences between normal fetuses and cases with isolated forms of CCA, whereas differences (ventricular size, brain size, cortical surface) were more pronounced in cases with associated anomalies.

Conclusions
In this preliminary work we used the technique of super-resolution 3D modeling to detect subtle differences of atypical cortical folding patterns of fetuses with CCA. In future, these tools may be further suitable to differentiate cases of isolated CCA with adverse neurodevelopmental outcome from those with close to normal development.

KEYWORDS: Callosal Dysgenesis, Fetal, Fetal MR Imaging
CNS Imaging Findings Associated with Parry-Romberg Syndrome/En Coup de Sabre and Correlation to Cutaneous and Neurological Abnormalities.

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Purpose
Parry-Romberg syndrome (PRS) and en coup de sabre (ECS) are both variants of morphea along a spectrum. Although numerous central nervous system (CNS) imaging findings of PRS/ECS have been reported, the prevalence of CNS imaging findings and relationship to cutaneous and neurological abnormalities has not been well characterized.

Materials and Methods
We performed a retrospective review of all patients less than 50 years of age at our institution over a 16-year interval with a confirmed clinical diagnosis of PRS/ECS by a skin/facial subspecialist. Two neuroradiologists evaluated the available imaging and characterized CNS imaging findings. These were correlated to the cutaneous and neurological abnormalities.

Results
Eighty-eight patients with PRS/ECS were identified [62 females (70.4%); average age: 28.8 years]. Nineteen of 43 (44%) patients with CNS imaging exams had abnormal imaging findings, although the only abnormal imaging finding in one patient was lateral ventricle asymmetry. Of the remaining 18 patients, findings were bilateral in 11 (61%), strictly ipsilateral to the side of facial involvement in six (33%), and strictly contralateral in 0 (6%). The two most common CNS imaging findings were white matter T2 hyperintensity in 14 of 43 (33%) patients and atrophy/encephalomalacia in five of 43 (12%) patients. Sixteen patients had serial imaging examinations over an average interval of 632 days (range 118-3438 days), of whom 13 (81%) had stable imaging findings. Three of 16 (19%) patients with serial imaging had change over time. One patient had decreased white matter T2 hyperintensity, progression of right atrophy, and development of right cortical T2 hyperintensity. Another had decrease in white matter T2 hyperintensity, development of encephalomalacia in left basal ganglia, and enlargement of a porencephalic cyst. The third patient had development of new areas of white matter T2 hyperintensity with subtle enhancement. Of 23 patients with a clinical neurologic abnormality and imaging, 12 (52%) had abnormal imaging findings. These included six of 18 (33%) with headaches and 7 of 7 (100%) with seizures. Six patients with PRS/ECS were evaluated by neurology and found to have no neurologic abnormality. Of those six, 4 (67%) had imaging and two (33%) had abnormal imaging findings, including 1 patient with bilateral cerebral aneurysms and 1 with a left cerebellar hemorrhage, prominent deep and subcortical WM T2 hyperintensities, and an area of T2 hyperintensity in the thalamus. Five of 6 (83%) patients with progressive cutaneous findings over the interval of serial examinations had stable imaging findings, with the other displaying increasing white matter T2 hyperintensities.

Conclusions
This study represents the largest study on neuroimaging studies in patients with PRS/ECS to date and is unique in that imaging findings were correlated with cutaneous and neurologic findings, all followed over time. Unlike prior reports, this study found that imaging findings are frequently bilateral. Imaging findings are inconsistently associated with clinical neurologic abnormality, are
frequently present in the setting of seizures, are usually stable over time, and often do not correlate with cutaneous disease activity.

KEYWORDS: Atrophy, Headaches, Seizure

Volumetric changes in hippocampal subregions and their relation to memory in pediatric non-lesional localization-related epilepsy

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¹Hospital for Sick Children, Toronto, Ontario, Canada

Purpose
Developmental differences in structure and function have been reported along the hippocampal subregions. The aims of this study were to determine if there were volumetric differences in hippocampal head (HH), body (HB), tail (HT) and total hippocampus (TotH) in children with nonlesional localization-related epilepsy relative to controls, and the relation between hippocampal subregions with episodic memory and clinical parameters.

Materials and Methods
Forty-eight children with nonlesional localization-related epilepsy, consisting of 29 left- and 19 right-sided epilepsy, and 27 healthy controls were recruited. All patients and controls underwent volumetric T1-weighted imaging, verbal and nonverbal memory testing. The volume of hippocampal subregions was compared between patients and controls. The associations between left hippocampal subregions with verbal memory, right hippocampal subregions with nonverbal memory, and hippocampal subregions with age at seizure onset and seizure frequency were assessed.

Results
Patients with left-sided epilepsy had smaller left HH (p=0.003) and HB (p=0.012), right HB (p=0.021) and HT (p=0.015), and right TotH (p=0.020) volumes. Those with right-sided epilepsy had smaller right HT (p=0.018) volume. There were no significant differences between verbal and nonverbal memory in left- and right-sided epilepsy relative to controls (all p>0.025). In left-sided epilepsy, there was a significant association between left HH volume with verbal memory (β=0.492, p=0.001). There was no significant association between left and right hippocampal subregions with verbal and nonverbal memory respectively in right-sided epilepsy and controls (all p>0.002). In left- and right-sided epilepsy, there was no significant association between hippocampal subregions with age at seizure onset and seizure frequency (all p>0.002).

Conclusions
We have found hippocampal volume reduction, but did not identify a gradient in the severity of volume reduction along the hippocampal axis in children with localization-related epilepsy. We also have found a significant association between reduced left HH volume with reduced verbal memory in left lateralized epilepsy, suggesting that the left HH may play a greater role in verbal episodic memory than the remaining hippocampus. Longitudinal study is needed to clarify whether there is a differential rate of volume reduction along the axis of the hippocampus in children with continuing seizures.
Subtraction imaging and MR co-registration to increase diagnostic yield of ictal and interictal SPECT in localization of epileptogenic foci in patients with intractable seizures.

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Purpose
Patients with intractable epilepsy are candidates for surgical resection if an epileptogenic focus can be identified. Current multidisciplinary evaluation, including neuro-clinical data, electroencephalogram (EEG), MR imaging (MRI), magnetoencephalographic (MEG) and nuclear medicine imaging has allowed for the ability to localize epileptogenic foci. SPECT perfusion imaging, in particular, is an important tool in identifying epileptogenic foci in patients with intractable seizures, however analysis typically has been performed subjectively. Improved quantitative processing of ictal and interictal SPECT perfusion data with MR coregistration may increase the ability to identify and localize seizure foci. In this study, we sought to determine the diagnostic yield of ictal-interictal subtraction imaging and MRI coregistration at a single institution.

Materials and Methods
All patients who underwent HMPAO-SPECT perfusion imaging for the evaluation of intractable seizures at a single tertiary care pediatric neuroscience institute over a two and one half year period were reviewed retrospectively. For patients with ictal SPECT (IS) and interictal SPECT (IIS), subtraction imaging was performed. All images were coregistered to volumetric T1-weighted MR images using a FDA approved software package (MIM-Vista, MIM Software, Cleveland, OH). Abnormal SPECT results were defined as visual hypoperfusion on interictal SPECT and/or statistically significant hyperperfusion on ictal SPECT with postprocessing subtraction. The presence of abnormality on pre-SPECT MRI was recorded for comparison.

Results
One hundred and sixteen patients with intractable epilepsy underwent SPECT imaging as part of their evaluation, including 60 (52%) with IS-IIS subtraction imaging, and 56 (48%) with IIS only. Ninety-six of 116 (83%) had an abnormality identified on SPECT. Of the 96 patients with abnormal SPECT studies, 50 had abnormal ictal scans, 77 had abnormalities on interictal SPECT, and 30 had abnormalities on both ictal and interictal SPECT. Twenty patients showed no abnormality on SPECT imaging. In total, 94 patients had an abnormality noted on MRI. The most common MRI abnormality noted was volume loss, followed by nonspecific white matter signal abnormality. Of the 116 patients, seven patients demonstrated normal findings on both MRI and SPECT. Fifteen patients demonstrated a normal MRI but an abnormal SPECT study. Thirteen patients had abnormalities on MRI without SPECT abnormalities. The remaining 81 patients had abnormalities on both MRI and SPECT. Only 56 of these 81 MRI findings were considered "corresponding abnormalities" to the SPECT study.
Conclusions
In patients with intractable epilepsy, SPECT perfusion imaging employing IS-IIS subtraction with MRI coregistration identifies likely seizure foci in a majority of patients, with a diagnostic yield higher than historical reports of qualitative analysis.

KEYWORDS: Epilepsy, Pediatric Epilepsy, Seizure

O-445

MR Guided LASER ablation of non-lesional epileptic foci in pediatric patients utilizing Magnetoencephalography (MEG) scan and EEG.

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\(^1\)Sutter Medical Center Sacramento, Sacramento, CA

Purpose
Medically refractory epilepsy affects approximately 300,000 patients in the United States. Early surgery reduces long term impact, comorbidities and improves quality of life. Patient fear of an open craniotomy and the use of intracranial electrode monitoring, combined with more extratemporal foci in pediatric cases delays surgical decisions. Often electroencephalogram (EEG) tracing localization may not correlate with any obvious MR imaging (MRI) abnormality. Multimodality studies [EEG, magnetoencephalography (MEG) scan, positron emission tomography (PET) scan and functional MRI (fMRI)] can be used to identify nonlesional epileptic foci and plan stereotactic laser ablation (SLA), a minimally invasive technique offering less morbidity and quicker recovery. To our knowledge, we present the largest cohort of
pediatric patients in the literature who were treated using MR-guided SLA of nonlesional epileptic foci.

Materials and Methods
All patients with medically refractory epilepsy were studied with video-EEG, then correlated the seizure onset of scalp EEG with MEG scan dipoles. All the patients had a normal MRI showing no signs of cortical dysplasia. Language and motor centers were localized by fMRI. A total of 19 pediatric patients aged between 4-20 years (mean age of 13.7, Table 1) underwent SLA. We combined EEG, MEG scan, fMRI, PET scan and utilized frameless BrainLab localization to perform minimally invasive MRI-guided SLA (Visualase Thermal Therapy System; Visualase, Inc., Houston, TX) was employed in this work. Critical safety points were placed near location of critical structures to limit temperatures below 50 C. A baseline pre-ablation EEG was performed in the OR with MR compatible plastic electrodes. Stereotactic laser ablation was performed while simultaneously observing the evolution of the estimated ablated cavity calculated from real time thermal images. A postablation EEG was repeated with the patient still in the MR suite demonstrating complete resolution of the abnormal spikes seen on the pre-ablation EEG. This defined successful ablation. Improved clinical outcome was characterized by seizure freedom or seizure reduction by more than 50%.

Results
The laser ablations were performed in frontal lobe (5/19), temporal lobe (3/19), occipital (1/19) and multilobar (10/19). All patients showed reduction of pattern of abnormal spikes on postablation EEG. Duration of follow up ranged anywhere from two to 24 months from SLA. Sixty-three and one half percent (12/19) of them are seizure free, 31.5% (6/19) have 50-96% reduction in seizures, 5% (1/19) patient only had 10% reduction in seizure. Two patients were treated twice, one became seizure free after the second SLA and the other had over 90% reduction in seizure frequency.

Conclusions
MR-guided SLA of epileptic foci in this large cohort of pediatric patients showed that 95% of patients became seizure free or had significant reduction in seizure frequency. Our outcomes are better than standard resective surgery and similar to success rate for standard mesial temporal resection. Stereotactic laser ablation could be a superior alternative to routine cortical resection given the significant decrease in morbidity, safety/precision of the technology and the quick recovery associated with this procedure. The utilization of MEG scan combined with EEG surface recording and fMRI allows multimodal localization of epileptic foci in patients with normal MRIs and no clear evidence of cortical dysplasia. Given the minimally invasive nature of SLA, patients can safely have a repeat laser ablation if the seizures do not resolve or significantly decrease in frequency.

KEYWORDS: Epilepsy, Laser, MEG

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Laser ablation location</th>
<th>Follow-up (months)</th>
<th>Seizure Free</th>
<th>50-96% seizure reduction</th>
<th>&lt;50% seizure reduction</th>
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<tr>
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Clinical, EEG, MRI and surgical outcomes of pediatric epilepsy with Astrocytic Inclusions versus Focal Cortical Dysplasia

L. Alshafai\(^1\), O. Snead\(^2\), E. Widjaja\(^3\), A. Ochi, C. Go, B. McCoy, H. Otsuob, J. Rutka

\(^1\text{University of Toronto, Toronto, Ontario, } \^2\text{Hospital for Sick Children, Toronto, Ontario, } \^3\text{The Hospital for Sick Children, Toronto, Ontario}

Purpose
To compare the clinical, electroencephalography (EEG), magnetoencephalography (MEG), MR imaging (MRI), and surgical outcomes of children with astrocytic inclusions (AI) relative to focal cortical dysplasia (FCD).
Materials and Methods
The clinical manifestations (including age at seizure onset, duration of epilepsy), video EEG (including seizure semiology and characteristics of interictal and ictal discharges), MEG, MRI features (including abnormal signal in cortex and subcortical white matter, increased cortical thickness, blurring of gray-white matter junction, abnormal sulcation and gyration pattern, reduced white matter volume and gray matter heterotopia) and surgical outcomes of children with histologically proven AI were compared to those with FCD.

Results
Six children had AI and 27 had FCD. Children with AI had early age at seizure onset, periodic spasms, and have unusual interictal epileptiform discharges consisting of mixture of generalized or diffuse hemispheric slow waves, sharp waves, spikes and polyspikes. Patients with AI were less likely to have clusters on MEG (p=0.057) or high T2/FLAIR in the subcortical white matter on MRI (p=0.015), more likely to demonstrate abnormal sulcation and gyration pattern (p=0.001) and have gray matter heterotopia (p=0.002) than FCD. Children with AI (25%) have a lower proportion of seizure-free outcome after surgery compared to FCD (55.5%), even though this was not statistically significant.

Conclusions
The clinical, EEG and MRI findings could help distinguish AI from FCD, and AI may have poorer prognosis following surgical resection. There have been several reports of eosinophilic astrocytic inclusions from histological brain specimens of patients with early onset epilepsy, with or without developmental delay and structural brain malformations (Hazrati et al., 2008; Hedley-Whyte et al., 2009; Horoupian et al., 2003; Kato et al., 1992; Minagawa et al., 1992; Van den Veyver et al., 2004; Visanji et al., 2012). These inclusions have been shown to be positive for filamin A in patients with intractable epilepsy (Hazrati et al., 2008; Hedley-Whyte et al., 2009) and Aicardi syndrome (Van den Veyver et al., 2004). Filamin A is an actin binding protein involved in neuronal migration. Other proteins such as cytoglobin and glutamate transporter I, also have been shown to be present. These inclusions also demonstrated increased expression of catalase and carbonic anhydrase I (Visanji et al., 2012). Animal model of status epilepticus has shown increase catalase levels in the hippocampus, striatum and frontal cortex (Freitas et al., 2004), suggesting that the increase catalase may be a reaction to oxidative stress and cell injury during epileptic seizures. Increased carbonic anhydrase II and XII also have been shown in animal model of status epilepticus (Halmi et al., 2006), suggesting a link between carbonic anhydrase and seizures. Although the proteomic content of the AI is increasingly recognized, less is known about the clinical, electrophysiological and neuroimaging manifestations of this condition. The reported cases of AI from resected brain tissue to date have been from patients with early onset epilepsy (Hazrati et al., 2008; Hedley-Whyte et al., 2009; Visanji et al., 2012). However, the surgical outcomes of patients with AI have not been well documented. Also, it is unknown if there are distinct clinical and diagnostic tests that could differentiate these epileptogenic lesions.

KEYWORDS: Epilepsy, Focal Cortical Dysplasia

<table>
<thead>
<tr>
<th>MRI features of astrocytic inclusions and focal cortical dysplasia</th>
<th>Astrocytic Inclusions (n=6)</th>
<th>Focal Cortical Dysplasia (n=27)</th>
<th>p-value</th>
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<td>High T1 signal in cortex</td>
<td>1 (17%)</td>
<td>10 (37%)</td>
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<td>High T2/FLAIR signal in cortex</td>
<td>0 (0%)</td>
<td>10 (37%)</td>
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<td>Count 2</td>
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<tr>
<td>High T2/FLAIR signal in subcortical white matter</td>
<td>1 (17%)</td>
<td>19 (70%)</td>
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<tr>
<td>Increased cortical thickness</td>
<td>0 (0%)</td>
<td>6 (22%)</td>
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<tr>
<td>Blurring of gray-white matter junction</td>
<td>1 (17%)</td>
<td>9 (33%)</td>
<td>0.422</td>
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<tr>
<td>Abnormal sulcation and gyration pattern</td>
<td>4 (67%)</td>
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<td>Reduced white matter volume</td>
<td>0 (0%)</td>
<td>1 (4%)</td>
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<td>Abnormal signal in the white matter extending towards ventricle</td>
<td>1 (17%)</td>
<td>1 (4%)</td>
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<td>Gray matter heterotopia</td>
<td>2 (33%)</td>
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(Filename: TCT_O-446_figure1.jpg)
Presurgical Language Evaluation with fMRI in Intractable Pediatric Epilepsy: Validation with Extraoperative Electroencephalographic Stimulation Mapping Under Different Clinical Scenarios

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Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Purpose
Surgical therapy is employed increasingly for treating intractable epilepsy in children. Correct assessment of language lateralization is critical for operative planning as language centers must be spared, and children with intractable epilepsy more commonly have atypical language distribution. Extraoperative electrocortical stimulation mapping (ESM) is a clinical gold standard for language lateralization and localization prior to surgery, however is limited by surgical exposure and is invasive. Validation of functional MR imaging (fMRI) in children with epilepsy is limited but is critical to inform use of this technique. This study aims to assess agreement between clinical fMRI language laterality measures and objective assessments of language laterality in pediatric epilepsy surgery patients using different interpretation scenarios.

Materials and Methods
Thirty pediatric epilepsy surgery patients with subdural grid placement and ESM covering typical language areas (29), Wada testing (1), or both (3) and language fMRI were identified. All fMRI examinations included verb generation (VG) and story processing (SP). Functional MRI was processed in a clinical system (BrainLAB iPlan 3.0) without knowledge of side of surgery or ESM results. Functional MRI examinations were evaluated by: 1. Visual inspection (VI), at the workstation with continuous thresholding, specifically evaluating the inferior frontal (FL) and temporal lobes (TL), and 2. Using standardized region of interest (ROI) calculations in the FL and TL. Lateralization indices (LI) comparing volumes of activation, left versus right, were calculated at: median statistical significance (mtROI, mid-way between peak significance and excessive artifact determined by VI), and lowest threshold (ltROI, before appearance of artifact): 0.2 used as the LI cutoff. Clinical objective language laterality (COL) was determined by ESM [Left: left stimulation sites (+) or right stimulation sites (-). Right: right stimulation sites (+) or left stimulation sites (-).] and Wada. Functional MRI scenarios included: left versus not left (LvNL); bilateral/right lateralization were "not left"; left versus right (LvR); bilateral were excluded; left + bilateral versus right (LBvR) bilateral/left lateralizing were left. LPV (probability of true left COL), RPV (probability of true right COL), and Concordance (overall agreement) were calculated.

Results
Average age was 13.7 years and 70% were right-handed. All had diagnostic VG and 22/30 had diagnostic SP paradigms. Nine patients (30%) had atypical (right, bilateral, or mixed) language lateralization by fMRI. See Figure for overall results. VI of VG fMRI in the FL demonstrated excellent agreement with ESM/Wada (LPV: 0.96, RPV: 0.8, Concordance: 0.93), identical to ROI-based analysis, using the LBvR scenario. VI of VG fMRI in the TL performed similar or better than ROI in all three comparison scenarios. While exhibiting a perfect LPV in all scenarios, SP fMRI had worse RPV and concordance using VI than VG, and in most other scenarios. SP demonstrated perfect LPV and RPV at ltROI, but a diagnostic exam could be completed in only 22/30 (73%) subjects. ltROI showed better performance than mtROI analyses in most scenarios. Best performance measures occurred using the LBvR scenario with worst performance using TL.
assessment and LvNL scenarios. An improvement in performance was noted using ROI analysis compared with VI with SP at ltROI.

Conclusions

Functional MRI demonstrated excellent agreement with objective measures of language lateralization in pediatric epilepsy patients. VG paradigms, evaluating the frontal lobe, performed the best and visual inspection of fMRI data was as good as ROI-based laterality in most tested scenarios. SP paradigms, while exhibiting excellent performance, especially using ltROI analysis, was more variable and was nondiagnostic in 8/30 patients suggesting the need for improved evaluation techniques for temporal language areas. Combination of VI and ROI analysis likely maximizes performance, especially using SP paradigms.

KEYWORDS: Language, Preoperative Language Lateralization

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<tr>
<th>Scenario</th>
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<th>ROI - VG Frontal, MID t</th>
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<td>LBvR</td>
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Usefulness of DTI analysis of brain tissue surrounding the cortical tuber for predicting epileptogenicity in tuberous sclerosis patients

A Yogi1, Y Hiarata1, E Karavaeva1, J Wu1, S Yudovin1, B Ellingson1, N Salamon1

1David Geffen School of Medicine at University of California Los Angeles, Los Angeles, CA

Purpose

Up to 90% of patients with tuberous sclerosis complex (TSC) have seizures, and 25-30% will develop intractable epilepsy. For these patients, neurosurgery is essential treatment of choice for
seizure control. Based on electrophysiological data, epileptogenic tissue is found in the tissue around tubers. The purpose of this study is to evaluate if diffusion tensor imaging (DTI) can detect the epileptogenic tissue in TSC.

Materials and Methods
From the UCLA epilepsy program TSC cohort, twenty-three patients underwent surgery between 2004 and 2011. Total of 699 tubers were included in the study. All patients had preoperative DTI. Tubers were divided in three groups according to T2 changes. The DTI analysis was performed using AFNI (Analysis of Functional NeuroImages). One neuroradiologist and one neurosurgeon manually outlined all tubers on T2-weighted images or FLAIR images in consensus, and created region of interests of tubers (ROI tuber). Region of interest tuber then was inflated by 2mm and 4mm and the original ROI tuber was subtracted to create an ROI of brain tissue which surrounds the tuber (ROI 2mm, ROI 4mm). Regions of interest which include tuber and surrounding tissue by 2mm and 4mm were generated as ROI tuber+2mm and ROI tuber+4mm respectively. Calcification, flow void, cerebrospinal fluid, bone, and air were carefully eliminated from those ROIs. All created ROIs were overlaid on apparent diffusion coefficient (ADC) maps and FA maps, and median and maximum values of ADC and FA were calculated in all ROIs. Epileptogenicity was defined by pre-operative EEG, MSI and intra-operative electrocorticography. This is confirmed by postoperative seizure control. We compare the DTI parameters between epileptogenic tubers and nonepileptogenic tubers, and each patient groups divided by age and tuber type, using Mann-Whitney U test and unpaired t test.

Results
Six hundred ninety-nine cortical tubers were identified by preoperative MRI, and 73 epileptogenic cortical tubers and 626 nonepileptogenic cortical tubers were identified. Five hundred fifty-three cortical tubers were available for ADC analysis (54 epileptogenic, 499 nonepileptogenic), and 411 were available for FA analysis (43 epileptogenic, 358 nonepileptogenic). The median ADC values of cortical tuber (p < .0018), surrounding tissue by 2mm (p < .006) and 4mm (p < .008), and cortical tuber with surrounding tissue by 2mm (p < .0045) and 4mm (p < .0014) in epileptogenic group were significantly lower than those in nonepileptogenic group. Maximum ADC values and all FA values showed no significant differences.

Conclusions
This is the first study demonstrating the ADC values of brain tissue surrounding epileptogenic tuber is significantly lower than nonepileptogenic group. Diffusion tensor imaging can be a promising tool to predict the epileptogenic tissue in tuberous sclerosis.

KEYWORDS: Diffusion Tensor Image, Epilepsy, Tuberous Sclerosis
Independent Contribution of Individual White Matter Pathways to Language Function in a Cohort of Pediatric Epilepsy Patients

M Paldino, J Monsalves, W Zhang

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Purpose
Patients with epilepsy and malformations of cortical development (MCD) are at high risk for language and other cognitive impairment. Specific impairments, however, are not well correlated with the extent and locale of dysplastic cortex (1). Such findings highlight the relevance of aberrant cortico-cortical interactions, or connectivity, to the clinical phenotype. Abnormalities within several white matter pathways have been reported in association with language dysfunction. However, in patient populations whose cerebral connectivity and brain function are both extensively abnormal, an association between a proposed biomarker and a particular cognitive function may be indirect (i.e., epiphenomenon). The goal of this study was to
determine the independent contribution of well described white matter pathways to language function in a cohort of pediatric patients with epilepsy.

Materials and Methods

Patients were identified retrospectively from an existing database of pediatric epilepsy patients with the following inclusion criteria: 1. Diagnosis of MCD. 2. Diffusion tensor imaging performed at 3 T. 3. Language characterized by a pediatric neurologist. Diffusion Toolkit and Trackvis (www.trackvis.org) were used for segmentation and analysis of the following tracts: corpus callosum, corticospinal tracts, inferior longitudinal fasciculi (ILF), inferior fronto-occipital fasciculi (IFOF), uncinate fasciculi (UF), and arcuate fasciculi (AF). Mean diffusivity (MD) and fractional anisotropy (FA) were calculated for each tract. Wilcoxon rank sum test (corrected for multiple comparisons) was used to assess potential differences in tract parameters between language-impaired and language-intact patients. In a separate analysis, a machine learning algorithm (random forest approach) was applied to measure the independent contribution of the measured diffusion parameters for each tract to the clinical phenotype (language impairment). In other words, the importance of each tract parameter was measured after adjusting for the contribution of all other tracts.

Results

Thirty-three MCD patients were included (age range: 3-18 years). Twenty-one patients had intact language, 12 were impaired. All tracts were identified bilaterally in all patients except for the AF, which was not identified on the right in 10 subjects and not identified on the left in 11 subjects. Mean diffusivity and/or FA within the left AF, UF, ILF, and IFOF differed between language-intact and language-impaired groups. However, only parameters related to the left uncinate and arcuate fasciculi were independently associated with the clinical phenotype (Figure 1).

Conclusions

Quantitative metrics derived from the left uncinate and arcuate fasciculi were associated independently with language function. These results support the importance of these pathways in human language function.

KEYWORDS: Diffusion MR Imaging, Epilepsy, Language
Tract Importance

(Filename: TCT_O-449_Figure1.jpg)

Tuesday
4:45PM - 6:15PM
Palais des congres de Montreal, 517bc

49 - ASPNR PROGRAMMING: 2014 ASPNR INTERESTING CASE-BASED SESSION
O-450
Interesting Cases Panelists

Vossough, A. · Chong, W. · Hoffmann, C. · Soares, B.
University of Pennsylvania · Great Ormond Street Hospital for Children · Sheba Medical Center · Emory University
Philadelphia, PA · London · Ramat-Gan · Atlanta, GA

Tuesday
4:45PM - 6:15PM
Palais des congres de Montreal, 517d

50 - MINI SYMPOSIUM-TUMOR - PART V
O-453

Advanced Imaging in Pediatric Gliomas: Diagnostic and Therapeutic Implications

Panigrahy, A.
Children's Hospital of Pittsburgh of UPMC
Pittsburgh, PA

O-454

Advanced Diffusion-Weighted MRI Analysis for Brain Tumor Tissue Characterization in Pediatric Patients

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1Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, IL

Purpose
The purpose of this study was to exploit the high b-value diffusion-weighted magnetic resonance imaging (DW-MRI) with advanced diffusion analysis using the anomalous diffusion model and the bi-exponential two-compartment model, for differentiation of malignant and benign brain tumor tissues in pediatric patients.

Materials and Methods
All MRI exams were performed on 1.5 T and 3.0 T scanners (Magnetom Aera/Skyra, Siemens Medical Solution). Diffusion-weighted MRI covering the entire tumor area was acquired with single shot echo planar sequence using 16 extended b-values (0-3500 s/mm²) applied in three orthogonal directions. A region of interest (ROI) was placed on each solid tumor region and the averaged signal intensity (S) at all b-values was measured within each tumor ROI. Conventional apparent diffusion coefficient (ADC) was calculated using a mono-exponential model fitting signal decay (b=0-1000 s/mm²). Extended diffusion parameters were derived from two advanced diffusion models: anomalous diffusion model and bi-exponential two-compartment model, by the Levenberg–Marquardt nonlinear fitting (Matlab program). 1) In the anomalous
diffusion model, the signal intensity at all 16 b-values (0-3500 s/mm^2) were fitted based on the equation \( S(b)/S_0 = \exp[-D\mu^2(\beta-1)\gamma G_d^\delta(\Delta-(2\beta-1)\delta/(2\beta+1))] \), where Gd is diffusion gradient amplitude, \( \delta \) and \( \Delta \) are diffusion gradient pulse width and interval, respectively. Two anomalous diffusion parameters -space constant \( \mu \) (unit: \( \mu m \)) and complex parameter \( \beta (0<\beta<1) \) were derived. 2) In the two-compartment model, signal intensity at 11 higher b-values 150-3500 s/mm^2 (to avoid perfusion effect) were fitted based on the equation \( S(b)/S_0 = V_{fast}\exp(-D_{fast}b)+V_{slow}\exp(-D_{slow}b) \). Extracellular diffusion coefficient (D_{fast}) and volume (V_{fast}), and intracellular diffusion coefficient (D_{slow}) and volume (V_{slow}) were derived. Each of the diffusion parameters (ADC, \( \mu \), \( \beta \), D_{slow}, V_{slow} and D_{fast}) was compared between malignant and benign tumor types using a nonpaired t-test with unequal variance (\( \alpha =0.05 \)).

Results
A total of 33 patients (1-25 years old) with biopsy-proven brain tumors were enrolled and divided into malignant (n=17: 5 nontreated and 12 treated tumors) and benign groups (n=16: 6 nontreated and 10 treated tumors) All diffusion measurements including \( \mu \), \( \beta \), ADC, D_{fast}, D_{slow} and V_{slow} for all nontreated and treated benign and malignant tumors were plotted in the Figure. By comparing all benign and malignant tumors regardless of the treatment status, \( \mu \), \( \beta \), D_{fast} and D_{slow} all demonstrated strongly significant differences between malignant and benign tumors with p<0.005, whereas ADC showed weaker significance (p=0.01). In addition, to avoid the treatment efficacy variation, only nontreated tumors were compared, where \( \mu \), \( \beta \), D_{slow}, V_{slow} and ADC all demonstrated significant differences between malignant and benign tumors (p<0.005 for all except p of V_{slow}=0.01 and p of ADC=0.007). Specifically, two treated malignant tumors that demonstrated closer measurements as the benign tumors showed clinically proven improved disease and complete remission after treatment.

Conclusions
Malignant tumors are characterized with more compact tissue density, higher intracellular volume and increased tortuosity and heterogeneity, which are reflected by lower ADC, lower \( \beta \) (i.e., increased complexity), higher space constant \( \mu \), lower intracellular diffusion (D_{slow}) and higher intracellular volume (V_{slow}), compared to benign tumors. This study provided in-depth explanations of tissue water diffusion behavior reflective of complex microstructural tumor tissue properties. These advanced diffusion analyses may prove to be useful in improving the accuracy and confidence in the diagnosis of various brain tumors, facilitating treatment planning, targeting treated tumor areas and in therapeutic response assessment.

KEYWORDS: Diffusion MR Imaging, Neoplasm Recurrence, Diagnosis
Pediatric cerebellar tumors: Apparent diffusion coefficient of the solid contrast enhancing component appears to predict tumor grade best.

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\textsuperscript{1}The Johns Hopkins University School of Medicine, Baltimore, MD, \textsuperscript{2}The Johns Hopkins Bloomberg School of Public Health, Baltimore, MD

Purpose
The role of apparent diffusion coefficient (ADC) in differentiating high and low grade pediatric cerebellar tumors has been shown previously and was attributed to differences in cellularity between tumors. In previous studies, ADC values have been measured only in the solid, enhancing component of the tumor. Accordingly, a large tumor component has been excluded from the evaluation and the measured ADC value may not be representative for the entire tumor. Our purpose is to compare the role of ADC measurement in 1) the solid, enhancing component and 2) the entire tumor in predicting the tumor grade of pediatric cerebellar tumors.
Materials and Methods
A retrospective study was performed including patients with histologically proven cerebellar tumors evaluated presurgically. For each patient, three regions of interest (ROI) were positioned manually: a) within the solid enhancing component and b) covering the entire tumor. Median ADC values were calculated. Control ADC values were obtained within macroscopically normal appearing cerebellum and thalami. Evaluation was performed by two observers. Ratios between 1) both ADC measurements of the tumors and 2) control ADC values of the normal cerebellum and thalami were calculated. The absolute ADC values and the ratios were correlated with the tumor grade. Statistical analysis included intraclass correlation, a two-sample Wilcoxon test, logistic regression and receiver operating characteristic (ROC) curves (only for absolute ADC values).

Results
Thirty-two patients (15 boys and 17 girls) were included in the study. The median age at presurgical MRI was 7.66 years (range 0.08-17.38 years). Fifteen patients had a high grade tumor, 17 a low grade tumor. Intra class correlation coefficients ranged between 0.98 and 1.0 for both measurements. For the solid enhancing tumor component, absolute ADC values (median: 1.49x10^{-3} mm/s² vs. 0.61x10^{-3} mm/s²), cerebellar ADC ratio (2.11 versus 0.88), and thalamic ratio (1.88 versus 0.75) were higher in low grade versus high grade tumors (p<0.0001). For the "entire tumor", absolute ADC values (1.79x10^{-3} mm/s² versus 1.05x10^{-3} mm/s², p=0.003), cerebellar ADC ratio (2.25 versus 1.38, p=0.006), and thalamic ratio (2.16 versus 1.24, p=0.003) were higher in low grade compared to high grade tumors. The area under the ROC curve was 0.961 and 0.812 for ADC measurements in the solid enhancing component and "entire tumor", respectively. Cutoff ADC values to differentiate between high and low grade tumors were calculated: 0.9x10^{-3} mm/s² (sensitivity 93%, specificity 94%) and 1.5x10^{-3} mm/s² (sensitivity 87%, specificity 71%) for ADC measurements in the solid enhancing component and "entire tumor", respectively.

Conclusions
Our study confirms the value of ADC measurement in predicting tumor grade in pediatric cerebellar tumors. Although both ADC measurements are able to predict histology, ADC measurements covering only the solid, contrast-enhancing tumor component has a higher sensitivity and specificity. Careful positioning of the ROIs within the enhancing, non-necrotic, nonedematous, contrast-enhancing tumor component appears to be essential for highly predictive ADC measurement.

KEYWORDS: Apparent Diffusion Coefficient, Cerebellar, Childhood

O-456

Perfusion MR Imaging for Grading Pediatric Brain Tumors

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Purpose
Relative cerebral blood volume (rCBV) has been demonstrated to correlate with glial tumor
grade and improve sensitivity and positive predictive value (PPV) of glial tumor grade assessment. Vascular permeability and contrast leakage also has been hypothesized to have diagnostic value. We evaluate the use of rCBV and time-signal intensity curves (TIC) in the assessment of pediatric brain tumor grade.

Materials and Methods

After IRB approval, 63 cases of pediatric brain tumors with perfusion imaging were collected retrospectively at our institution. Inclusion criteria included pathology proven diagnosis with WHO grade and preoperative dynamic susceptibility contrast perfusion MR imaging (DSC). Dynamic susceptibility contrast images were obtained using an echo-planar imaging sequence during the first pass of a bolus of gadopentetate dimeglumine (MultiHance, Bracco Diagnostics Inc., Princeton, NJ) on 1.5 and 3 T MRI scanners (Siemens Avanto and Verio, Erlangen, Germany). Two fellowship-trained neuroradiologists independently obtained 3-5 mm2 ROIs for maximum rCBV values of each tumor while blinded to pathologic diagnosis. Relative CBV measurements and qualitative analysis of TIC was performed using a commercially available workstation (Dynasuite Neuro, InVivo, Pewaukee, WI). The maximum rCBV value obtained by each neuroradiologist was averaged for each tumor and correlated to WHO grade using Spearman's rho. Receiver operating characteristic (ROC) analyses were performed to determine the optimum rCBV threshold for tumor grading. TIC from the ROI with the maximum CBV value were evaluated by each neuroradiologist independently and categorized as demonstrating no contrast leakage effects (signal returns to baseline after first pass bolus), contrast leakage with T1-dominant effects (signal returns to baseline and continues to increase beyond the baseline), or contrast leakage with T2* dominant effects (signal never returns to baseline). Interobserver agreement was assessed using Cohen's kappa statistic. Consensus opinion was obtained in cases with discrepant impressions of contrast leakage and compared with tumor grade.

Results

Patient ages ranged from 1.0 to 16.8 years with a mean of 6.3 years. The series included 25 high and 38 low grade tumors. Thirty-nine of the tumors were in the posterior fossa, and 24 tumors were supratentorial. A positive correlation exists between tumor maximum rCBV and tumor grade (r=0.30, p=0.0155). Receiver operating characteristic analysis of rCBV to predict tumor grade demonstrated an area under the curve of 0.65 (0.52-0.77, p=0.029). An rCBV cut off value of 1.38 was selected by maximizing Youden's index, which resulted in a sensitivity of 92% (74-99) and specificity of 39.5% (24.0-56.6). Independent assessment of contrast leakage effects by two neuroradiologists had a Cohen's kappa of 0.69 (0.54 – 0.84). 25/25 tumors with T1-dominant leakage were low grade (1.00 PPV, 0.83-1.0, p<.0001). By comparison, tumors with a T2* (10/15, 0.67 PPV, 0.39-0.87) and no (15/23, 0.65 PPV, 0.43-0.82) leakage patterns were predominantly high grade. Figure: Cerebral blood volume map of a 4-year-old male with pilocytic astrocytoma of the left brachium pontis. Region of interest of the maximum rCBV value shows a TIC with T1 dominant leakage.

Conclusions

Maximum rCBV values of pediatric brain tumors obtained from DSC techniques have positive correlation with increasing brain tumor WHO grade. The recognition of a T1 predominant leakage curve on the time-signal intensity profile is 100% predictive for a low grade tumor.

KEYWORDS: Dynamic Susceptibility Contrast-Enhanced, Pediatric Brain Tumors
Case Summary
Total Cases = 63

Max age (years) = 16.8
Min age (years) = 1.0
Avg age (years) = 6.3

Posterior fossa = 39
Supratentorial = 24

WHO I = 25
WHO II = 13
WHO III = 9
WHO IV = 16

Pilocytic astrocytoma = 17
Medulloblastoma = 9
Ependymoma WHO III = 7
Pilomyxoid astrocytoma = 6
Ependymoma WHO II = 3
ATRT = 3
GBM = 3
Choroid plexus papilloma = 2
Fibrillary astrocytoma = 1
Craniophayngioma = 1
Desmoplastic infantile ganglioglioma = 1
Ganglioglioma = 1
Ganglion cell tumor = 1
High grade diffuse glioma = 1
Low grade glioma = 1
Low grade glioneuronal tumor = 1
Low grade oligoastrocytoma = 1
Oligodendroglioma = 1
Pineal parenchymal tumor of intermediate differentiation = 1
PNET = 1
Anaplastic astrocytoma = 1
Radiosurgery of Brain Metastasis - Radiologic and Histologic Consequences

Minja, F.
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Abstract/Presentation Summary
Patients with intracranial metastatic lesions are increasingly being treated with single fraction high dose stereotactic radiosurgery (SRS), as first line therapy. For most patients SRS is an effective means of intracranial metastatic lesion control. However, following SRS, a significant number of patients develop enlarging enhancing lesions, often with extensive surrounding T2 signal abnormality on magnetic resonance (MR) imaging at the original tumor site. We have previously reported that although most metastatic lesions are stable or smaller in size during the first 36 months post-SRS, a transient increase in volume is seen in approximately one-third of lesions [Patel TR et al, 2011]. These enlarging enhancing lesions raise the challenging clinical
dilemma between tumor recurrence (TR) versus a radiation induced inflammatory process, often referred to as radiation necrosis (RN). The differentiation between TR and RN is challenging on routine MR imaging, as both entities can present with enlarging enhancing lesions with surrounding abnormal T2 signal. We will review the enhancement pattern of metastatic lesions following SRS, together with histopathology correlation. We will also briefly explore the role of advanced imaging modalities (MR perfusion, MR spectroscopy and FDG-PET) for differentiating TR from RN.

O-458

Pseudoprogression and lesion response in metastatic disease of the brain treated by radiosurgery.

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Purpose
In this HIPPA-compliant, IRB-approved retrospective study, 104 patients were identified who had metastatic disease to the brain that was treated by SRS. Patients were excluded who had less than two scans or medical records that were inadequate and/or incomplete. A total of 41 SRS-treated lesions in 22 patients were identified. One hundred sixty-eight scans were reviewed by a CAQ-certified neuroradiologist and bidimensional measurements were obtained of the targeted metastases. Scans were assessed for percent change of the product of the bidimensional measurements as a function of time. Lesions were stratified into those which, on the last included examination, had increased in size, those which had decreased in size, and those which did not change in size.

Materials and Methods
In this HIPPA-compliant, IRB-approved retrospective study, 104 patients were identified who had metastatic disease to the brain that was treated by SRS. Patients were excluded who had less than two scans or medical records that were inadequate and/or incomplete. A total of 41 SRS-treated lesions in 22 patients were identified. One hundred sixty-eight scans were reviewed by a CAQ-certified neuroradiologist and bidimensional measurements were obtained of the targeted metastases. Scans were assessed for percent change of the product of the bidimensional measurements as a function of time. Lesions were stratified into those which, on the last included examination, had increased in size, those which had decreased in size, and those which did not change in size.

Results
Of the 41 SRS-treated lesions, 22 regressed by the final examination. Of these, two lesions demonstrated an early increase in size with subsequent spontaneous regression (pseudoprogression). The increase in the bidimensional cross product of the lesions showing pseudoprogression ranged from 30% to 64% above baseline measurements. These lesions first demonstrated pseudoprogression 0.5 to 4.3 months after treatment and regressed 1.9 to 6.2 months after treatment. Of the remaining lesions that regressed, 89% had regressed at four months and all had regressed by six months following treatment. The mean time between treatment and the first scan showing regression was 2.4 months. Of the lesions that ultimately
increased in size, 38% showed an initial decrease. The mean time between the decrease in size and the ultimate increase in size over baseline measurements was 7.0 months.

Conclusions
Among all lesions treated in this series, 5% demonstrated an initial increase in size prior to spontaneously regressing below baseline measurements. Successfully treated tumors responded quickly to treatment, with 93% decreasing in size by two months and regression occurring in a mean of 2.4 months after treatment (range, 0.8-7.6 months).

KEYWORDS: Metastases, Pseudoprogression, Radiation

O-459

Screening for Brain Metastases: A Post Contrast 3D T1 High Resolution Sequence is Sufficient

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Purpose
To demonstrate that the postcontrast 3D T1-FFE sequence is sufficient to screen for brain metastases for oncologic clinical trials in neurologically asymptomatic individuals.

Materials and Methods
Review of the intramural NCI database identified patients with Stage IV melanoma enrolled into clinical immunotherapy trials for which MR imaging (MRI) to exclude brain metastases is a requirement. For retrospective MRI review, 98 cases (38 with brain metastases) met the following inclusion criteria: (1) stage IV melanoma with no history of brain metastases (2) absence of neurological symptoms and (3) maximal metastasis diameter of 1 cm. Clinical MRI included precontrast 5mm sagittal and axial SE T1, axial FSE T2, and postcontrast 5mm axial SE T1, T2 FLAIR and ~ 1 mm isotropic sagittal 3D T1-FFE (Philips 1.5 T or 3.0 T Achieva) or FLASH (Siemens 3.0 T Verio). The 3D T1 sequence was anonymized and sent to the PACS (Carestream) as a coded study for interpretation by three neuroradiologists. Readers were asked to count metastases using a presentation state including native slices, MPR and slab MIP reconstructions. In addition, one reader performed an interpretation of the complete MRI (all sequences). The clinical diagnosis (a combination of the initial MRI interpretation and subsequent clinical course) and consensus review of discordant cases was used as gold standard. The study was powered to detect a 10% difference in sensitivity and a 5% difference in specificity from the gold standard (100% for both).

Results
Using the 3D T1 sequence alone, each reader had a sensitivity of 92%, and specificities from 95% to 98%. For reinterpretation of the complete MRI, the sensitivity and specificity was 95% and 97%. None were significantly different than the gold standard.

Conclusions
High resolution postcontrast 3D T1 sequences commonly are reserved for planning of stereotactic radiosurgery or biopsy and not performed routinely. However, this sequence has been shown to be more sensitive than the routine spin echo T1 sequences for metastasis detection.
For this and other reasons (e.g., image registration), we perform the 3D T1 routinely. In practice, we focus on this as the most important component of the exam for metastasis detection. Anecdotally, the review of the additional sequences presents "information overload" that actually distract from the primary purpose of the exam (detecting brain metastases). In this study, the postcontrast 3D T1 performs no differently than a complete diagnostic MRI for detection of metastasis in the stage IV melanoma patients with a high prevalence of brain metastases. The applicability of these results to other patient populations requiring screening for brain metastases may be influenced by differences in MRI signal characteristics of different tumor types. To summarize, in neurologically asymptomatic patients with stage IV melanoma, a single postcontrast 3D T1 sequence is sufficient to screen for metastases to meet entry criteria for clinical trial enrollment.

KEYWORDS: Metastases

O-460  

Clinical Trials in Neuro-oncology: What the Neuroradiologist Needs to Know

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Abstract/Presentation Summary
In this presentation, the importance of neuroimaging in multicenter trials for patients with brain tumors will be discussed. Whenever a new use of neuroimaging is proposed, whether that imaging is routine and standard of care or advanced and experimental, a multicenter clinical trial remains the most effective means available to provide the strong evidence needed to bring about a change in clinical practice, and to support reimbursement for the procedure. Unfortunately, clinical trials have important drawbacks; they may not definitively answer the question being studied, and because of the expense and the length of time needed to accrue sufficient numbers of patients to the trials, it is impractical to study every important imaging question with a trial. The status of clinical trials in neuro-oncology, for both primary brain tumors and metastatic disease, will be reviewed with an emphasis on trials that have important implications for the imaging assessment of these conditions. Imaging continues to play important role for determining the progression free survival endpoint that has been used, generally successfully, in the evaluation of new therapies for primary brain tumors. The Response Assessment in Neuro-oncology (RANO) criteria is currently the most commonly used paradigm used to evaluate primary brain tumors in clinical trials, but these measurements may also be requested as part of clinical practice. The justification for the RANO criteria and the challenges faced in implementing it will therefore be discussed. The role of ACRIN and ECOG-ACRIN will be outlined in the context of the new National Clinical Trials Network program for cancer. Increasingly, the limitations of standard of care structural MR imaging (as currently being practiced) for the evaluation of brain tumors are being recognized. Efforts to evaluate advanced imaging such as spectroscopy, diffusion-weighted imaging and dynamic susceptibility weighted imaging in multicenter trials will be reviewed, as well as initiatives to improve the ability of structural imaging to evaluate therapeutic responses and to guide clinical care.
Purpose
To review risks and outcomes associated with treatment of patients with malignant brain tumors with intra-arterial chemotherapy after blood-brain barrier disruption at a single institution.

Materials and Methods
During the period from 1995-2010, patients with primary malignant brain tumors including glioblastoma multiforme, anaplastic astrocytomas, anaplastic oligodendrogliomas, oligodendrogliomas, primary central nervous system (CNS) lymphomas and germinomas were treated with repeated courses of osmotic blood-brain barrier disruption with mannitol followed by intra-arterial methotrexate or carboplatin. Following treatment, follow up was conducted for a number of years and included complete physical examinations, CT and MRI imaging of the brain, and standard laboratory tests. Complications arising during or after treatment and outcomes were documented.

Results
Forty-nine patients were treated. A total of 606 procedures were performed with seizures being the most common procedure-related complication (2.1% of procedures) and one permanent neurological deficit noted (0.2% of procedures). For primary CNS lymphoma, the overall response rate was 94% (59% complete, 35% partial) with a median overall survival of 3.6 years. For germinomas the response rate was 100%. Response rates and median overall survival were less with gliomas.

Conclusions
Intra-arterial chemotherapy after blood-brain barrier disruption with mannitol is safe and well tolerated with a low incidence of catheter-related complications and with very good response rates for primary CNS lymphoma and germinomas and excellent median overall survival for primary CNS lymphoma. Whether this treatment can offer superior response rates and overall survival as compared to conventional therapies needs to be investigated with multicenter randomized trials.

KEYWORDS: Blood-Brain Barrier, Brain Neoplasms, Intraarterial Chemotherapy

<table>
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<tr>
<th>Response</th>
<th>Tumor Type</th>
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<td>GBM N = 22</td>
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<td>AA N = 3</td>
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<td>Medan Follow up (days)</td>
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<td>Mean OS Range (days)</td>
<td>347 (33-772)</td>
<td>449 (185-868)</td>
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<tr>
<td>Median OS (days)</td>
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<td>295</td>
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</table>

AA: anaplastic astrocytoma; AE: adverse event; AO: anaplastic oligodendroglioma; BBBD: blood brain barrier disruption; CR: complete response; IA: Intra-arterial; GBM: glioblastoma multiform; GERM: germinoma; NA: :not applicable; OLIGO: oligodendroglioma; OS: Overall survival; PCNSL: primary central nervous system lymphoma; PD: progressive disease; PR: partial response; PT: Patient; RT: radiation therapy; SD: stable disease; TTP: time to progression; TX: Treatment

+ 2 = PT stopped TX; 2 = PT switched to IA or RT; 1 = stopped due to AE
Purpose
Antisense (AS) agents have potential as immunotherapeutic agents and are being assessed as a means to stimulate a patient's immune system to combat certain forms of cancer. The purpose of this preliminary investigation is to determine whether MR perfusion techniques can serve as a response biomarker for endstage human glioblastoma (GBM) treated with an AS oligodeoxynucleotide directed against the insulin-like growth factor type 1 receptor.

Materials and Methods
Twelve GBM patients were enrolled in this safety trial using an antisense DNA regimen. Criteria include end stage disease with failure to respond to a conventional therapeutic regimen. A "vaccine" was created using recently harvested GBM tissue and antisense DNA. Ten semipermeable biodiffusion chambers were filled with sterilized and irradiated autologous tumor cells with 2.5 μg of exogenous free antisense and implanted into the patient's rectus sheath for 24 hours and removed. Baseline and serial MR imaging was performed at regular time intervals using dynamic susceptibility contrast (DSC) perfusion and 15 direction diffusion tensor imaging. Serial clinical assessment included Karnofsky performance scale and peripheral white blood cell (WBC) counts as well as multiplex cytokine assays to assess immune response. Hemispheric regions of interest (ROIs), tumor "hot-spot" ROIs and ROIs of contralateral hemisphere were used to generate relative cerebral blood volume (rCBV) values. Twelve anatomical features were assessed to identify serial changes in enhancement characteristics, invasiveness of the normal white matter, as well as changes in noncontrast-enhancing tumor and peritumoral edema. Temporal changes in anatomical MR, rCBV were compared to conventional response criteria, tumor progression/response and clinical status in five patients.

Results
Of all 12 patients treated, seven died of disease progression, one of hemorrhage, and one of sepsis. Two patients remained clinically stable for over a year before succumbing to disease progression and one patient continues to survive with a Karnofsky score of 80 at six months after treatment. All patients were categorized clinically into either a short survival cohort (N=9) or a
longer survival cohort (N=3); eight patients were characterized as having no immune response while four patients had a quantifiable immune response reflected as an increase in WBC counts, T cells, B cells and a decrease in M2 macrophages (immunosuppressive CD163+ monocytes). Of the longer term survivors, enhancement characteristics progressed while the rCBV initially increased and then normalized in the affected hemisphere within two months after treatment compared to two nonresponders in which the rCBV values remained elevated. An example of a long term survivor is shown in the Figure.

Conclusions
Elevations in rCBV may occur with use of immunotherapies in the treatment of GBM. This paradoxic effect may not be indicative of interval tumor growth but may be a reflection instead of an inflammatory response after induction vaccination. Perfusion MRI may demonstrate a paradoxical response when novel therapies are employed to treat GBM. MR biomarkers should be reconsidered with immunotherapies and GBM.

KEYWORDS: Glioblastoma, Immune
Imaging Technology: When Is Enough - Enough

Seidenwurm, D.
Radiological Associates
Sacramento, CA

Abstract/Presentation Summary
There is emerging consensus, except perhaps among radiologists, that recent imaging growth has been excessive. There are several reasons why imaging rates are higher in the US than other OECD countries. Systemic causes like fee for service payment, rapid commercialization and dissemination of new technologies and research based techniques, competition at the level of the provider and referral source rather than at the consumer or payer level, and medical legal concerns contribute to the problem. Another contributor is our increasing Mannerism, a response to declining rates of innovation through demonstration of superfluous technological virtuosity. A similar phenomenon occurred among artists post renaissance. Solutions to the problems of excessive imaging rates may include economic and regulatory forces. However, the optimal approach is through professionalism and scientific reasoning among radiologists and other physicians. We need to think harder before we scan "better", and rigorously analyze the incremental benefits of thinner slices, more sequences, contrast agents and techniques applied to clinical patients outside of controlled research studies. An organizing principle might be "number needed to scan", which would allow the application of Bayesian inference to everyday clinical circumstances. This will permit application of advanced imaging to targeted populations most likely to benefit, preserving resources for optimal allocation within and outside of imaging.

The Role of Imaging in Pre-Operative Planning and Guidance in Modern Skull Base Surgery

Bhatia, R.
Miami, FL

3D Computerized Evaluation of Aneurysms

Truwit, C.
Hennepin County Medical Center
Minneapolis, MN
Abstract/Presentation Summary
Until recently, DSA has been considered the gold standard in the search for intracranial aneurysms (1). Most studies find a false negative rate on the order of 5%, largely related to vessel overlap and failure to find the optimal view (2). This has been mitigated to considerable extent by the advent of 3DRA which, like CTA and MRA, offers views not as easily or reliably obtained in the angiography suite. Likewise, studies of the sensitivity of CTA and MRA show a false negative rate on the order of 5-10%. In this case, the rate limiting factors are different, typically related to failure to focus on one vessel at a time, incomplete assessment beneath the anterior clinoid processes, incomplete assessment of the post-circle of Willis cerebral vasculature, and failure to perform a systematic search through the cerebral vasculature, allowing for missed mirror and multiple aneurysms. That said, as recently noted by the UCLA group (1), adoption of systematic review processes can offer improved sensitivity of CTA over DSA, especially for very small aneurysms measure 4mm or less. Thus, in the search for, and evaluation of, intracranial aneurysms, the role of advanced visualization cannot be understated. Whereas earlier efforts were somewhat limited by the speed of advanced visualization workstations, this is no longer the case, as almost all such systems allow for near real-time processing. In addition, whereas previous efforts were generally limited to MIP, surface rendered, and MPR, current systems also display endoluminal views which allow for proper characterization of the aneurysm neck and potential branch vessels arising from the aneurysm wall (away from the neck). As noted above, during catheter angiographic studies, one vessel is assessed at a time. This rule is not universally followed when performing advanced visualization of CTA and MRA, unfortunately, affording the reviewer the opportunity for distraction and incomplete assessment. In addition, neuroradiologists often state that careful attention to the individual axial slices is imperative to the proper interrogation of a CTA dataset. While this is undoubtedly true, as noted by the UCLA group, this is not enough: by this method alone, as many as 10% of aneurysms are missed (3). On the other hand, review of 3D images alone, in the absence of careful review of the axial slices and MPR slices, also exposes the reviewer to a 10% miss rate (3). During this presentation, the concept of a systematic approach to the evaluation of CTA (and MRA) on advanced visualization workstations will be discussed. This includes identifying and reviewing those areas of known fall negatives, such as intra- and infraclinoid aneurysms, as well as small, second aneurysms that can be overlooked. In addition, such a methodological approach can generally be performed just a few minutes in most cases, allowing it to be a routine rather than an exceptional, part of the evaluation of CTA and MRA of the cerebral vasculature.

O-466
5:40PM - 6:00PM

Do We Need to Follow All Aneurysms?

Villablanca, J.
David Geffen School Of Medicine at UCLA
Malibu, CA

Abstract/Presentation Summary
This presentation will review the incidence and pathophysiology of cerebral aneurysms. We will explore the role of imaging in the detection, characterization and triage of brain aneurysms including a brief review of the literature. Using clinical examples, the role of imaging in
treatment selection will be discussed. Comparative advantages and limitations of CTA, BS-CTA, TOF-MRA and CE-MRA will be outlined. Recent evidence on the management of asymptomatic incidental cerebral aneurysms will be presented. Finally, we will identify common sources of interpretational error, review recent studies on cost effectiveness strategies, and summarize major points.

O-467

**Confessions of a Dictaphone**

Chapman, P.
Radiology Of Huntsville
Huntsville, AL

Tuesday
4:45PM - 6:15PM
Palais des congres de Montreal, 520

52 - ADVANCED IMAGING SEMINAR: TRANSLATIONAL ADVANCED IMAGING FOR TISSUE CHARACTERIZATION

O-468

**The Role of SWI in Neurodegenerative Disease: From the Fetus to Dementia**

Haacke, E.
Wayne State University
Detroit, MI

Abstract/Presentation Summary

In this presentation, we shall introduce the basic elements of susceptibility weighted imaging (SWI) and how one can use phase information to enhance image contrast. SWI is a 3D phase enhanced gradient echo imaging method that shows increased sensitivity in the detection of venous blood and blood products such as clot or hemorrhages. In this presentation, we will review the main process of producing an SWI data set from the phase information and discuss issues related to signal-to-noise and resolution. We will introduce the concept of a fully flow compensated double echo sequence and how it will be useful when there is high iron content present in tissue. The ME approach also makes it possible to collect T2* maps and to compare these results with quantitative susceptibility mapping. At 3T, we have been using a resolution of between 0.5mm3 and 1mm3 while at 7T we have been using 0.2 x 0.2 x 1mm3. More specifically, among other diseases, we consider the application of SWI to traumatic brain injury (TBI), stroke, tumors, Sturge-Webber disease (SWD) and multiple sclerosis (MS). 1) trauma: High resolution SWI has been shown to be superior to conventional gradient echo imaging in detecting hemorrhages caused by TBI. Small lesions are more visible on SWI compared to conventional GRE. 2) stroke: Both computed tomography (CT) and MRI have been used for initial radiologic evaluation of acute stroke and patient selection for thrombolytic therapy. MRI
is more sensitive than CT for identifying acute infarcts. 3) SWD: We have studied many cases of
SWD and found that SWI shows abnormalities in the white matter consistent with abnormal
transmedullary veins. Many patients also have prominent cortical SWI abnormalities as well. 4)
MS: SWI reveals lesions with increased iron content as well as increased iron content in the
basal ganglia. 5) fetal imaging: SWI has been used to map the development of the venous system
from 20 to 37 weeks and to look at oxygen saturation levels in the superior sagittal sinus. 6)
dementia: SWI has been used to study cerebral amyloid angiopathy (CAA) and monitor changes
in microbleeds over time. 7) developmental venous anomalies: SWI is perhaps the best method
for evaluating telangiectasias and other DVAs. Recent advances in inverting phase into a source
image called quantitative susceptibility mapping (QSM) can be applied to any case where SWI is
being used since the phase is available. SWI is exquisitely sensitive to even small microbleeds
and has excellent diagnostic capabilities while QSM provides a quantitative map of the iron
content independent of local geometry. In summary, SWI and SWIM provide a powerful means
to study neurological diseases.

O-469
5:15PM - 5:45PM

Latest in Clinical Applications of Quantitative Susceptibility Mapping (QSM)

Wang, Y.
Weill Medical College of Cornell University
New York, NY

Abstract/Presentation Summary
Quantitative susceptibility mapping (QSM) has become sufficiently accurate for measuring
strong susceptibilities of biomaterials including iron distribution (ferritin) in the deep brain
nuclei and basal ganglia, deoxyhemoglobin (dHb) in the veins, blood degradation products
(hemosiderin in late stage), concentrated calcifications and exogenous species such as
gadolinium. Clinical applications of QSM are being developed to use these imaging biomarkers
to probe iron distribution in neurodegenerative and inflammatory diseases, hemorrhage,
metabolic consumption of oxygen, and calcium deposition, and to guide and monitor therapy.
QSM can also remove blooming artifacts in traditional T2* weighted imaging, providing an
accurate definition of the geometries of magnetic biomaterials in MRI. This presentation will
illustrate QSM applications in the following areas: • Diamagnetic biomaterial based applications
to differentiate diamagnetic calcifications from paramagnetic materials such as hemosiderin •
Paramagnetic heme iron (deoxyhemoglobin, metahemoglobin, hemosiderin) based applications
to measure metabolic rate of oxygen consumption and to define microbleeds and hemorrhage •
Paramagnetic nonheme iron (ferritin) based applications to measure iron overload in
neurodegenerative disease and to define targets for deep brain stimulation • Paramagnetic
contrast agent biodistribution quantification based application in contrast enhanced MRI and
molecular MRI, and • Mixed diamagnetic and paramagnetic applications to measure
demyelination and iron content in multiple sclerosis.

O-470
5:45PM - 6:15PM

Susceptibility Tensor Imaging and Fiber Tracking
Liu, C.
Duke University, School of Medicine
Durham, NC

Abstract/Presentation Summary
Susceptibility tensor imaging (STI) is a recently developed MRI technique for imaging and quantifying tissue magnetic susceptibility (Liu, 2010). STI utilizes images acquired with the 3D gradient echo sequence. From the phase maps of gradient echo images, STI is able to compute a susceptibility tensor for each voxel by solving a system of linear equations. A susceptibility tensor can be either isotropic such as in the cerebral spinal fluid or anisotropic such as in the brain white matter; susceptibility tensor may also be paramagnetic or diamagnetic. Susceptibility tensor can be decomposed in two three eigenvectors and corresponding principal susceptibility values. These eigenvalues and eigenvectors are rotationally invariant and are independent of the coordinate system, thus providing a quantitative measure of tissue property. In the white matter, the largest principal susceptibility is shown to be in the direction parallel to the axonal fibers (Li et al., 2012a; Liu, 2010). This relationship can be utilized to reconstruct fiber tracts of the brain in a fashion similar to diffusion tensor imaging tractography (Liu et al., 2012). Further constraints on the tensor may be applied to simplify the acquisition of STI (Li et al., 2012b; Wisnieff et al., 2013). In the brain white matter, anisotropic susceptibility tensor originates from the anisotropic molecular susceptibility of lipids in the myelin sheaths and the ordered microstructures of axons (Lee et al., 2012; Li et al., 2012a; Liu, 2010; Wharton and Bowtell, 2013). Neonatal brains and demyelination in multiple sclerosis have thus reduced diamagnetic susceptibility and susceptibility anisotropy (Liu et al., 2011). Magnetic susceptibility anisotropy also exists outside brain, for example, in the kidney and heart. Consequently, STI provides a new technique that may have broad applications in imaging and characterizing tissue microstructure.

Tuesday
4:45PM - 6:15PM
Palais des congres de Montreal, 524

53 - GENERAL PROGRAMMING - ASNR INTRODUCES THE STUDY GROUPS
O-471

Introduction

Wintermark, M.
University of Virginia
Charlottesville, VA

O-472

CSF Flow
Bradley, W.
USD Medical Center
San Diego, CA

Abstract/Presentation Summary
The International Hydrocephalus Imaging Working Group (IHIWG) is an informal group of neuroradiologists, neurosurgeons, neurologists, bioengineers and basic scientists which meets twice a year at the ASNR and at the ISHCSF (International Society for Hydrocephalus and CSF Disorders). We discuss basic concepts like where CSF is formed and taken up and the possible role of AQ4 receptors. We discuss issues related to the diagnosis and treatment of various forms of hydrocephalus and related diseases, eg, pseudotumor. We discuss various MRI-based techniques for demonstrating CSF flow, eg, Phase-Contrast and TimeSLIP, as they help in the management of diseases such as NPH and Chiari I. In the context of NPH we discuss possible causes of the idiopathic form, eg, benign external hydrocephalus. We compare various methods to predict response to shunting, eg, phase contrast measurements of the aqueductal CSF Stroke Volume, the DESH (Disproportionately Enlarged Subarchnoid space Hydrocephalus) pattern on a coronal MRI, the high volume tap test, saline infusion, and external lumbar drainage. We discuss new findings using DTI and MR elastography for evaluation of NPH. In the context of Chiari I, we discuss computational flow dynamics based on PC MRI using the Navier-Stokes equation to predict CSF pressures over the cardiac cycle and the impact on syrinx formation. By coupling PC MRI measurements of CSF, arterial blood, and venous blood flow over the cardiac cycle, we discuss the ability to noninvasively estimate intracranial pressure. We discuss new techniques like TimeSLIP (basically arterial spin labeling of CSF) and the many applications in the evaluation of intracranial diseases.

O-474
5:10PM - 5:30PM

Tumor Genomics

Colen, R. · Pope, W.
MD Anderson Cancer Center · University of California Los Angeles
Houston, TX · Los Angeles, CA

O-475
5:30PM - 5:50PM

Translational Imaging

Druzgal, T. · Whitlow, C.
University of Virginia · Wake Forest School of Medicine
Charlottesville, VA · Winston-Salem, NC

O-477
5:50PM - 6:00PM

Vessel Wall Imaging
Wasserman, B. · Mikulis, D.
Johns Hopkins University · Toronto Western Hospital
Baltimore, MD · Toronto, ON

Abstract/Presentation Summary
An overview of the activities of the recently formed vessel wall imaging study group will be presented. The group has conducted four webinars since the study group formed a year ago where interesting intracranial and extracranial cases have been shown and discussed. Committees have been formed to promote networking, protocol standardization, research, and education. Some of the successful milestones achieved by the group in this first year include: • Development of a 3-D T1 weighted black blood sequence that should work effectively on Siemens 3T platform. This has been achieved with the help and hard work of MR physicist David Saloner. The sequence is close to being in a distributable form. Meetings are being planned with other vendors to enable similar sequences for other platforms. • White papers are being led by Luca Saba and Danny Mandell on cervical carotid wall imaging and intracranial arterial wall imaging, respectively. • The first collaborative research paper is being developed with a target publication for the end of 2014. • A website is being developed with the assistance of the ASNR and should become available within the next few months. We are encouraging ASNR members to join the study group, contribute cases to the webinars, participate in the working committees, and participate in research activities.

Questions

Wednesday
7:30AM - 8:30AM
Palais des congres de Montreal, 517bc

54 - BRAIN IMAGING SESSION (SAM)
O-479

Vasculitis and Demyelinating Diseases

Johnson, C.
New York-Presbyterian Hospital
New York, NY

Abstract/Presentation Summary
Cerebral vasculopathies include atheromatous and nonatheromatous diseases. Cerebral
Atherosclerosis is the most frequent etiology of intracranial vascular stenosis and the third most common cause for thromboembolic stroke following cardiac and carotid sources. Nonatheromatous vasculopathies are a heterogeneous group of disorders that include true vasculitis and noninflammatory vasculopathies such as amyloid angiopathy, CADASIL syndrome and vasomotor disorders. Vasculitis is characterized pathologically by inflammation and variable necrosis of the vessel wall and can be grouped according to involvement of large, medium or small vessels. Large vessel vasculitides include giant cell arteritis such as temporal arteritis and polyarteritis nodosa. Other systemic vasculitides involve small vessels. Primary angitis of the central nervous system affects medium and small sized vessels. In addition to primary systemic vasculitides causes of secondary CNS vasculitis include multiple infectious agents, connective tissue diseases, various drugs, oncologic disease such as lymphoma, Behcet's disease and sarcoidosis. Clinical presentations related to cerebral vasculopathies are varied but include headache, focal neurologic deficits, ataxia, nonspecific encephalopathy, seizure and visual disturbance. In vasculitis cerebrospinal fluid analysis shows evidence of inflammation including elevated protein and lymphocytic pleocytosis. Neuroimaging is important in diagnosing cerebral vasculopathy. CT angiography is utilized in selected cases. MR imaging findings are varied but include multifocal T2 hyperintensities in white and gray matter, hemorrhage and areas of parenchymal or leptomeningeal enhancement. Vessel wall imaging can aid in the diagnosis. Diffusion weighted imaging may show areas of recent ischemia while susceptibility weighted imaging is useful to show recent or chronic hemorrhage. MR or CT angiography may be normal or show multisegmental vascular stenoses. Conventional angiography may be considered the "gold standard" but is infrequently performed unless there is a high clinical suspicion in the absence of findings at MR or CT angiography. Demyelinating diseases have clinical and imaging findings in common with those found in cerebral vasculopathies. Demyelinating diseases can be classified into several categories among which are inflammatory demyelination and viral demyelination. The most common form of inflammatory demyelination is multiple sclerosis. MR is the primary imaging modality. The diagnosis can be suggested based on classic characteristic appearance of white matter lesions and use of the McDonald criteria. Demyelinating diseases which have unique imaging findings include Balo's concentric sclerosis, a subtype of MS, and neuromyelitis optica. Acute disseminated encephalomyelitis (ADEM) is characteristically a monophasic disease though recurrent ADEM can occur. ADEM is immune mediated, more common in children and typically occurs within 2 weeks following an infection or vaccination. Imaging findings may be similar to those in multiple sclerosis but the white matter lesions are more often asymmetric and spare the callosal-septal interface. Tumefactive demyelination may be difficult to differentiate from tumor though some imaging findings including those at spectroscopy may suggest this diagnosis. The primary viral demyelinating disease is progressive multifocal leukoencephalopathy (PML) caused by the JC virus in an immunocompromised host. PML has been associated with the use of natalizumab (Tysabri), a monoclonal antibody, for treatment of multiple sclerosis. MR imaging screening of patient's receiving Tysabri is routinely obtained. Findings related to immune reconstitution in patient's with JC virus infection need to be differentiated from those from those related to progressive demyelinating disease. Imaging plays an important role in the diagnosis and subsequent followup of cerebral vasculopathies and demyelinating diseases. Characteristic imaging findings often suggest the appropriate diagnosis and aid in monitoring of treatment response.
Primary Brain Tumors in Adulthood

Tampieri, D.
Montreal Neurological Hospital and Institute
Montreal, Quebec

Abstract/Presentation Summary
The latest WHO classification of CNS Brain tumors was published in 2007. The tumors are classified depending on their cellular origin and few new tumors types were added including angiocentricglioma, papillary glioneuronaltumour, rosette-forming glioneuronaltumour of the fourth ventricle and others. The classification from Grade I to IV reflects the degree of malignancy. Grade I are usually considered benign tumors without malignant transformation. Grade IV are the most aggressive with local invasive feature and may lead to metastasis mainly via the CSF. Grade II and III are aggressive tumors that tend to evolve to grade IV in time. The diagnosis is histological based on the presence of atypical cells, neo-vascularity, necrosis and mitotic index. The imaging findings of brain tumors may vary according to the tumors grade, and advanced imaging techniques such as spectroscopy, diffusion and perfusion sequences may help in the differential diagnosis of certain tumors type. The molecular markers in high gradegliomas are important, they have both a diagnostic and prognostic value and they help to predict the response to treatment. In Primary GBM, usually the most aggressive type of tumor with shortest survival rate, the presence of MGMT (O-Methylguanine-DNA Methyltransferase) has a favorable prognostic value. This is a DNA repair gene, if is methylated the response to Temozolamide is better because the DNA of the tumor cell can not be repaired. Therefore GBMs with MGMT methylated have longer survival rate. In consideration of the advanced neurosurgical techniques available when anatomically possible, gross total resection is the goal of the intervention. Subsequently patients are usually enrolled in specific protocols based on the histological type of the tumors. For high gradegliomas the combination of Temozolimide and radiotherapy has become the standard of practice. However this combination may lead to confusing imaging findings in the follow up MRI exams and the differential diagnosis of recurrent tumor versus pseudo-progression still remain difficult. The assessment of the MRI characteristics of these lesions using also advanced imaging techniques is paramount to the patient's clinical evolution and treatment.

Emergency Imaging in Neuroinfections

Del Carpio-O'Donovan, R.
McGill University Health Center, Montreal General Hospital
Montreal, QC

Abstract/Presentation Summary
Infectious diseases involving the brain require prompt and accurate diagnosis. Imaging in the Emergency Department(ED) consists initially of CT scanning. With this first approach, certain
key decisions can be taken: medical vs surgical management, proceed to CSF testing, complement study with iv. contrast medium or MRI. Adequate clinical information is possibly more relevant than with other categories of disease. The geographical origin of the patient, personal contacts, work, lifestyle, immune status, extreme ages constitute key information. Emergent infectious diseases are a considerable challenge. MRI is proving indispensable in the ED and for infectious acute pathology besides obvious advantages for children and pregnant women. It is useful in differentiating abscess from glioblastoma, more sensitive for meningeal processes and for complications such as subdural or epidural empyema. Appropriate localization of the lesion is of paramount importance. Potential for rapid progression and permanent neurological deficits gives great urgency to the diagnosis and appropriate treatment.

Questions and Answers

Wednesday
8:30AM - 10:00AM
Palais des congres de Montreal, 517bc

55 - GENERAL PROGRAMMING - EVIDENCE BASED MEDICINE: IMAGING IN ALZHEIMER'S DISEASE - WHAT IS THE EVIDENCE?
O-483
Clinical Practice Guidelines and Appropriateness Criteria
Anzai, Y.
Univ. Washington Medical Center
Seattle, WA

O-484
Brain Imaging for Alzheimer's Disease
Larvie, M.
Massachusetts General Hospital
Boston, MA

Abstract/Presentation Summary
The diagnostic criteria for neurodegenerative diseases generally, and Alzheimer's disease (AD) specifically, have evolved in concert with advances in brain imaging. Although until very
recently the diagnosis of AD was based solely on clinical examination, it is now recognized that brain imaging can strongly add to the sensitive and specific diagnosis. The major imaging modalities for AD are CT, MRI, FDG PET and amyloid PET, and the selection of appropriate imaging is dependent upon the clinical circumstance. We will consider three different scenarios: 1) Evaluation of acutely recognized diminished mental status in a patient whose cognitive baseline is not well-established; 2) Evaluation of subtle cognitive deficits (such as mild cognitive impairment) of insidious onset; 3) Identification of early AD pathology in a patient with no clinical symptoms (that is, pre-clinical AD). The optimal approach to these scenarios will make use of imaging examinations with different receiver operating curves, ranging from less sensitive and less specific to more sensitive and more specific. In support of evidence-based practice, the utility of different imaging modalities will be presented in the context of specific clinical applications.

O-485

Advanced Imaging of Alzheimer's Disease - The Role of DTI and ASL

Petrella, J.
Duke University Medical Center
Durham, NC

O-486

Amyloid Imaging for Alzheimer's Disease

Nasrallah, I.
University of Pennsylvania
Philadelphia, PA

Abstract/Presentation Summary
Alzheimer disease is neuropathologically characterized by aggregation of amyloid beta plaques and tau-containing neurofibrillary tangles. Over the past decade, a number of Positron Emission Tomography (PET) tracers have been developed to evaluate one of these pathophysiological hallmarks: cerebral amyloid aggregates. These agents have had significant impact on Alzheimer disease research over this period and have potential to benefit clinical trial design and clinical evaluation of patients with cognitive decline. This presentation will: • Discuss the various PET agents currently available for cerebral amyloid imaging. • Review approaches to standard clinical interpretation of amyloid PET and methods for quantification of radiotracer uptake. • Explore the utility of amyloid imaging radiotracers in reference to other biomarkers of Alzheimer disease, including diagnostic and prognostic value of amyloid PET. • Outline suggested appropriate use criteria proposed by the Amyloid Imaging Task Force of the Society of Nuclear Medicine and Molecular Imaging and Alzheimer's Association.
Panel Discussion

Wednesday
8:30AM - 10:00AM
Palais des congres de Montreal, 517d

56 - ASSR PROGRAMMING: ADVANCED IMAGING OF THE SPINE
O-487

Demyelinating Diseases of the Cord

Thurnher, M.
Medical University Of Vienna
Vienna

Abstract/Presentation Summary
Evaluation of MR imaging in a patient with an intramedullary lesion should focus on key-features: a) the location of the lesion on the cross sectional area of the cord, best evaluated on axial images, b) the length of the lesion evaluated on sagittal images, c) the presence of cavitation and cysts, d) signal intensity on T2-WI, e) the presence of enhancement and enhancement type, and f) associated leptomeningeal enhancement. The knowledge of the presence or absence of the brain lesions is important information for narrowing the differential diagnosis. Finally, clinical information, demographics, and immune status should be incorporated. In this lecture imaging characteristics and typical patterns of intramedullary lesions will be presented. A diagnostic algorithm, which includes imaging, clinics and CSF analysis, will be discussed.

O-488

New Concepts of CSF Flow Studies or Higher Field Spine Imaging

Bradley, W.
USD Medical Center
San Diego, CA

Abstract/Presentation Summary
This talk will discuss new applications for CSF flow in the spine and other new applications in the pipeline over the next decade generally at higher field. The CSF flow applications are based on Vic Haughton's group's work using computational flow dynamics to model flow and pressure gradients in the upper cervical spine, particularly in the context of Chiari I (Hentschel S, Haughton V, et al, AJNR 2010; 31:997-1002). By using the Navier-Stokes equation pressures
can be calculated in the spinal subarachnoid space over the cardiac cycle and the tendency for CSF to enter the central canal via the perivascular spaces can be demonstrated computationally (Drosdal IN, Mardal K-A, Stoverud K, Haughton V, The Neuroradiology Journal 26: 585-590, 2013).

O-489

DWI and MRS of the Spine

Tanenbaum, L.
Mount Sinai Medical Center
New York, NY

Abstract/Presentation Summary
The role of diffusion weighted imaging has expanded beyond the brain to whole body applications. This presentation will explore the contribution of DWI in the routine evaluation of spinal conditions focusing on its role in the detection, characterization and surveillance of neoplastic, degenerative and infectious diseases. MR spectroscopy has the power to delineate the chemical signature of tissues in health and disease. Research suggests detection of key MRS biomarkers may have a role analogous to provocative discography in identification of the painful disc. This presentation will cover the key findings in the painful disc and review the research work done to date.

O-490

New Concepts About CSF Flow and What I Learned in a Recent CSF Symposium with Bill Bradley

Law, M.
USC Keck School of Medicine & Medical Center of USC
Los Angeles, CA

Questions

Wednesday
8:30AM - 10:00AM
Palais des congres de Montreal, 517a

57 - ASFNR PROGRAMMING: CVR
Quantitative CVR Mapping

Mikulis, D.
Toronto Western Hospital
Toronto, ON

Abstract/Presentation Summary
Quantitative imaging methods have primarily been applied for research investigation of normal and pathophysiological conditions. However, there are numerous examples where quantitative imaging research has translated into the clinical environment. For example, measurement of blood flow metrics (CBF, CBV, MTT, TMAX), and vascular permeability has found clinical application in the assessment of cerebral ischemia and CNS neoplasia. Measurement of CVR has also been available for many years and has likewise been used primarily for research. The major contribution that the body of CVR research has made is establishment of the relationship between steal physiology in patients with cerebrovascular steno-occlusive disease and the risk of disabling ischemic stroke. More recent work has shown that there is a relationship between steal physiology and subacute brain injury in patients who are not experiencing ischemic events. In view of the clinical potential of CVR for assessing vascular risk both in terms of stroke risk and for distinguishing embolic from hemodynamic transient ischemic events, as well as the ability of MR to make this assessment without the need for injectable tracers, interest in clinical MRI CVR mapping is increasing. Further impetus is derived from the notion that the normal brain operates under the framework of demand vasodilatation. That is, activation of neurons is accompanied by a considerable increase in blood flow to support increased metabolic demand as the brain is poor in storing high-energy metabolites. The brain depends on this flow support. It is therefore not surprising that resting blood measurements are ineffective in assessing the impact of steno-occlusive disease under resting blood flow conditions as autoregulatory compensation can maintain normal blood flow albeit with increased transit time. Transit time could be considered an important metric in this regard but there is no consensus on a threshold for significance. In fact CVR can be normal with carotid occlusion and increased transit time secondary to excellent collaterals. This presentation will therefore focus on the application of CVR as a metric for assessing the significance of cerebrovascular steno-occlusive disease. The key CVR finding is the detection of decreased blood flow in response to a global vasodilatory stimulus (CO2), i.e. steal physiology (lack of demand vasodilatation). The detection of decreased blood flow to a global vasodilatory stimulus can be identified with either qualitative or quantitative CVR approaches. Both methods including advantages and disadvantages will be discussed. "Chronic Neurovascular Uncoupling Syndrome" In 1954, C. Miller Fisher first described the relationship between carotid occlusive disease and rapidly progressive dementia in patients who were not experiencing ischemic events. More recently it has been shown that activation of neural networks is accompanied by a significant increase in local cerebral blood flow (on the order of 50%) that is spatially congruent with those networks. Interestingly, the increase in blood flow secondary to neural activation is greater than the consumption of additional oxygen provided by this flow increase. This interaction has been termed neurovascular coupling (or uncoupling by some in the sense that the additional oxygen delivered is not fully consumed - we have preferred the term neurovascular coupling since we feel it is a normal physiological response). There are numerous
theories as to why such high increases in flow occur including removal of waste products and maximization of microvascular surface area for optimal tissue transfer of oxygen. An important consideration is that the brain is poor at storing high-energy metabolites. An increase in energy demand during activation of neural networks must therefore be accompanied by rapid synthesis of high-energy metabolites. An important issue arises in the setting of high-grade steno-occlusive disease of the major cervical and cerebral arteries. Under these conditions vasodilatation of the vasculature distal to the steno-occlusive process occurs in order to compensate for a potential blood flow deficit, but this consumes vascular reserve and the ability to further vasodilate in response neural activation is diminished. When compensatory collaterals are poor, vascular reserve can become exhausted leaving no further vasodilatory response. The key question is, if blood flow cannot increase to support the metabolic demand of the tissue during neural activation, does this result in injury to the brain as this, by definition, is ischemia? Initial evidence indicates that this in fact is true. Under these conditions, neurovascular coupling becomes uncoupled. Evidence for the effects of neurovascular uncoupling will therefore be discussed in this presentation.

**O-501**

**Clinical Relevance of CVR Mapping**

Derdeyn, C.
Mallinckrodt Inst. Radiology
St. Louis, MO

Abstract/Presentation Summary

The brain and brain vasculature can compensate for reductions in oxygen delivery through autoregulatory vasodilation to maintain cerebral blood flow and through increased oxygen extraction [1]. Oxygen delivery can be reduced in a variety of situations, including reduced cerebral blood flow (arterial stenosis, hypotension) and anemia. A number of imaging tools have been developed to assess for the presence of these compensatory mechanisms. Some of the most commonly used methods evaluate cerebrovascular reserve (CVR). CVR describes the degree to which the brain vasculature can respond to a vasodilatory stimulus, such as acetazolamide or hypercapnia. A normal response is a robust increase in flow or flow velocity. When the response is absent, muted, or paradoxically worsened (steal physiology) after the stimulus, the presence of pre-existing autoregulatory vasodilation is inferred. The strongest evidence for clinical utility for CVR is for predicting the risk of future stroke in patients with atherosclerotic carotid occlusive disease [2, 3]. Tests of CVR have great potential for clinical use in other situations as well. These include subarachnoid hemorrhage-induced vasospasm [4], non-atherosclerotic vasculopathies (moyamoya) [5], sickle cell disease [6] and prediction of hyperperfusion syndrome. These tests may have value in predicting stroke risk and identifying patients that may benefit from revascularization procedures. This talk will review the physiology of hemodynamic impairment, a brief overview of the available tools for assessment, and then a discussion of clinical applications and the evidence to support them.

**O-502**
Breathhold CVR

Pillai, J.
The Johns Hopkins Hospital
Baltimore, MD

Abstract/Presentation Summary
Breath-hold Blood Oxygen Level Dependent (BOLD) cerebrovascular reactivity (CVR) mapping will be introduced in this lecture. The importance of this technique in clinical presurgical mapping will be stressed, both as an important quality control tool for assessing reliability of clinical BOLD fMRI and as a method for detection of neurovascular decoupling or uncoupling (NVU) potential. The phenomenon of NVU and how it may affect the BOLD signal will be discussed from both pathophysiologic and practical standpoints. Some important differences between the breath hold CVR technique and conventional exogenous CO₂ delivery approaches will be discussed including advantages and disadvantages of each approach. Brief mention will be made of research applications of this method related to NVU involving brain tumors of different grades. The great clinical utility of BOLD breath hold CVR mapping will be demonstrated using case examples from Johns Hopkins Hospital. These examples will show how this technique can make a difference in neurosurgical planning and why this technique will likely rapidly evolve into a standard of care for clinical fMRI.

Wednesday
8:30AM - 10:00AM
Palais des congres de Montreal, 520

58 - ASNR ANNUAL BUSINESS MEETING (members only)
Wednesday
8:30AM - 10:15AM
Palais des congres de Montreal, 524

59 - PARALLEL PAPERS: Interventional: Aneurysms II
O-504
8:30AM - 8:37AM

A Randomized Trial Comparing Platinum and Hydrogel Coiling in Patients Prone to Recurrence After Endovascular Treatment - The PRET Trial: Immediate Procedural results

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Purpose
Some patients are at high risk of aneurysm recurrence following endovascular treatment. The PRET trial, sponsored by the Centre Hospitalier de l'Université de Montréal and funded by MicroVention Inc., aimed to compare hydrogel to bare platinum coiling in patients with aneurysms prone to recurrence, i.e., in patients with large aneurysms (≥ 10mm; PRET-1) or in
patients with a major recurrence after previous coiling (PRET-2). We report periprocedural safety and operator-assessed immediate angiographic results.

Materials and Methods
Patients were randomized to the hydrogel coil or control arms (concealed allocation) by using minimization criteria. Recently ruptured and unruptured aneurysms (UAs) were included. Any type of bare platinum coils were allowed in the control arm. The present abstract includes aggregated results. Safety was evaluated according to the number of days in hospital, the modified Rankin score (mRs) at discharge and the discharge location (home or not).

Angiographic results were graded according to the Montreal scale.

Results
Thirty-four centers recruited 443 patients in six countries. Mean age was 58 +/- 11; mean aneurysm sizes were 14 +/- 4 mm for 247 PRET-1 and 11 +/- 7mm for 196 PRET-2 patients; 18% were ruptured aneurysms (29% in PRET-1; 4% in PRET-2); 42% of aneurysms were in the posterior circulation. Coiling was successful in 95% of patients. Forty-three (9.7%) periprocedural complications were reported. Patients were hospitalized for less than five days in 81.5% (93.5% of unruptured cases) and discharged home in 91% of cases (97% of UA cases). Two patients with ruptured aneurysms died (unrelated to treatment). At discharge and one month, 28 (6.6%) and 15 patients (4%) had a mRS >2. At discharge, 0 and five (1.4%) of 357 treated UA patients were dead or dependent (mRS>2). Operators assessed immediate angiographic results as complete obliteration or residual neck in 78% of cases. Analyses per allocated groups will be available at the time of the meeting.

Conclusions
Although immediate angiographic results may be suboptimal, bare platinum and hydrogel coiling can be performed very safely, even in large and recurrent aneurysms.

KEYWORDS: Aneurysm Embolization, Hydrocoil

O-505

WEB device for intracranial aneurysm embolisation: A case series

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Purpose
The WEB device is a novel device for the endovascular treatment of both ruptured and unruptured intracranial aneurysms. We present our experience in a series of patients treated at our institution.

Materials and Methods
This prospective study included 16 patients who were treated with the WEB device over a nine-month period. Aneurysm size, location and whether the aneurysm was ruptured or not was recorded, along with type and size of WEB device. Complications in the postoperative period also were documented.

Results
In all 16 cases a WEB device was deployed successfully. One case involved an acutely ruptured aneurysm. Complications were recorded in five cases, including thromboembolic events,
aneurysm rupture and the necessity of a second stent. A right facial palsy and left sensory deficit was the result of a thromboembolic event. All 16 patients have survived at the time of submission.

Conclusions
This initial series of 16 patients shows that aneurysm embolization is feasible with WEB device. Long term follow up of these patients, along with larger cohort studies are needed to further evaluate this new technique.

KEYWORDS: Aneurysm Embolization, Aneurysm Treatment, Endovascular Embolization

O-506
8:44AM - 8:51AM

Low-Profile Visible Intraluminal Support Device (LVIS) Jr: Initial Multicenter Experience

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Purpose
Wide-neck aneurysms incorporating a portion of the parent artery can be challenging to treat and may require combined balloon-remodeling and stent-assisted techniques. Low profile visible intraluminal support device (LVIS) Jr can be delivered through a remodeling balloon and is a new hybrid stent design that incorporates a lower porosity, is more navigable than current generation stents and also possesses some flow diversion characteristics. Study reports the initial multicenter experience using the LVIS Jr stent.

Materials and Methods
We reviewed the cases in which LVIS Jr was used in conjunction with coil embolization. Aneurysm characteristics, technical details, and periprocedural events were recorded. All patients were premedicated and maintained on dual antiplatelet therapy.

Results
We had 20 patients (13 females, 7 males) with 20 aneurysms (12 AComA, 3 MCA bifurcations, 4 BA termination and 1 LICA) treated using LVIS Jr devices. Two patients have been treated during acute phase of SAH. All but one stent were deployed successfully. The stent was placed before aneurysm coiling in 12 cases and as a bail out situation in seven cases, via a remodeling balloon in five cases. A "Y" stent construction was planned in five cases however, was only required in three cases, since only a single stent placement resulted in satisfactory coverage of the neck in two cases. Fourteen aneurysms were completely occluded initially and remained so at follow up, one patient progressed to complete occlusion on follow up. There were no permanent neurological procedural complications.

Conclusions
The LVIS Jr stent is a promising device for stent-assisted coiling. It has high navigability, can be delivered through a remodeling balloon and has flow diversion characteristics which potentially expand the options currently available for management of wide-neck aneurysms.

KEYWORDS: Aneursym, Aneurysm Treatment, Stents
OVERALL BUENOS AIRES FLOW DIVERTERS EXPERIENCE AT SEVEN YEARS FOLLOW-UP.

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Purpose
The aim of the study was to show the results of the use of flow diversion devices (FDD) in the treatment of wide neck, recanalized, dissecting, fusiform, giant and/or complex intracranial aneurysms (IA).

Materials and Methods
Between March 2006 and October 2013, 673 patients with 804 IA were treated. Female, 65.4%, median age was 58 years (Range 6-82 years). Pipeline (PED) was used in 497 patients with 599 IA; 57 patients with 66 IA with Surpass; 61 patients with 67 IA with CMFM; Silk was implanted in four patients (4 aneurysms); Sequent was used in 24 patients, (26 IA); and P64 in 29 patients (41 IA). Nine hundred fifty-nine devices were implanted.

Results
Intracranial aneurysms were 85.3% in anterior circulation; 22% were incidental and 78% were symptomatic IA; 51% were large and giant IA; 19% had been treated previously. All patients were under double antiplatelet drugs for 6-12 months post-treatment. Therefore our global morbimortality rate was 4.6% and 1.9% related to the procedure. The range of clinical and angiographic follow up was between three months and seven years.

Conclusions
Flow diversion device implantation showed low complications and high occlusion rate. In our seven-year experience with FDD we concluded that vessel repair is feasible, durable and achieves a definite endovascular reconstruction of parent vessel.

KEYWORDS: Aneursym, Aneurysm Treatment, Flow Diverter

SILK flow diverter for complex intracranial aneurysms- A Canadian registry

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Purpose
Flow diverter is a relatively new technology for treatment of complex intracranial aneurysms.
There have been small case series in the literature with very few studies with larger number of patients. We are presenting the results of registry of patients treated with SILK flow diverter (SFD) in Canada.

Materials and Methods
Seven centers across Canada were contacted to fill out case report forms for patients treated with SFD in their center. The case report forms were sent to Dr. Jai Shankar in Halifax, where the final analysis was performed. Individual centers were responsible for approval from their ethics committee. The information then was collected and analyzed. The image analysis was performed by individual operators. All patients were followed at least until aneurysms were completely obliterated.

Results
Total of 88 patients were treated with SFD in six centers in Canada since 2009. The number of patients varied from three to 25 across centers. The aneurysms were located on posterior circulation in 11 patients (Basilar-4; vertebral-7) and in anterior circulation in 69 patients (Cavernous ICA-20; Intradural ICA-45; ACA-2; MCA-2). Most of the aneurysms were saccular in shape except 13 fusiform and three blister aneurysms. The size of aneurysms varied from 2 mm to 60 mm with the neck varying from 2- 48. Twelve and one half percent (Thromboembolic-7, Hemorrhagic-4) patients had peri-operative complications but only 8% had clinical manifestation. Two (2.3%) patients died. Thirty-four (39%) of patients had complete obliteration of the aneurysm; 19 (22%) had partial obliteration and another 35 (40%) had no information on this.

Conclusions
Overall SFD appears to be a safe and effective tool to treat complex intracranial aneurysms.

KEYWORDS: Aneurysm, Flow Diverter

O-509
9:05AM - 9:12AM

BLISTER-LIKE ANEURYSMS: ENDOVASCULAR TREATMENT WITH FLOW-DIVERTING STRATEGY.

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Purpose
The current literature describing neurosurgical and endovascular treatment of fragile blister-like aneurysms (BLA) offers no clear consensus on the optimal treatment modality. We present our experience in treating BLA with endovascular techniques.

Materials and Methods
We report 20 patients with 30 BLA, mean age 51 years, (range 30-70) that were treated using reconstructive endovascular technique with FD. Treatment, angiographic and clinical outcomes were evaluated retrospectively.

Results
Between October 2008 and October 2013, 23 patients with 33 BLA were seen. In this special cohort, 23 patients presented with subarachnoid hemorrhage (blood BLA), seven headache and three were incidental; 7 patients had multiple aneurysms. Dual antiplatelet therapy was indicated
for the entire group. All patients were treated initially with 36 FD embolization devices. Three patients with subarachnoid hemorrhage required coiling before stenting. No rebleeding or thrombotic complication occurred periprocedurally. Long term control angiography was available in all patients. The occlusion rate at three, six and 12 months, was 90%, 100% and 100% respectively. Clinical outcome (mRS) was 0-2 in 16 patients and three in three patients. One patient died due to clinical complication.

Conclusions

Endovascular treatment of BA/Like-BA using a FD device may represent a valid alternative and a promising strategy that can be performed with acceptable clinical and radiological results.

KEYWORDS: Blister Aneurysm, Flow Diverter

O-510

9:12AM - 9:19AM

Flow Diverter Stenting in recanalized Intracranial Aneurysms previously treated with a regular stent

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¹Besancon University Hospital, Besancon, France

Purpose

To evaluate clinical and angiographic results and long term follow up in a series of patients with a recanalized intracranial aneurysm previously treated using a regular stent.

Materials and Methods

Nine patients with a recanalized intracranial aneurysms treated by a regular stent and coils (1 neuroform stent in three patients, 1 enterprise stent in three patients, 2 enterprise stents in two patients and 1 Leo stent in one patient) were included in the study. Flow diverter stents were Pipeline stent (ev3 company) in six cases and Surpass stents in three. DynaCt or XperCT was used in all cases in order to evaluate correct deployment of the stent.

Results

Flow diverter stent deployment failed in one case and was very challenging in two. No clinical complications were observed immediately after the procedure and at follow up. All patients underwent long term angiographic and MR follow-up studies. Complete occlusion was observed in six of eight patients in whom the procedure was successful.

Conclusions

Flow diverter stenting in aneurysms previously treated with a regular stent remains a challenging procedure and should be reserved for selective cases. The evaluation of the full deployment of the previous stent could be difficult, however this information is crucial in order to plan a correct indication for flow diverter stenting.

KEYWORDS: Aneurysm Embolization, Flow Diverter, Interventional

O-511

9:19AM - 9:26AM

INTRASACCULAR FLOW DIVERSION FOR BIFURCATION AND TERMINAL ANEURYSMS: BUENOS AIRES EXPERIENCE
Purpose
WEB dual layer or WEB II, is the second generation of an intrasaccular flow diversion device planned for the treatment of bifurcation and terminal intracranial aneurysms (IA). We report our initial experience in a series of patients treated with this device, regarding the feasibility, safety and mid-term follow up.

Materials and Methods
Between April 2012 and October 2013, the WEB II was implanted in 18 patients with 20 IA. Eighteen IA were in anterior circulation (1 ruptured). Middle cerebral artery (MCA) was the most common location (14 IA). Clinical or angiographic controls were performed at three and 12 months.

Results
The WEB II was deployed successfully in all patients; in three cases it was necessary to reposition the device. No hemorrhagic complications were observed; two patients presented thromboembolic complications, successfully treated with IA fibrinolitic. At three months the occlusion rate was 77.7%. Six aneurysms were controlled at 12 months: four showed complete occlusion, and two required retreatment with stent and coils. No hemorrhagic or ischemic complications in the follow up period. mRS 0 in all patients.

Conclusions
WEB II showed to be a safe alternative for the treatment of bifurcation and terminal aneurysms, with low rate of complications and retreatment. Longer follow up is necessary.

KEYWORDS: Aneurysm Treatment, Flow Diverter
treatment of intracranial cerebral aneurysms. Following balloon angioplasty expansion of stenotic regions, C-arm CT was again used to re-evaluate stent conformation and apposition.

Results
Incomplete stent expansion and apposition to vessel walls was seen in five cases, using C-arm CT, after which balloon angioplasty was used in stenotic regions. C-arm CT was useful in predicting successful stent expansion in all five cases. Stent shortening could also be seen on postangioplasty C-arm CT, which may be a necessary component to successfully expanding the highly dense configuration of flow-diverting stents.

Conclusions
Use of C-arm CT in conjunction with standard angiography successfully allows for accurate visualization and optimal re-expansion of stenotic or distorted flow-diverter stents, especially in areas of dense or tortuous skull-base vascular anatomy that may otherwise be difficult or impossible to fully appreciate.

KEYWORDS: C-Arm CT, Stenosis, Stents

Examples of Pipeline Embolic Devices (PED) being deployed near the skull base, with poor visualization under fluoroscopic guidance alone (A, both examples). (B) Balloon angioplasty of the stenotic regions of the PED. (C) C-Arm CT reconstruction of the pre-angioplasty stent shape (red) and the post-angioplasty (white), showing expansion of previously stenotic regions as well as some stent shortening as a result of the stent expansion. (D) Post-Angioplasty fluoroscopy views.
Prospective Study of Early MRI Appearances Following Flow Diverting Stent Placement for Intracranial Aneurysms.
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²Auckland Hospital, Auckland, New Zealand

Purpose
Following pipeline embolization device (PED) and other flow diverting stent placement to treat intracranial arterial aneurysms, complications of delayed aneurysmal and parenchymal hemorrhage, with or without preceding symptomatology have been described (1-4). Speculation remains regarding the etiology of both forms of hemorrhage, with hemorrhage risk of 0-6% in reported series (4, 5). MR imaging (MRI) case reports (1, 2) have identified perianeurysmal edema, aneurysm expansion and aneurysm wall enhancement in symptomatic patients prior to delayed aneurysm rupture. We sought to document whether such MR findings were common in asymptomatic patients following flow diverting stent insertion. There is limited literature on routine MR findings following flow diverting stents (6).

Materials and Methods
Patients requiring flow diverting stent placement for treatment or retreatment of cerebral aneurysms were included prospectively in the study over a 20-month period. Early postprocedure MRI studies were obtained between two and 10 days poststent placement and compared with pre-operative imaging. Aneurysm size, shape, surrounding edema, wall enhancement and the occurrence of parenchymal diffusion-weighted imaging (DWI) positive lesions were noted. Clinical data were gathered as to neurological symptomatology and clinical complications.

Results
Twenty-eight aneurysms in 27 patients were included in the study. Early postprocedure MRI studies were obtained in 24 patients. There were exclusions for claustrophobia (one) and booking errors (two). Two patients had delayed MRI beyond the target time, both at day 16. Two aneurysms were in the vertebrobasilar territory with the remainder anterior circulation. Median age was 53 years and median aneurysm pretreatment diameter was 13mm. Aneurysm mural enhancement was present in 64% of cases measuring 1-3mm thick. Mild (3mm or less) new perianeurysmal edema was present in 25% without clear association with headache. Aneurysm size was stable, or within 1mm of pretreatment dimension in all cases except one where the aneurysm asymptomatically increased by 4mm (26mm from 22mm). Any DWI lesion was present in 54% cases. Thirty-three percent had more than five DWI lesions or any lesion greater than 5mm; two (2/27 or 8% overall) of these cases experienced clinical ischemic complications. New foci of susceptibility effect ipsilateral to the stent and almost always not associated with diffusion restriction were found in 43% (9/21) of cases that had susceptibility-weighted sequences performed. A further 29% of these studies (6/21) had susceptibility foci ipsilateral to the stent which were possibly new but did not have an earlier comparison SWI sequence. There were no cases of intracranial hemorrhage and no deaths.

Conclusions
Asymptomatic aneurysm mural enhancement and perianeurysmal edema frequently are seen following flow diverting stent placement. Such findings early after flow diversion should not necessarily be interpreted as a sign of impending aneurysm rupture. Diffusion-weighted imaging data suggest a comparable embolic risk to that reported with aneurysm coiling (7). New susceptibility foci following stent placement has not been reported previously but is common in our series. The etiology of this signal change is uncertain but may warrant further investigation.
with regard to its potential relevance to ipsilateral parenchymal hemorrhage following flow diversion.

KEYWORDS: Aneurysm Thrombosis, Flow Diverter, MR Imaging/MR Angiography

O-514

3D-DSA reconstruction from Sparse Projections with C-arm CT

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Purpose

Three-dimensional digital subtraction angiography (3D-DSA) is the 3D imaging tool to provide detailed vessel structures, and is becoming indispensable in making decisions of treatment plans, especially for aneurysm cases. However, a certain amount of dose and contrast media are required in order to get feasible information for those purposes. We show the possibility that dose and contrast can be reduced without compromising image quality with total variation (TV), a form of iterative reconstruction.

Materials and Methods

Ten sets of 3D-DSA projection data were used for this study, and each 3D-DSA projection data had 108 projections. Standard 3D-DSA images used in practice were reconstructed from 108 projections with the Feldkamp method. New 3D-DSA images, TV1s, TV2s and TV3s, were reconstructed with the TV method from 108, 54 and 36 projections, respectively. Projection data sets of 54 and 36 projections were retrieved by sampling every two and three projections, respectively. The TV1s, TV2s and TV3s were compared individually with the standard images by two experienced neuroradiologists/neurosurgeons, and a semi-quantitative five-point grading scale (1=poor, 4=comparative with the standard images 5=even better) were used for visibility of fine vessels and aneurysms.

Results

The standard image, TV1, TV2 and TV3 were shown on Figure 1(a), 1(b), 1(c) and 1(d), respectively. We could see comparable fine vessels on the standard image and TV2, and TV1 showed even finer vessels. Averaged five-point grading scales were 5, 3.9 and 3.3 for TV1s, TV2s and TV3s, respectively. TV3s would be inappropriate for diagnostic purposes, but would have significant information for guide-wire or catheter navigational purposes.

Conclusions

TV method showed image quality improvement compared with Feldkamp method to enhance clinical usefulness, and also showed that potential reduction of either x-ray dose or amount of contrast media.

KEYWORDS: Angiography
Magnetically Assisted Remote Controlled Endovascular Catheter for Interventional MRI: In Vitro Navigation at 1.5T versus X-ray Fluoroscopy

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Purpose
To compare in vitro navigation in a vascular phantom of a magnetically assisted remote controlled (MARC) catheter under real-time MR imaging (MRI) with manual navigation under MRI and x-ray guidance in endovascular catheterization procedures.

Materials and Methods
A custom 2.9 French clinical grade microcatheter prototype with a solenoid coil at the distal tip was deflected with a foot pedal actuator used to deliver ± 300 mA. Investigators navigated the catheter into branch vessels in a custom cryogel abdominal aortic phantom. This was repeated under MRI guidance without magnetic assistance and under conventional x-ray fluoroscopy. MR imaging experiments were performed at 1.5 T using a b-SSFP sequence. The mean procedure times and percent success were determined and analyzed with a linear mixed effects regression analysis.

Results
The catheter was clearly visible under real-time MRI. One hundred and ninety-two (80%) of 240 turns were completed successfully with magnetically assisted guidance versus 144 (60%) of 240 turns with nonassisted guidance (P<.001) and 119 (74%) of 160 turns with x-ray guidance (P=.028). Overall mean procedure time was shorter with magnetically assisted than with nonassisted guidance under MRI (37±6 s versus 55±3 s, P<.001), and between magnetically assisted and standard guidance under x-ray (37±6 s versus 44±3 s, P=.045). When stratified by angle of branch vessel, magnetic assistance was faster than nonassisted MR guidance at turns of 45°, 60°, and 75°.

Conclusions
We have developed and tested a MARC catheter for endovascular navigation under real-time MRI guidance. For catheterization of branch vessels arising at large angles relative to the parent vessel, magnetic-assisted catheterization was faster than manual catheterization under MRI guidance and comparable to x-ray guidance. This work forms the foundation for improved endovascular catheter navigation under MRI, enabling further exploration of simulated interventions for the treatment of stroke, vascular malformations, and tumors - all of which may benefit from the physiologic information available through real-time MRI but not x-ray fluoroscopic guidance.

KEYWORDS: Devices, Image-Guided Procedures
Does Configuration And Location Of Intracranial Aneurysm Influence Pipeline Stent Deployment? Single Center Analysis

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Purpose
Pipeline embolization device (PED) is an FDA approved flow diverting stent indicated for endovascular treatment of large or giant wide-necked intracranial aneurysms (IAs) located in anterior circulation. Pipeline embolization devices have shown encouraging results in PITA and PUFS studies, but limited data exists on their use in posterior fossa IAs and the number of stents used in different types of aneurysms. We hypothesize that fusiform aneurysms require more PEDs to achieve complete occlusion.

Materials and Methods
We reviewed 15 patients who underwent pipeline stenting for various IAs between June 2011 and July 2013. Inclusion criteria included patients who were unsuitable for coiling/clipping, had nonruptured aneurysms and without any prior interventions. Several patients had pre-existing neurological deficits with cranial nerve or brain stem compression. All patients were continued on dual antiplatelet therapy and platelet assays were obtained before and after the surgery. Follow-up conventional angiograms were performed at six and 12 months with CTA at 24 months, while morbidity was evaluated using Barthel Index before and three months after the procedure. Presence of a residual aneurysm was assessed on catheter angiograms using Raymond criteria.

Results
Mean size and volume of aneurysms recorded were 17.3 mm and 2940.5 mm³ respectively. There were eight fusiform (n=8) and eight saccular (n=7) aneurysms in our cohort. A total of 59 PEDs were placed with 15 stents in saccular and 44 stents in fusiform type of IAs. There were no long term clinical complications, in-stent stenosis, aneurysmal ruptures or lobar hemorrhages; while five patients developed restricted diffusion on MR imaging (MRI) scans during peri-operative period (<30 days). Complete resolution of aneurysmal sac was noted in 11 (73.3%) patients on follow-up angiograms, while two of four failure cases were basilar fusiform IAs which did not show complete resolution.

Conclusions
We conclude that fusiform IAs require more PEDs to achieve successful occlusion. Interestingly, deliberate lower mesh density used in treatment of basilar aneurysms due to risk to perforators result in higher rates of incomplete occlusion.

KEYWORDS: Aneurysm Sizes, Pipeline Embolization Device

O-517
10:01AM - 10:08AM

The Penumbra Coil 400 System Beyond Intracranial Aneurysms - Initial Experience with 19 Unusual Lesions

E Wyse¹, M Pearl², M Radvany², P Gailloud¹
Purpose
The Penumbra Coil 400 is a new large size detachable coil system (coil diameter 0.020, coil length up to 60cm). This increased coil size requires the use of a larger delivery microcatheter (Penumbra PX Slim). While the system has proved to be efficient for the embolization of intracranial saccular aneurysms, its potential role in the treatment of more unusual lesions remains unclear. This report describes a series of patients treated with the Penumbra Coil 400 system for indications other than intracranial saccular aneurysms.

Materials and Methods
We report 19 consecutive procedures performed over a one-year period in 13 adult and six pediatric patients (age range 1 week to 75 years), including embolizations for transverse sinus dural arteriovenous fistulas (DAVF) (5 cases), other cranial, cervical, or spinal arteriovenous fistulas (AVF) (6 cases), vein of Galen arteriovenous malformations (VGAM) (2 cases), as well as four cases of internal carotid artery sacrifice, and two cases of splenic or renal aneurysms embolizations. The endovascular access was either transarterial (8 cases) or transvenous (9 cases). In pediatric cases, a 4-French diagnostic catheter was used as the guiding catheter. In two instances (diploic AVF and DAVF), the lesion was accessed by direct puncture using the outer dilator of a micropuncture set.

Results
All the procedures were technically successful, without periprocedural or immediate postprocedural complications. Each of the targeted lesions could be accessed with the Penumbra PX catheter, in spite of its larger caliber, including navigating tortuous spinal venous networks or access via a micropuncture dilator in cases performed by direct puncture. Complete occlusion of the lesions was achieved in all but one case. The latter patient was a one-week old baby with a VGAM, who remained in cardiorespiratory failure in spite of three transarterial embolizations; transvenous occlusion of the venous aneurysm was performed, with persistent minimal flow through the coil pack at the end of the procedure, while still fully heparinized. The large size of the coils was found to be particularly advantageous in pediatric cases, where the reduced number of needed coils directly translated into shorter procedural times, limiting radiation exposure. As illustrative examples, the embolization of a VGAM in a two-year-old boy was achieved with a total of 18 coils (radiation dose: 124.3 mGy, 834.13 uGym2) (Figure 1 left), the treatment of a complex intracranial AVF in a six-month-old girl with 30 coils (radiation dose: 139.5 mGy, 346.68 uGym2) (Figure 1 right).

Conclusions
The Penumbra Coil 400 system was, in our experience, successful in treating a range of unusual lesions both in adults and children. Besides potential financial and logistic advantages, the decreased procedural times made possible by the reduced number of coils needed to achieve complete embolization was felt to be particularly advantageous in children, where radiation dose limitation is critically important.

KEYWORDS: Devices, Endovascular Therapy
O-123

MRI Features Distinguish Subtypes of Infratentorial Ganglioglioma with High Specificity.

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¹St. Jude Children’s Research Hospital, Memphis, TN

Purpose
Abnormalities involving BRAF, a regulator in the mitogen-activated protein (MAP) kinase signaling pathway crucial to cell growth and differentiation, have been found in many cancers
including ganglioglioma, a low-grade glioneuronal tumor that is rare below the tentorium. Recently, we identified two histopathologically and genetically distinct subtypes of infratentorial ganglioglioma: classic tumors with a high frequency of \( \text{BRAF:p.V600E} \) mutation (Group I), and pilocytic astrocytomas with gangliocytic differentiation with a high frequency of KIAA1549-BRAF fusion (Group II). The purpose of this study was to determine whether MR imaging (MRI) phenotype could differentiate between subtypes of infratentorial gangliogliomas.

Materials and Methods
After pathologic and genetic analysis of 27 infratentorial gangliogliomas involving the cerebellum, brainstem and spinal cord, a neuroradiologist blinded to pathologic/genetic analysis evaluated MR imaging available in 25/27 subjects (14 Group I, 11 Group II) for tumor cysts/necrosis, hemorrhage, enhancement, restricted diffusion, circumscription, edema and location. Radiologic features then were compared between histopathologic/genetic subtypes, and sensitivity and specificity for distinction of tumor subtypes calculated.

Results
Group I gangliogliomas were most frequently poorly circumscribed (79%) and rarely cystic/necrotic (14%). Three of eight (38%) with diffusion-weighted imaging (DWI) were diffusion-restricted; none were midline or hemorrhagic. Group II gangliogliomas were more frequently cystic/necrotic (91%), midline (55%), hemorrhagic (45%) and well circumscribed (64%); five of six (83%) with DWI were diffusion-restricted. The presence of cysts/necrosis was 91% sensitive and 86% specific for differentiating Group II from Group I gangliogliomas. The presence of hemorrhage and/or midline location increased specificity to 100%.

Conclusions
Radiologic phenotype differentiates subtypes of infratentorial ganglioglioma with high sensitivity and specificity.

KEYWORDS: Genetics, MR Imaging, Pediatric Brain Tumors

Wednesday
10:30AM - 12:00PM
Palais des congres de Montreal, 517bc

60 - SPECIAL SESSION
O-518
10:30AM - 11:00AM

Keynote Speaker: A Unifying Role for Prions in Neurodegenerative Diseases

Prusiner, S.
University of California, San Francisco
San Francisco, CA

Abstract/Presentation Summary
Mounting evidence argues that prions feature in the pathogenesis of many, if not all, neurodegenerative diseases. Such disorders include Alzheimer's, Parkinson's, Lou Gehrig's and Creutzfeldt-Jakob diseases as well as the frontotemporal dementias. In each of these illnesses, aberrant forms of a particular protein accumulate as pathological deposits referred to as amyloid plaques, neurofibrillary tangles, Lewy bodies, as well as glial cytoplasmic and/or nuclear...
inclusions. The heritable forms of the neurodegenerative diseases are often caused by mutations in the genes encoding the mutant, prion proteins that accumulate in the CNS of patients with these fatal disorders. The late onset of the inherited neurodegenerative diseases seems likely to be explained by the protein quality control systems being less efficient in older neurons and thus, more permissive for prion accumulation. To date, there is not a single drug that halts or even slows one neurodegenerative disease.

O-519

11:00AM - 11:15AM

Neurodegeneration and Brain Connections: The Role of Neuroimaging

Petrella, J.
Duke University Medical Center
Durham, NC

O-520

11:15AM - 11:30AM

CLARITY & Beyond: Towards Integrative Understanding of the Brain in Health and Disease

Chung, K.
Massachusetts Institute of Technology
Cambridge, MA

Abstract/Presentation Summary
Obtaining detailed structural and molecular information from complex biological systems while simultaneously maintaining the global perspective has long been a fundamental challenge in neuroscience and throughout biology. Current pioneering methods, while proven adequate to study small-scale fine structures, fall short of providing integrated system-wide information. To address this challenge, we have developed a novel technology (which we term CLARITY) that rapidly transforms intact tissue into a hydrogel hybrid that is optically-transparent and macromolecule-permeable while retaining structural and molecular information. This unique framework enables effective and complete access of intact tissue using both light microscopy and molecular phenotyping techniques (immunohistochemistry and in situ hybridization). Exogenous macromolecules can rapidly penetrate deep into transmuted tissue for labeling and can be completely removed after imaging, enabling multiple rounds of molecular interrogation in 3D volumes of tissue. The application of CLARITY to the adult mouse brain has enabled imaging of long-range circuits, local circuits, subcellular morphological details, and molecular architectures. Finally, we find that this technique allows fine structural analysis of postmortem human brain, opening the door to the possibility of mapping the human brain at single cellular resolution with integrated molecular information. Taken together, this technology promises to provide high-content system-wide structural and molecular information that may enable integrative understanding of large-scale intact biological systems.
The Human Connectome Project

Van Essen, D.
Washington University School of Medicine
St. Louis, MO

Abstract/Presentation Summary
Recent advances in noninvasive neuroimaging enable the systematic exploration of human brain circuits in health and disease. The Human Connectome Project (HCP) is systematically characterizing brain circuitry, its variability, and its relation to behavior in a population of 1,200 healthy adults (twins and their non-twin siblings). This talk will review progress by the HCP consortium in acquiring, analyzing, and freely sharing these massive and highly informative datasets. The HCP obtains information about structural and functional connectivity using diffusion MRI and resting-state fMRI, respectively. Additional modalities include task-evoked fMRI and MEG, plus extensive behavioral testing and genotyping. Each of these methods is powerful, yet faces significant technical limitations that are important to characterize and be mindful of when interpreting neuroimaging data. Comparisons with anatomical data obtained in nonhuman primates aid in evaluating different imaging methods and also yield insights regarding the evolution of human cerebral cortex. Advanced visualization and analysis methods developed by the HCP enable characterization of brain circuits in individuals and group averages at high spatial resolution and at the level of functionally distinct brain parcels. Comparisons across subjects are beginning to reveal aspects of brain circuitry that are related to particular behavioral capacities and which are heritable or related to specific genetic variants. Data from the HCP is being made freely available to the neuroscience community via a user-friendly informatics platform. Altogether, the HCP is providing invaluable information about the healthy human brain and its variability. It will set the stage for characterizing brain circuits during healthy development and in abnormal brain connectivity in many brain disorders and diseases.

Wednesday
1:00PM - 2:30PM
Palais des congres de Montreal, 517bc

61 - ASSR PROGRAMMING: CONTROVERSIES IN SPINE TRAUMA (SAM)
O-522
1:00PM - 1:15PM

MRI in Spinal Injury

Van Goethem, J.
University Hospital Antwerp
Antwerp

Abstract/Presentation Summary
MRI has gained importance in imaging of spinal trauma with its increased availability for the emergency room physician. It is apparent that the depiction of the spinal cord is of primary importance, and with the adoption of MR, the utility of myelography and post-myelography CT
has diminished to the point of vanishing (in the absence of contraindications to MR). MR is capable of depicting the vertebra and supporting structures, intervertebral disks, the spinal cord and nerve roots, and trauma-associated injuries such as hemorrhage, traumatic disk herniations, and primary cord injury such as hematomas, edema, and even cord transection. Any patient with presumed spinal cord injury should undergo an emergent MR study. MR is superior at depicting the previously mentioned lesions which guide surgical management in these patients. Careful clinical examination with a determined level of injury is an excellent means of directing the level to be studied. Many trauma protocols may also mandate evaluation of the other spinal segments to exclude additional injury which may be masked by a higher level spinal cord injury. The sensitivity of MR for injuries of the soft tissue associated with trauma is well known, but MR may also demonstrate changes within the bone marrow of traumatized vertebrae which are inapparent on plain film studies, and even on CT, such as bone contusions. MR has also been shown to be both sensitive and specific for ligamentous injury in the trauma setting. We have used MR to provide a "ligament screen" exam for major trauma patients for several years now, with consistent results. The typical exam protocol for this purpose includes sagittal T1, sagittal T2, and sagittal STIR images, as well as axial imaging. Edema in the interspinous or supraspinous ligaments is particularly conspicuous on STIR images. Some observers may prefer fat-suppressed T2 images, which provide similar conspicuity of the changes of ligamentous injury. In whiplash patients special attention to the ligaments of the craniocervical junction is important. In these patients a dedicated 3D proton density sequence with thin reconstructed slices is able to show lesions to the transverse, alar and atlanto-occipital ligaments as well as the tectorial membrane.

O-523

1:15PM - 1:30PM

Dynamic or Static Imaging? Flexion/Extension Imaging of the Spine

Go, J.
LAC/USC Medical Center
Los Angeles, CA

Abstract/Presentation Summary
Flexion/extension imaging of the cervical spine has been used to examine spinal alignment, ligamentous integrity, and instability. Different methodologies have been used including the use of static and dynamic imaging with or without weight bearing as well as different modalities including plain radiography, fluoroscopy, CT and MRI. The use of flexion/extension imaging still remains controversial and currently there is no level I data in spine literature which verifies its use in imaging. This lecture will examine the controversial role of flexion/extension imaging in the assessment of ligamentous integrity and laxity, instability, and presence or absence of pseudoarthrosis or non-union. The information gained from flexion/extension imaging will be reviewed as well as normative values used in the different imaging modalities. Though controversial, the information used from flexion/extension imaging is still used to determine medical and surgical management.

O-524

1:30PM - 1:45PM
Is There a Role for MRI in Ligamentous Injury of the Spine?

Parizel, P.
Antwerp University Hospital/University of Antwerp
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Abstract/Presentation Summary
Traumatic injuries of the spine and spinal cord are common, devastating and potentially lethal lesions. Imaging studies are essential to ascertain the exact location of the injury, to discern between stable and instable lesions, to evaluate the impact of the traumatic event on the spinal cord and nerve roots, and on the diameters of the spinal canal and neural foramina. Increasingly, MRI has become a useful and even mandatory adjunct to ‘clearing’ the spine. In obtunded patients with cervical spine injury, while multi-detector row CT is reported to have negative predictive values as high as 98.9% for ligament injury and 100% for unstable cervical spine injury, still MRI remains the method of choice for showing spinal cord contusion, ligamentous injury, intervertebral disk edema and bone marrow edema. MRI provides direct evaluation of the spinal soft tissue structures, including ligaments, neural structures (spinal cord and nerve roots), intervertebral disks, and vasculature. An abnormal MRI after normal plain X-ray films and CT cervical spine examinations can result in a change of management. Moreover, it has been shown that an initial MRI evaluation after spinal cord injury provides supplemental prognostic information on the recovery of motor function in the upper and lower extremities. Correct identification of soft tissue injuries has a direct influence on patient management, helps to make a decision about acute surgery, and impacts prognosis. Literature data indicate that reliance on CT imaging alone to "clear the cervical spine" after blunt trauma can lead to missed injuries. There is increasing evidence to support the addition of MRI in evaluating spine trauma patients who are obtunded, or unexaminable, despite a negative CT scan. While multidetector CT is still the modality of choice for most patients admitted with spine trauma, the role of MRI is rapidly growing, because of its ability to directly evaluate the soft tissues of the spine. Early and accurate identification of injury to the neural structures (spinal cord and nerve roots), soft tissues (intervertebral disks, ligaments, muscles) and vascular structures has a great impact on patient management and outcome. Moreover, the identification of ligamentous injury of the spine may have important medicolegal consequences.

O-525

Medicolegal Aspects of Imaging Spine Trauma

Kim, P.
University of Southern California
Los Angeles, CA

Abstract/Presentation Summary
One of the major pitfalls faced by physicians is a lack of understanding of the basic legal aspects of medical malpractice. There are several salient points to consider. Vigilance and minimizing errors is always most desirable, but error-free neuroradiology is unattainable. Best medical judgment, although not error free, is at least defensible as noted in the case law discussed here.
Errors of protocol, on the other hand, are extremely difficult to defend, particular failure to communicate significant results. Understanding this alone will reduce risk immeasurably. Errors resulting from bias, particularly alliterative errors, are most insidious and require significant self-vigilance. Many of these errors, as well as perceptual errors, are the result of rushing, distraction, or fatigue resulting from high-volume workloads. Other pitfalls are not under the radiologist's control. One unfortunately cannot easily choose the clinical colleagues associated with his or her practice but vigilance for their errors can certainly reduce the risk of being sued. Finally, because cervical spine trauma are is commonly associated with malpractice litigation, heightened caution and vigilance for potential missed diagnoses is emphasized.

Discussion and Questions

Wednesday
1:00PM - 2:30PM
Palais des congres de Montreal, 517d

62 - SNIS PROGRAMMING - ACUTE STROKE IMAGING AND THE REAL WORLD
O-526

Acute Stroke Imaging: Use of CT Modalities for Endovascular Management Triage Decisions - Denver Experience

Frei, D.  
Radiology Imaging Assoc.  
Lakewood, CO

O-527

Acute Stroke Imaging: Use of Combined CT and MRI Modalities for Endovascular Management Triage Decisions - Cleveland Clinic Experience

Hussain, M.  
Cleveland Clinic  
Cleveland, OH

Abstract/Presentation Summary
Stroke secondary to large vessel occlusion remains a devastating disorder. Intra-arterial stroke
therapy shows promise as a treatment for this condition. However, despite improved recanalization rates, patient outcomes have not shown improvement in clinical trials of intra-arterial stroke therapy. This likely is due to issues of patient selection. In order to improve patient selection, a "Hyperacute MRI" protocol was initiated at the Cleveland Clinic in 2010. Since implementation, the volume of procedures for IAT was cut in half, with substantial improvement in outcomes and reduced mortality. The talk will focus on the development and implementation of the Hyperacute MRI protocol, with a discussion of the changes in outcomes and future directions.

O-528

Care Paths and Advanced Stroke Imaging Triage: Implications for Cost Repositioning and Longitudinal Care Strategies

Modic, M.
Cleveland Clinic Foundation
Cleveland, OH

Abstract/Presentation Summary
CarePaths are organized around a medical condition in order to reduce unnecessary variations in patient care over time, venue and provider. Validated health status measures/outcomes, process, cost and patient experience are tied together and embedded and enabled within the electronic medical record. This construct provides the infrastructure necessary for continuous improvement, cost repositioning and longitudinal care strategies. The stroke carePath model will be used to illustrate the interplay between care coordination, innovation, care transformation and cost using examples at the individual patient and population levels. The importance of the interplay of workflow, regional implementation and care management will be illustrated.

Wednesday
1:00PM - 2:30PM
Palais des congres de Montreal, 517a

63 - INTERNATIONAL SESSION: ASNR INTRODUCES ITS FIRST BILINGUAL SESSION: SOCIETY OF FRENCH NEURORADIOLOGY (SFNR)

O-529

Brain Perfusion Imaging Techniques in Neonates

Proisy, M.
CHU Rennes Hospital SUD
Rennes, ---

O-530

Quantitative DTI for Prognostic Evaluation in Acute Brain Injury
O-531 1:20PM - 1:30PM
Cerebrovascular Reserve in Clinical Practice

Krainik, A.
University Hospital of Grenoble
Grenoble, --

O-532 1:30PM - 1:40PM
MRI Red Flags Against the Diagnosis of Multiple Sclerosis

Dousset, V.
University Bordeaux Segalen
Bordeaux, Bordeaux

O-533 1:40PM - 1:50PM
Exome Sequencing of Familial Form of Intracranial Aneurysm

Bourcier, R. · Desal, H.
University Hospital of Nantes
Nantes

Abstract/Presentation Summary
Introduction: Familial form of intracranial aneurysm (ICA) is defined by the presence of two or more first-degree relatives with ICA. It is considered that about 10% of all ICA occurs in a familial context but this may be an underestimation. Nowadays genetic analysis has not allowed identifying any gene involved in familial forms of ICA. In the present study, we aim to discover rare genetic variants causally related to ICA in large French families. Material and methods: Among families followed in our center (Departernent of Neuroradiology of CHU Nantes, France), we have selected two large families with more than 5 siblings affected by ICA. Disease segregation in these families is consistent with autosomal-dominant inheritance model. Syndromic forms of ICA were ruled out in the index case by medical genetic consultations. First- and second-degree relatives aged over 20 years were screened with encephalic MRI for the presence of ICA. Blood sample was taken from each patient. Whole-exome sequencing was performed for two relatives in each family with IAC. Sequence data analysis was carried out with Samtools and GATK algorithms. Series of filters were applied to exclude variants which are
unlikely to contribute to ICA, such as those with a minor allele frequency above 1% in the general population. The remaining variants were prioritized using the following criteria. Genes were given higher priority if (1) they were related to selected categories and genes of interest in the Gene Ontology (GO) database; (2) more affected individuals within the family carried the variant; (3) any controls sent from the family of interest did not carry a variant within the gene; (4) the variants within the gene were predicted to be deleterious by protein prediction programs (SIFT, Polyphen2); (5) they were within a highly conserved region as defined by GERP.

Results: After whole-exome sequencing, a mean coverage of 124X was achieved for the coding portion of the genome. On average, 89% of the targeted bases were covered by at least 20 sequencing reads. Among the 29 rare non synonymous variants shared by two affected relatives from the first family, we have identified one non sense variant within a gene involved in angiogenesis. We are currently sequencing this gene in additional ICA cases. Functional investigations are also ongoing. Conclusion: Our study has already led to the identification of a rare variant in a gene potentially involved in the aneurysm formation in a large ICA family. This could help us to identify pathways and mechanisms causing the formation and rupture of ICA. We could then, based on this information, better select which patient to screen, to follow and to treat among people with IAC.

O-534

1:50PM - 2:00PM

State of the Art and New Algorithms of Endovascular Treatment for Intracranial Aneurysm

Spelle, L.
Beaujon Hospital
Paris, Paris

Advanced Hemodynamic Profiling of Intracranial Aneurysms Prior to Flow Diversion

Eker, O.
CHU Montpellier
Montpellier, --

O-536

2:10PM - 2:20PM

Randomized Trial in Acute Stroke Therapy: THRACE Intermediate Results

Bracard, S.
CHU Nancy
Nancy, Nancy
Methods All patients aged between 18 and 80 years with an acute ischemic stroke occurred within 4 hours are eligible for the study. Inclusion criteria are an occlusion of the intracranial carotid artery, the M1 portion of the middle cerebral artery or the upper third of the basilar and with a NIHSS score between 10 and 25. All the patients are treated with the reference IV treatment (0,9 mg/kg of rTpa). In the thrombectomy arm, thrombectomy is performed at the end of IV perfusion, with one of the thrombectomy device available. The modified Rankin Score at 3 month after treatment is the primary outcome. Secondary outcomes are the Barthel score at 3 month and the Quality of Life with Euroqol EQ-5D generic questionnaire at 3 and 12 months after treatment. The sample size was estimated at 480 patients. 325 were are already included at the end of 2013. After the intermediate analysis of the first 220 patients, the Safety Committee recommendation was to continue the study.

O-537

Diversion: French Prospective Observational Registry in Flow Diversion for Intracranial Aneurysms

Turjman, F. University of Lyon Lyon, --

Abstract/Presentation Summary
F.Turjman (1), L. Spelle (2), J. Berge (3), L. Pierot (4), L. Huot (6), F. Chapuis (6), A. Bonafe(5), Department of Neuroradiology from Lyon (1), Paris Beaujon (2), Bordeaux (3), Reims (4) and Montpellier (5) and Pôle Information Médicale Evaluation et Recherche (IMER) Hospices Civils de Lyon (6). INTRODUCTION: The goal of this study was to assess the impact of flow diverter (FD) devices in the treatment of intracranial aneurysms on aneurysmal occlusion rates, morbidity, mortality, and complication rates in an unselected cohort subjected to real life clinical practice. The current study was designed by the French Society of Neuroradiology in collaboration with the French Agency for drugs and devices safety (ANSM) in order to monitor all flow diverters (FD used in France in the treatment of intracranial aneurysms from October 8th, 2012 to February, 7th 2014. We report here an interim analysis concerning the immediate (intra and peri-procedural) results of endovascular treatment of intracranial aneurysms with FD. Of patients enrolled during the first year of the study. METHODS: The inclusion criteria were the use of a FD in the treatment of an intracranial aneurysm in patient older than 18 year who agreed to participate to the study. The primary endpoint was the rate of morbi-mortality at 1-year. This prospective study involved all active French centers. SAEs were assessed by an independent DSMB and the imaging data were reviewed by 2 interventional neuroradiologists independent to the study. Exhaustivity of the data will be assessed by crossing the reported data in a given center with the sales reported by the companies. The study was funded by the neuroendovascular companies and sponsored by the French Society of Neuroradiology. Data of patients enrolled during the first year of the study in the centers having included 10 patients or more are considered here. 10% of all files and all SAE were monitored by an independent CRO. Descriptive analysis of aneurysms characteristics and clinical results of the procedures was performed. RESULTS: From October 8th 2012 to October 7th 2013, 308 patients were enrolled
in the study in 17 centers in France and treated with the flow-diverter devices (FD). Among these patients, data from 223 (72.4%) with 266 cerebral aneurysms treated, representing 228 procedures, were available for the analysis. Aneurysm size was >15 mm for 31 (11.7%), 5-15 mm for 129 (48.5%), and <5 mm for 106 (39.9%). Aneurysm locations were extradural in 38 cases and intradural in 224. For intradural aneurysms, the location was supraclinoid internal carotid artery (ICA) in 117 cases (52.2%), middle cerebral artery in 30 (13.4%), posterior communicating artery (PCoA) in 9 (4.0%), and anterior communicating artery (ACoA) in 14 (6.3%). The vertebrobasilar system accounted for 12 cases (5.4%) and paraclinoidal for 27 (12.1%). Three aneurysms were not treated. At least 274 FD were used: 165 (60.2%) were PIPELINE Embolisation Devices (Covidien); 76 (27.7%) Silk (Balt); 20 (7.3%) FRED (Microvention); 11 (4.0%) SURPASS Neuroendograft System (Stryker); and 2 devices were not identified. In 38 (14.5%) case aneurysms, devices were used with coils. Success rate was 94.9%. Complete stasis was obtained in 38 (14.7%) aneurysms, significant flow reduction in 69 (26.7%). Adverse events occurred during 39 patients procedures (17.1%). During hospitalization, 27 SAEs occurred, including 7 hemorrhages, 12 ischemic events, and 1 visual impairment. Three patients died from cerebral hemorrhage. At discharge, overall morbidity rate were was 20.6%.

CONCLUSION: Our prospective study confirms that morbidity and mortality rates in treatment with FD rates in an unselected cohort subjected to real life clinical practice do not differ from those reported in the largest series.

Wednesday 
1:00PM - 2:30PM
Palais des congres de Montreal, 520

64 - ADVANCED IMAGING SEMINAR: TRANSLATIONAL ADVANCED NON-GAUSSIAN DIFFUSION IMAGING
O-538
1:00PM - 1:30PM

Gaussian vs. Non-Gaussian Diffusion - Who Cares and Why You Should!

Jensen, J.
Medical University of South Carolina
Charleston, SC

Abstract/Presentation Summary
Diffusion MRI (dMRI) encompasses a variety of specific methods that exploit the ability to sensitize the MRI signal to water diffusion by applying strong magnetic field gradients during the pulse sequence. These "diffusion gradients" cause spin dephasing that is enhanced by molecular motion. Thus tissues with stronger diffusion will have a reduced dMRI signal. The various dMRI methods differ in the choice of the diffusion gradients (e.g., their strengths, directions, and durations) and in the algorithms used for post-processing of the data. These distinctions determine what aspects of water diffusion can be quantified. For clinical dMRI, the most widely used technique is diffusion tensor imaging (DTI) [1]. However, DTI is based on an approximation that water diffusion is Gaussian. This means that the distribution of water molecule displacements for a given time interval is idealized as obeying a Gaussian (i.e., normal) probability distribution. For water in a homogeneous solution, this would typically be an
excellent assumption. In contrast, water diffusion in brain departs significantly from a Gaussian form and is therefore referred to as "non-Gaussian diffusion." This diffusional non-Gaussianity is a consequence of restrictions, such as cell membranes, and compartmentalization, such as for the inter- and extra-cellular water pools [2]. For this reason, diffusional non-Gaussianity is a natural indicator of microstructural complexity in brain tissue. Nonetheless, there are no measures provided by DTI that quantify this property, and DTI imaging protocols are, in fact, designed to minimize non-Gaussian diffusion effects, in order to be consistent with the assumptions underlying this technique. To access the information associated with non-Gaussian diffusion, several "advanced" dMRI methods have been proposed, including high angular resolution diffusion imaging (HARDI) [3-5], diffusion spectrum imaging (DSI) [6], and diffusional kurtosis imaging (DKI) [7]. All these approaches share the feature that dMRI data is acquired with somewhat larger diffusion weightings than typical for DTI, which increases the sensitivity to non-Gaussianity. HARDI, which refers to several related techniques, focusses on trying to improve the angular resolution to which the water diffusion can be characterized. This is particularly useful for white matter fiber tractography and provides a resolution to the so-called "fiber crossing problem" of DTI-based fiber tractography [8]. DSI is a method of quantifying the distribution of diffusion displacements without making any assumptions about its form. DKI is designed to be a minimal extension of DTI that includes metrics of non-Gaussianity and aims to maintain the practical advantages of DTI to the extent possible.

O-539

Selected Application: Stroke

Sun, P.
A. Martinos Center for Biomedical Imaging, Radiology, MGH and Harvard Medical School
Charlestown, MA

Abstract/Presentation Summary
Kurtosis, a measure of non-Gaussian diffusion, has been introduced as a new metric for imaging a host of neurological disorders. Our recent study shows that DWI lesions with no change in mean kurtosis (MK) are likely to respond favorably to early reperfusion while lesions with abnormalities in both mean diffusion (MD) and kurtosis show poor recovery, suggesting that diffusion kurtosis imaging (DKI) is capable of stratifying the heterogeneously injured DWI lesion. As diffusion in cerebral tissue is anisotropic, the standard DKI protocol requires collecting DWI images with multiple b values along varied diffusion directions, resulting in relatively long acquisition time. The scan/processing time of DKI has to be substantially shortened before DKI can be used routinely. In addition, unlike the relatively homogeneous mean diffusion images, the complexity of cerebral structure and composition leads to a heterogeneous MK map, in which the specificity of kurtosis abnormality to ischemia is somewhat compromised. A means to minimize the intrinsic cerebral tissue MK variation would thus enhance the conspicuity of the ischemic kurtosis lesion, to in turn facilitate the practical use of kurtosis MRI in the acute stroke setting. Our study investigated a recently proposed fast mean kurtosis imaging method and demonstrated substantial kurtosis/diffusion lesion mismatch during acute ischemic stroke. In addition, regression analysis showed the kurtosis/diffusion lesion mismatch obtained using conventional and fast DKI methods were significantly correlated. We
also demonstrated that multi-parametric image analysis of kurtosis significantly enhanced tissue segmentation of ischemic kurtosis lesion over the standard MK map.

O-540

Selected Applications: Brain Tumor & Huntington's Disease

Van Cauter, S.
University Hospitals Leuven
Belgium

Abstract/Presentation Summary
Although different methods have been proposed to measure non-Gaussian diffusion, most clinical studies investigating the non-monoexponential diffusion related signal decay, apply the DKI model. The intuitive concept of DKI as an extension of the widely used DTI technique and the implementation of b-values, readily implementable in routine clinical and experimental scanners, have proven this technique attractive in the non-invasive investigation of several neuropathologies. In this lecture, we will focus on the role of DKI in characterizing the microstructural complexity in gliomatous brain tumours. Kurtosis related parameters have proven to be more accurate than conventional diffusion metrics in determining glioma grade. Furthermore, we will discuss a potential role of DKI in differentiating therapy related changes from tumor relapse in glioblastoma patients. The second part of the lecture will focus on the added value of DKI in the identification of biomarkers in Huntington's disease. Although this devastating disease is most often diagnosed in mid-life, it is known that the key to its clinical expression may be found during brain maturation. Recent experimental studies have shown the DKI-related parameters are promising to assess changes in tissue microstructure and detect alterations during neurodevelopment.

Wednesday
1:00PM - 2:30PM
Palais des congres de Montreal, 524

65 - GENERAL PROGRAMMING - SUBSPECIALTY AND REGIONAL SOCIETY AWARD PAPERS, DYKE AWARD, FOUNDATION OF THE ASNR PAPERS

O-547

Gold Medal Award Winner Presents

Naidich, T.
Mount Sinai Hospital
New York, NY

O-542
Louis A. Gilula, MD Mentor Award - American Society of Spine Radiology (ASSR) - Simulation-Based Educational Curriculum for Lumbar Puncture to Improve Operator Confidence and Efficiency

McLaren, T.
Medical University of South Carolina
Johnson City, TN

Abstract/Presentation Summary
A Bourgeois1, T McLaren2, K Hudson, MD1, A Pasciak1, A Faulkner1, E Heidel1, Y Bradley1
1 University of Tennessee Department of Radiology and Graduate School of Medicine. Knoxville, TN. 2 East Tennessee State University Quillen School of Medicine. Johnson City, TN. Introduction: The use of anthropomorphic detail phantoms in simulation-based medical education has rapidly increased in the past few decades, aimed at improving operator confidence and patient outcomes. However, further adaptation of simulation-based procedural instruction is often cost-prohibitive and provides uncertain clinical benefit. We describe the integration of a novel, low-cost, durable lumbar spine phantom and formal educational curriculum for performing lumbar punctures (LP) with the aim to increase operator efficiency and confidence.

Methods: Following IRB approval, 6 PGY-2 residents were enrolled in an educational curriculum including 2 formal didactic lectures, an instructional video, and 20 simulated fluoroscopically-guided lumbar punctures performed on a novel phantom created for the purposes of this study. Data from 114 lumbar punctures performed by the six enrolled residents were compared with retrospective data from 514 LP’s performed by 17 residents who underwent no formal training. A 10-question survey analyzing the operators’ confidence, understanding of anatomic landmarks and knowledge of procedural risks was administered to the test group before and after their first 15-25 LP’s. Results: The LP curriculum test group had significantly decreased procedural fluoroscopy time (0.87 min) compared to the control group (1.09 min) for all lumbar punctures, including both diagnostic LP and LP for myelogram on an aggregate basis (p = 0.002). This relationship is preserved when independently accounting for diagnostic LP alone (p = 0.002) and LP for myelogram alone (p = 0.001). No statistically significant relationship in failed LP’s between the two groups or variability in outcomes among different clinical indications for LP were observed. Survey-based subjective measures of operator confidence showed improvement following completion of the curriculum. Conclusion: The didactic and simulation-based curriculum for fluoroscopically guided lumbar puncture produces tangible improvement in operator confidence, procedural efficiency, and likely reduces patient radiation exposure.

O-543

The Norman E. Leeds Award - Eastern Neuroradiological Society (ENRS) - Management of Delayed Cerebral Ischemia in Subarachnoid Hemorrhage: Is Imaging for Vasospasm Necessary?

Rawal, S.
University of Toronto
Toronto, Ontario
Abstract/Presentation Summary
Background and Purpose: Delayed cerebral ischemia (DCI) is a serious complication that may occur following aneurysmal subarachnoid hemorrhage. If DCI is suspected, imaging methods designed to detect vasospasm or regional hypoperfusion are often employed prior to instituting therapy. Uncertainty in the strength of the relationship between angiographic vasospasm and DCI-related outcomes raises the question of whether imaging to select patients for therapy is effective in improving outcome in patients suspected to have DCI. Methods: A decision analysis was performed using a Markov model. In the context of suspected DCI, strategies were to either treat all patients immediately, or to first undergo diagnostic testing by digital subtraction angiography (DSA), CT angiography, or CT perfusion to assess vasospasm. According to current practice guidelines, treatment consisted of induced hypertension. Outcomes were survival in terms of life-years and quality-adjusted life-years (QALYs). Results: When treatment was assumed to be ineffective in non-vasospasm patients, Treat All and DSA were equivalent strategies; when a moderate treatment effect was assumed also in non-vasospasm patients, Treat All became the superior strategy. One-way sensitivity analyses demonstrated that the model was robust; two and three-way sensitivity analyses with variation of disease and treatment parameters reinforced dominance of the Treat All strategy. Conclusions: Testing for the presence of vasospasm in patients suspected of DCI before initiating hypertensive treatment did not lead to improved outcomes. In patients suspected of having DCI, imaging studies to rule in or rule out vasospasm are not beneficial, and should not be performed before initiating medical therapy.

O-544 1:40PM - 1:50PM
The Gabriel H. Wilson Award - Western Neuroradiological Society (WNRS) - Atypical Age-Related Cortical Thinning in Episodic Migraine

Chong, C.
Mayo Clinic Arizona
Scottsdale, AZ

Abstract/Presentation Summary
Purpose: Migraine is a debilitating neurological disorder affecting over 36 million people in the U.S. Although the clinical manifestations of the disease are well described, the pathophysiology of migraine remains poorly understood. It has been proposed that migraine is a progressive disorder with cumulative effects on brain structure and function. In this study, we assessed age-related cortical thinning patterns in migraine patients compared to healthy controls to test the hypothesis that migraine is associated with greater age-related thinning in areas subserving pain processing. Methods: 32 healthy controls (mean age=35.3 years; SD=11.6) and 27 age and gender matched episodic migraine patients (mean age=33.6 years; SD=12.3) underwent high resolution 3T structural scanning. Scans were post-processed using a surface based semi-automatic analysis technique and cortical thickness was estimated with a General Linear Model vertex-by-vertex approach. Results were modeled for each hemisphere using a group-by-age, main effect analysis to estimate the effect of age on cortical thickness for each group separately, and an age-by-diagnosis analysis to estimate differences in age-related cortical thinning between migraine patients and normal controls. Results: Although migraineurs and normal controls both
have expected age-related thinning in many regions along the cortical mantle, migraineurs have age-related thinning of regions that do not thin in healthy controls, including: somatosensory cortex, precuneus, fusiform and anterior insular cortex. Cortical thinning of these regions is more prominent with advancing age. There were no regions where normal controls had greater age-related cortical decline relative to migraineurs. Conclusion: Results suggest that migraine is associated with atypical cortical thinning of pain processing regions. Recurring migraines could have a cumulative effect on cortical structure that becomes more prominent with advancing age in regions associated with sensory-discriminatory and affective pain processing.

O-545

1:50PM - 2:00PM

Southeastern Neuroradiology Society (SENRS) - Pseudoprogression in Glioblastoma: Clinical Features & Imaging Assessment

Holder, C.
Emory Univ. School Of Med.
Atlanta, GA

Abstract/Presentation Summary
Pseudoprogression (PsP) is a relatively recently recognized phenomenon that presents a difficult challenge in the imaging assessment of patients undergoing standard treatment (resection followed by temozolomide and radiation therapy) for glioblastoma. This lecture will review the phenomenon of PsP and the current Response Assessment in Neuro-Oncology (RANO) guidelines and recommendations with regard to this entity. PsP can be indistinguishable from early true progression (TP) by MR imaging. As a result, a patient with PsP may be incorrectly assumed to have early TP, in which case treatment may be altered, such as addition of an anti-angiogenic agent, or enrollment in a clinical trial for 'recurrent or progressive' glioblastoma. If enrolled in a clinical trial, a patient with PsP may then go on to improve (in the normal course of evolution of PsP), and the clinical trial agent may be incorrectly given credit for the improvement. Some factors to consider with regard to PsP include: Timing – most cases of PsP occur within 90 days after completion of radiation therapy, with almost all cases occurring within 180 days. MGMT promoter methylation status – Methylation of the MGMT gene promoter turns off the DNA repair mechanism of the tumor cells, and therefore confers a more favorable prognosis. Although PsP can occur in MGMT-unmethylated tumors, MGMT-methylated tumors are more likely to have PsP. Also, PsP is a favorable phenomenon in terms of prognosis (UN-methylated is UN-favorable). Clinical status of the patient – patients with TP are generally worsening clinically, whereas patients with PsP are usually clinically stable or even improving. Communication between neuroradiologists and our colleagues in neuro-oncology, radiation oncology and neurosurgery is invaluable. Without change in treatment, patients may go on to have marked regression of enhancing tumor, which is diagnostic of PsP; therefore, no final clinical decisions should be made on the basis of the first post XRT-chemo MRI scan.

O-546

2:00PM - 2:10PM

AJNR Editorial Fellow: Article Citations: Title Features That Lead to Higher Citations
F Chokshi¹, J Kang², M Castillo³
¹Emory University School of Medicine, Marietta, GA, ²Emory University, Atlanta, GA, ³UNC Chapel Hill, Chapel Hill, NC

Purpose
When the effect of title characteristics on number of citations (NOC) was evaluated in 2010 for the Lancet, British Medical Journal (BMJ), and Journal of Clinical Pathology (JCP) it was found that 3 title characteristics were statistically associated with higher NOC: 1) total number of words (NOW), 2) presence of a colon symbol (POC) & 3) presence of acronym (POA). We aimed to demonstrate if similar associations are found in radiology journals.

Materials and Methods
We queried Web of Science for all original research and review articles published in AJNR, Radiology and AJR from Jan 1, 2006 to Dec 31, 2012. Article titles characteristics listed above were tabulated for all 3 journals. First, we fit a Poisson regression model to investigate the association between the NOC and the 3 title characteristics named above for each journal. We also adjusted for the potential confounders year. Second, regression coefficients estimates and standard errors were computed; coefficient of significance was assessed using the Wald test. Third, we used the Wald test to detect the pairwise difference in the effect of title characteristics and year of publication on the NOC between journals (AJNR vs. Radiology, AJNR vs. AJR, Radiology vs. AJR). Standardized differences in effects (Z-value) and p-values for different title characteristics were computed.

Results
Between 2006-2012 published manuscript counts were: AJNR 2581, AJR 3998, and Radiology 2662.

TITLE CHARACTERISTICS AND NOC PER JOURNAL If 1 word increased in title, then NOC increased 1.6% in AJNR and 2.6% in AJR. NOC decreased by 0.8% in Radiology (all p<0.001). POC led to 16%, 15%, and 7.4% increases of NOC in AJNR, Radiology, and AJR, respectively (all p<0.001). POA resulted in 10%, 14%, and 13.3% increases of NOC for AJNR, Radiology, and AJR, respectively (all p<0.001). COMPARISON OF EFFECT OF TITLE CHARACTERISTICS AND NOC BETWEEN JOURNALS (Table 1) NOW: AJR had the strongest association with NOC compared to AJNR and Radiology. All differences are significant. POC: Radiology and AJNR have stronger associations with NOC compared to AJR, however there was no significant difference between AJNR and Radiology. POA: AJR has a stronger association with NOC than AJNR; no significant differences between AJNR and Radiology or between AJR and Radiology were found. Effect of Year of Publication: Radiology has the strongest effect on NOC compared to AJNR and AJR.

Conclusions
Manuscript title characteristics (NOW, POC, and POA) are highly associated with higher NOC within 2 robust specialty journals (AJR & Radiology) and a subspecialty journal (AJNR). Attention to these factors during title selection/modification can have significant impact on NOC.

KEYWORDS: Outcome, Outcomes

Table 1

<p>| AJNR vs. Radiology | Radiology vs. AJR | AJR vs. AJNR |</p>
<table>
<thead>
<tr>
<th></th>
<th>Z</th>
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<tr>
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<td>5.752</td>
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O-541

ASNR Cornelius G. Dyke Memorial Award - Anatomical Connectome Reveals Abnormal Connectivity in Complete Corpus Callosum Agenesis

Meoded, A.
The Johns Hopkins University School of Medicine
Baltimore, MD

Abstract/Presentation Summary
Purpose: The corpus callosum (CC) is the major commissure in the human brain. In complete CC agenesis, the fibers of the CC are not missing, but heterotopic and form abnormal white matter tracts. Investigating the anatomical brain connectivity is crucial for understanding the structural reorganization of white matter circuits in children with CC agenesis. The structural connectome is an innovative technique suitable for the study of large-scale white matter connectivity of the human brain and the cerebral organization. Here, we apply a multiscale structural connectomics analysis to investigate white matter connectivity in children with complete CC agenesis. In more detail, we aim to 1) investigate connected/disconnected subnetworks, 2) characterize the topological network measures and 3) search for aberrant circuits in children with CC agenesis.

Materials and Methods: Patients were selected from our pediatric neuroradiology database based on 1) complete CC agenesis by conventional MR imaging (MRI) and 2) availability of diffusion tensor imaging (DTI) data without artifacts enabling high quality postprocessing. Age- and gender-matched controls also were selected. Diffusion tensor imaging data were acquired using a 1.5 T scanner. Postprocessing was performed using TORTOISE software. After nonlinear registration to MNI space, the cerebral and cerebellar cortex were parcellated into 108 regions using the AAL template. Probabilistic tractography was used to define connections between any pair of gray matter regions and an association matrix of structural connectivity was created for every subject. Structural connectomes for controls were created after excluding the CC (virtual callosotomy). Further analysis included 1) network-based statistics (NBS) to detect interconnected subnetwork as a whole and 2) topological network measures analysis to perform quantitative analysis of network metrics across different densities. Results: Eleven patients (6 males, mean age 11.7 years) and 11 healthy controls were included in this study. One patient with two aberrant interhemispheric tracks was excluded from network analysis. Network-based statistics revealed three highly connected subnetworks (two intrahemispheric, one interhemispheric) in patients compared to controls. Topological network measure analysis showed higher clustering coefficient, smaller characteristic path length, higher global efficiency, slightly higher local efficiency (at higher density level), smaller assortativity and higher transitivity values across the range of densities in patients compared to controls. Network hubs were found in both insular and the left and right insula, and precuneus gyri and right lingual
gyrus in patients and in the right postcentral gyrus and cerebellar 8th lobule and bilateral precuneus gyri in controls. Conclusions: In patients with CC agenesis, the structural network is more segregated and less integrated compared to controls. This represents more local (between neighboring anatomical regions) rather than global interactions. In patients, the absence of hubs in the cerebellum may reflect compensatory mechanisms to maintain local efficiency at the cost of global connectivity. Highly interconnected subnetworks in patients also suggest effective local connectivity and may reflect compensatory rewiring mechanism in CC agenesis. Connectome analysis provides new information about abnormal connectivity and potential reorganization of white matter tracts in CC agenesis.

Questions

Wednesday
3:00PM - 4:30PM
Palais des congres de Montreal, 517bc

66 - GENERAL PROGRAMMING - PSYCHIATRIC DISORDERS AND THE EMOTIONAL BRAIN: NORMAL AND DERANGED
O-550

Anatomic Foundation and Relevant Networks

Naidich, T.
The Icahn School of Medicine at Mt. Sinai
New York, NY

Abstract/Presentation Summary
Part I of this presentation (TP Naidich) will discuss the I. Anatomic Foundation, including the Insula and cingulate-insular connections, Nucleus accumbens: Core and shell; Amygdala, Periamygdaloid cortex and extended amygdaloid complex; Septum-Hypothalamus and Olfactory cortex; Substantia nigra and dopamine system; Periaqueductal gray matter (PAG) and Ventral tegmental area (VTA), and Cerebellum II. Relevant Networks, including the Default mode network vs. Task-directed network; Reward system, and Stress system: pituitary-hypothalamic axis, amygdaloid corticotrophic releasing hormone (CRH), and extracranial CRH III. Affective States, including Empathy, Negative affective states, and Homeostasis vs. Allostasis

O-551

Circuitry of Affective States and Disorders of Emotion
Schmahmann, J.
Massachusetts General Hospital
Boston, MA

Abstract/Presentation Summary
Part II of this presentation (JD Schmahmann) will discuss the IV. Disorders of Emotion, including Major Depressive Disorder (MDD), Obsessive Compulsive Disorder (OCD), Addictive States; Schizophrenia, Links to Alzheimer disease V. Anatomic-Biochemical-Circuitry of Emotional Disorders, including Disrupted insular-cingulate-amygdaloid interactions; and Deranged interactions of amygdala and Extended amygdaloid complex with the Stress system (adrenal, amygdala and hypothalamic-pituitary axis); Allostasis VI. Neuromodulation by Deep brain stimulation (DBS); Serotonin reuptake inhibitors (SRIs); Ketamine; and Interactive-adversive training; VII. Pulling it Together: Present Consensus and Understanding

Wednesday
3:00PM - 4:38PM
Palais des congres de Montreal, 517d

67 - PARALLEL PAPERS: Adult Stroke
O-552

Imatinib Reduces Infarction and Blood-Brain Barrier Permeability in a Transient Occlusion-Reperfusion Rodent Model: a MRI Study

Z Merali¹, J Leung¹, D Mikulis², F Silver², A Kassner¹
¹The Hospital for Sick Children, Toronto, Ontario, Canada, ²Toronto Western Hospital, Toronto, Ontario, Canada

Purpose
Permeability imaging using dynamic contrast-enhanced (DCE) MR imaging (MRI) can assess early blood-brain barrier (BBB) breakdown in acute ischemic stroke (AIS). Previous studies have shown a correlation between BBB permeability (KPS) and subsequent hemorrhagic transformation (HT) in patients with AIS (1). Agents that can stabilize the BBB such as Imatinib could play an important role in reducing the risk of HT in AIS. One study using a permanent occlusion rodent model found that mice given Imatinib had lower BBB leakage and were less likely to proceed to HT after thrombolytic therapy (2). However, this type of model neglects reperfusion injury, which is a significant factor in the development of HT and did not include imaging. The purpose of our study was to use a transient occlusion AIS model combined with MRI to quantify the BBB stabilizing effect of Imatinib in a rodent, to measure infarct size and validate the results with histology.

Materials and Methods
Male Sprague-Dawley rats (n=18, 250-300g) underwent a 60 minute occlusion of the middle cerebral artery as described by Longa et al (3). Either Imatinib (100mg/kg) or saline was administered at 1-hour and 20-hours after reperfusion. DCE-MRI performed on a 3 T clinical magnet (Philips Acheiva 3.0 T TX) using an eight-channel wrist coil was conducted at five hours...
and 24 hours after reperfusion. A 60uL bolus of contrast (Gadovist, 2mmol/mL) was injected via tail vein catheter over 12 seconds shortly after the start of the DCE scan (TR/TE=6.3/2.2 ms, FOV=100×85 mm2, matrix=168×142, slice=1 mm, volumes=36, time=4:20 min). T2-weighted images were acquired to quantify lesion volume. Imaging data were coregistered and analyzed using an in-house tool (MR Analyst v2.1; University of Toronto, Canada). Infarct regions of interest (ROIs) were manually defined on the T2-weighted images then applied to the DCE-MRI data to calculate mean KPS using a two-compartment pharmacokinetic model (4). A Student's T-test was performed between control and treatment groups to detect significant differences (p<0.05) in KPS as well as lesion volume. In addition, Evans blue extravasation and Western blot protein analysis was performed in three animals (5).

Results
KPS and infarct size quantified from data at the five-hour time point were not significantly different between groups. At 24 hours after occlusion, the group treated with Imatinib had reduced infarct sizes (226mm3±38.6 treatment versus 288mm3±38.6 control, p<0.05) and KPS (0.104mL/100g/min±0.034 treatment versus 0.173mL/100g/min±0.063 control, p<0.05). Also, the treatment group had reduced extravasation of Evans blue into the central nervous system (CNS) tissue at 24 hours (0.49ng/mg±0.03 treatment versus 0.57ng/mg±0.08 control, p<0.05). In addition, Western blot analysis revealed that the tight junction protein ZO-1 was expressed at significantly higher (p<0.05) levels in the infarcted hemispheres of the Imatinib-treated rats compared to controls.

Conclusions
Using transient occlusion model, we observed that Imatinib has BBB stabilization properties after 24 hours, as assessed by structural and DCE-MRI as well as histology. Further studies will investigate if Imatinib can reduce the risk of HT after administration of a thrombolytic agent.

KEYWORDS: Acute Stroke, Animal Model, Permeability MR Imaging

![Graph showing KPS comparison between control and treatment groups at 5-hours and 24-hours.](Filename: TCT_O-552_asnr_imatinib.jpg)
Purpose
The primary purpose of this study was to describe MR findings seen after mesenchymal stem cell (MSC) implantation in patients with chronic stable infarcts in the middle cerebral artery (MCA) territories and to compare changes in brain volume in stem cell transplanted patients to age-matched normal controls and age-matched control patients with chronic MCA infarcts.

Materials and Methods
MR examinations in five patients with stable chronic MCA territory infarcts who underwent MSC implantation into the peri-infarct region via stereotactic surgery were reviewed retrospectively. Patients were imaged immediately after MSC implantation and at one year. Imaging findings after implantation and at one year were recorded. Images immediately postimplantation and at one year underwent quantitative volumetric comparison using automated brain extraction and registration software (SIENA, FSL software library) to determine the percent brain volume change (PBVC). Images for controls at initial imaging and at one year also were analyzed for PBVC. Comparison of PBVC for MSC implantation patients and controls was determined using a two-tailed unpaired t-test.

Results
MR findings immediately post-implantation included susceptibility signal loss and enhancement at the site of implantation, with enhancement persisting up to one year in some patients. Immediate postprocedural complications included a small subdural hemorrhage in one patient. No acute infarct was seen as result of the implantation. No findings suggestive of a teratoma, tumor, or heterotopia were seen at either imaging time point. Volumetric analysis showed slight increase in brain volume in the MSC patients (0.736, range 0.726 to 5.05), which was higher than that of control patients with encephalomalacia without MSC implantation (-0.271, range -2.31 to -0.535) but less than age-matched normal controls (2.90, range 0.881 to 4.491), although due to the small sample size, this did not reach statistical significance (p=0.24 and 0.52, respectively).

Conclusions
Enhancement and susceptibility signal loss after MSC implantation can be seen up to one year after the procedure. Complications after the procedure were limited to typical postsurgical complications and no complications unique to the MSC implantation such as teratoma, tumor, or heterotopia were seen. Initial findings suggest a possible trend in increased brain volume in patients receiving MSC implantation compared to infarcted patients who did not receive stem cells; however, this was limited by the small number of patients who undergo this procedure and further investigation is warranted.

KEYWORDS: Stem Cell, Stroke
Black Holes on Time to Peak Map: Is it the core of the core

R Meagher¹, J Shankar²
¹Diagnostic Imaging, Dalhousie University, Halifax, Nova Scotia; ²Neuroradiology, QE II Hospital, Halifax, Nova Scotia

Purpose

CT perfusion (CTP) is widely used and established in multimodality imaging of acute stroke. In CTP, time to peak (TTP) image maps represent the time from the beginning of contrast material injection to the maximum concentration of contrast material within a region of interest. A black hole is a frequently observed, yet not yet formally defined, phenomenon seen on TTP image maps where black, or no color, is assigned to an area of brain parenchyma. As of now it is unclear the meaning or significance of this finding. The purpose of this study was to describe the black hole phenomenon seen on TTP image maps for acute stroke perfusion imaging, and to propose a framework for future characterization and analysis while promoting awareness and discussion into the significance of TTP black holes.

Materials and Methods

Perfusion analysis was performed for all patients with a single vendor-supplied software package, by using a semiautomatic deconvolution algorithm. Images were analyzed first on whether an acute stroke was present. A black hole is defined as an area color coded black on the TTP image map which is not assigned a TTP value and does not correspond with cerebral spinal fluid containing spaces, vessels or bone on the unenhanced CT exam of the brain. Furthermore a black hole must have a surrounding area of increased TTP unless present within brain parenchyma supplied by perforating arteries. Regions of interest (ROIs) were randomly drawn on an area of the black hole and on an immediately adjacent area of brain parenchyma which was not color coded black (any other color was accepted). Within the respected ROI, values for cerebral blood volume (CBV), cerebral blood flow (CBF) and TTP were recorded. Follow-up CT or MRI exams of the brain performed at least one day post CTP acquisition were interpreted and parenchyma corresponding to black holes was assessed for the signs of infarction.

Results

In the five month interval 84 CTP exams were performed 42 of which had follow-up imaging available for review. Of these 23 patients were diagnosed with acute stroke on CTP. Twenty-three of 23 patients (100%) demonstrated black holes. Twelve patients had follow-up CT and 11 follow-up MRI. All black holes corresponded with areas of infarcted brain on follow-up studies (specificity of 100%). Of the 23 black holes 16 received iv TPA, one of which also underwent mechanical thrombectomy, and seven received no intervention. Cerebral blood flow values of black holes (mean 6.10 ml/100ml/min) and adjacent brain (mean 35.85 ml/100ml/min) parenchyma were significantly different (P <.000001). Cerebral blood volume values in black holes (mean 0.84 mL/100ml) and adjacent brain (mean 2.55 mL/100ml) parenchyma also were significantly different (P <.000001).

Conclusions

In conclusion, our result shows that black holes on TTP image maps represent areas of infarct at the time of acquisition. All CTP exams positive for acute stroke demonstrated corresponding
black holes. Time to peak image maps can be challenging to interpret and appear to contain more information than initially appreciated.

KEYWORDS: CT, CT Perfusion

O-555 3:21PM - 3:28PM

Characterization of carotid artery plaque using CT multi-spectral imaging: comparison between 2 different systems

L Saba¹, G Argiolas², P Lucatelli³, M Piga⁴, F Zaccagna⁵, E Genovese⁴
¹University of Cagliari, Monserrato, Italy, ²AOB, Cagliari, Italy, ³University la Sapienza, Roma, Italy, ⁴University of Cagliari, Cagliari, Italy, ⁵University of Rome - Sapienza, Rome, Italy

Purpose
Previous studies have demonstrated that the carotid artery plaque's attenuation values significantly change according to the selected keV. The purpose of this study was to compare the two different computed tomography (CT) scanners in the multispectral analysis of carotid artery plaque.

Materials and Methods
Sixty consecutive (males 47; median age 69 years) patients were analyzed prospectively. Carotid arteries were studied with two different multi-energy CT scanners (Discovery HD 750, GE Healthcare and Somaton Definition, Siemens) that use two different modality to produce the multi-energy values (dual tube versus fast switching technologies). All patients received a 15 mL timing bolus of contrast medium to synchronize the data acquisition followed by an injection of a volume of 60 mL of contrast medium at 5 mL/sec flow rate. Plaque analysis in 120 carotid arteries was performed (4 excluded because absence of detectable). Plaque and datasets were reconstructed by using a dedicated workstation. For each plaque HU value was quantified with a square region of interest (ROI) at mono-energy values of 66, 70, 77 and 86 keV (equivalent to 80, 100, 120 and 140 kV). Wilcoxon test was used to test the differences between the HU values in the plaques at different keV.

Results
Eleven plaques were excluded because no plaque was present. In the remaining 109 Wilcoxon analysis showed a statistically significant difference in HU values among the mono-energy values of 66, 70, 77 and 86 keV (P = 0.0001) both for GE and Siemens systems. A statistically significant reduction of HU values was found by increasing the monochromatic keV values.

Conclusions
Results of this study suggest that using multi-energy CT scanners, independently from the model and technology implemented, the plaque's HU values significantly change according to the selected keV.

KEYWORDS: Carotid Artery, Carotid Plaque, Dual Energy Spectral

O-556 3:28PM - 3:35PM

Imaging of Cerebral Air Embolism
Purpose
Cerebral air embolism (CAE) is the result of the inadvertent entry of air into the venous or arterial systems. The iatrogenic sources of CAE are multiple, the most common origins that have been reported in the literature include central venous catheters, lung biopsy and at angiography. A right hemispheric predominance in CAE neurological syndromes has been described due to a preferential pathway to the right common carotid artery from the heart. Reported cases of CAE imaging findings are consistent with expected findings from an 'embolic shower', with multiple areas of peripheral infarction or ischemia in different arterial territories. The detection of intracranial locules of air has been described; however noncontrast-enhanced computed tomography (NECT) has a relatively low sensitivity for the detection of intracranial gas. Sensitivity depends upon the volume of gas present and, more crucially, the time interval between CAE and NECT. The goal of this study is to establish the expected imaging findings in patients with confirmed iatrogenic CAE.

Materials and Methods
A comprehensive medical chart review of all patients admitted for hyperbaric oxygen therapy (HBOT) for iatrogenic cerebral embolism at a tertiary referral center between May 2002 and January 2013 was performed. Imaging on these patients was read by two fellowship-trained neuroradiologists, blinded to clinical examination findings.

Results
Sixty-six patients were admitted for HBOT, of which 49 patients (74%) underwent neuroimaging. Of these, 10 patients (20%) had a reduced level of consciousness, 21 (42.8%) suffered seizures, 14 (28.5%) had localizing signs (50% right hemispheric) and two (4%) had witnessed air embolism during surgery and were transferred directly for HBOT. Time interval between documented event and initial neuroimaging was broad (15 minutes – more than 48 hours), 17 (25.8%) patients had imaging performed less than 240 minutes postevent (15-232 minutes, median 98 minutes). Air was demonstrated in 2/49 (4%) of initial studies and 0/49 (0%) of follow-up studies. Sixteen of 49 (32.6%) patients demonstrated early infarct changes on initial imaging, of which 8/16 (50%) involved several different arterial territories, when unilateral, equal involvement (4/16 25%) of left and right hemispheres was present. Follow-up imaging was performed on 24 patients, with a time interval of (7-74 hours, median 29 hours) between initial and follow-up imaging. All patients with early infarct changes on initial imaging demonstrated expected evolution. Eight of 24 (33.33%) patients demonstrated new infarct changes on follow-up imaging with 2/8 (25%) involving multiple arterial territories, 4/8 (50%) left hemisphere and 2/8 (25%) right hemisphere.

Conclusions
The detection of intracranial air following documented CAE is an unusual finding. The majority of initial studies are normal, thus the clinical scenario and examination findings are vital in patient management decisions. In our study, 50% of those with early infarct changes on initial imaging had multiple arterial territories involved. In this study, there was no predilection for right hemispheric syndromes.

KEYWORDS: Emboli, Stroke
Analysis of hyperdense sign on non-contrast CT for diagnosing cerebral venous thrombosis

S Zaheer¹, R Glikstein¹, S Patro¹, N Seppala¹, N Steffenhagen¹, D Iancu¹

¹University of Ottawa, Ottawa, Ontario, Canada

Purpose
Timely diagnosis of cerebral venous thrombosis (CVT) is essential. Noncontrast CT (NCCT) is the initial investigation of choice, where the occluded sinus appears hyperdense. The purpose of this study was to assess the value of hyperdense sign and attenuation ratios in diagnosing CVT on NCCT.

Materials and Methods
Using a case control retrospective study we evaluated 19 patients with acute CVT and 20 control patients without CVT who presented to ER with similar symptoms. Final diagnosis of CVT was confirmed or ruled out with CT/MR venogram for all the patients. Three blinded readers (junior resident, fellow and staff neuroradiologist) evaluated the initial NCCT for hyperdense sign first using only axial slices, then axial, coronal and sagittal reformats, and finally using region of interest (ROI) attenuation measurements. In addition to absolute values, attenuation ratios were measured to better differentiate thrombosed from nonthrombosed sinuses. These ratios were measured as follows: target sinus/lowest attenuation sinus (ratio 1), target sinus/basilar artery (ratio 2), target sinus/internal carotid artery (ICA) (ratio 3), target sinus/nonhemorrhagic temporal lobe (ratio 4) and target sinus/nonhemorrhagic frontal lobe (ratio 5).

Results
Overall, the hyperdense sign was found to be: 61.4% sensitive (95% CI 51.8%-70.2%), 96.8% specific (95% CI 95.7%-97.6%), and 94.1% accurate (95% CI 92.9%-95.2%) on axial slices only; 64.9% sensitive (95% CI 55.3%-73.4%), 98.8% specific (95% CI 98.0%-99.2%), and 96.2% accurate (95% CI 95.2%-97.1%) with the addition of coronal and sagittal reformats, and 62.3% sensitive (95% CI 52.7%-71.1%), 98.7% specific (95% CI 97.9%-99.2%), and 96.0% accurate (95% CI 94.9%-96.9%) with absolute attenuation measurement. The expertise of the reader, addition of sagittal and coronal reformats to axial slices, and objective measurement of ROI did not have any significant effect on sensitivity, specificity or accuracy of hyperdense sign.

There was statistically significant difference in average attenuation between acutely thrombosed sinuses (68.6HU, 95% CI 65.3-71.9) and nonthrombosed sinuses (52.1HU, 95% CI 50.7-53.5). Sixty-one HU was the optimal cut-off for diagnosis of CVT with 84.4% sensitivity and 89.6% specificity. The proposed attenuation ratios showed varying results: Ratio 1: thrombosed 1.43 (95% CI 1.36-1.51) versus nonthrombosed 1.06 (95% CI 1.05-1.08). Optimal cut-off of 1.29 lead to sensitivity of 87.5% and specificity of 96.0%. Ratio 2: thrombosed 1.95 (95% CI 1.80-2.09) versus nonthrombosed 1.45 (95% CI 1.40-1.49). Optimal cut-off of 1.68 gave 81.3% sensitivity and 81.6% specificity. Ratio 3: thrombosed 1.81 (95% CI 1.68-1.93) versus nonthrombosed 1.37 (95% CI 1.33-1.42). Optimal cut-off of 1.54 resulted in sensitivity of 78.2% and specificity of 79.2%. Ratio 4: thrombosed 1.89 (95% CI 1.77-2.00) versus nonthrombosed 1.42 (95% CI 1.38-1.46). Optimal cut-off of 1.63 lead to sensitivity of 84.4% and specificity of 83.2%. Ratio 5:
thrombosed 1.95 (95% CI 1.84-2.07) versus nonthrombosed 1.47 (95% CI 1.43-1.51). Optimal cut-off of 1.80 gave 78.1% sensitivity and 94.4% specificity.

Conclusions
Although subjective assessment of hyperdense sign on NCCT to diagnose CVT has rather low sensitivity, an objective threshold for hyperattenuation (> 61HU) and attenuation ratio of the suspected sinus/normal appearing sinus (> 1.29) may improve sensitivity. These findings need to be validated in further prospective studies.

KEYWORDS: Cerebral Venous Thrombosis, CT

O-558

Temporal Resolution of Microvascular Dysfunction in Aneurysmal Subarachnoid Hemorrhage

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Purpose
After aneurysmal subarachnoid hemorrhage (SAH), delayed cerebral ischemia (DCI) contributes significantly to functional and cognitive disability (1). It has long been thought that DCI is primarily related to reduced cerebral blood flow (CBF) from proximal vasospasm (2), but recent evidence suggests that microvascular and neuronal dysfunction may be involved (3). Due to the inability to predict which patients will develop DCI, therapeutic interventions often are delayed and target proximal vasospasm only, thus infarction still occurs frequently. We sought to characterize the changes in microvascular dysfunction by evaluating cerebral blood flow (CBF) and permeability surface (PS) in DCI after SAH.

Materials and Methods
IRB approval was obtained. Thirty-three SAH patients underwent multiple CTA and CTP exams on admission and at subsequent time points in the early (days 0-3) and delayed phases (days 4-16). Patients were stratified into DCI and nonDCI groups based on outcome measures of cerebral infarction and permanent neurologic deficits. All CTP data were postprocessed into CBF and PS quantitative maps using CT Perfusion software program 4D version (General Electric Healthcare, Milwaukee, WI). Region of interest (ROI) placement was performed using standardize protocol sampling the cortex of the anterior, middle and posterior cerebral artery vascular territories. If a perfusion deficit was present, then the ROIs sampling the perfusion deficit were included in the statistical analysis. If no perfusion deficit was present, then all ROIs were used. Cerebral blood flow and PS quantitative data were plotted in time-series curves to describe the temporal resolution of these parameters after SAH in patients with and without DCI.

Results
Figure 1a shows the CBF pattern after SAH with reduced CBF in the early phase (days 1-3) followed by a gradual increase of CBF into the delayed phase. In the early phase, there is a 45% decline in CBF in DCI compared to no significant change in patients without DCI. Significant angiographic vasospasm on CTA, defined as >50% narrowing, occurred on mean day 8. At this

3:42PM - 3:49PM
time point, there was a 24% decline in CBF in DCI patients compared to a 20% increase in patients without DCI. Figure 1b reveals a biphasic pattern of PS after SAH with peaks in the early and delayed phases (days 1-3 and 10-12). This temporal pattern is maintained in patients with and without DCI; however, the mean PS is statistically significantly higher in the DCI group (p<0.05) at these time points.

Conclusions
Cerebral blood flow and PS have characteristic temporal patterns after SAH. In the early phase (days 1 – 3), PS, a surrogate marker for blood-brain barrier permeability, is significantly higher in patients who eventually develop DCI compared to those who do not. Further study is necessary to determine whether the relationship between CBF and PS could be used to prospectively distinguish between patients with and without DCI so that early treatments can be targeted towards prevention of DCI.

KEYWORDS: Aneurysmal Subarachnoid Hemorrhage, Blood-Brain Barrier, CT Brain Perfusion

Reliability and Performance of a User-Independent Platform for CT-Perfusion Analysis: Threshold-Derived Automated Systems Outperform Examiner-Driven Approaches to Prognosis and Outcome Prediction in Acute Ischemic Stroke

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Purpose
Revascularization strategies aim to curtail ischemic progression in acute ischemic stroke (AIS). Emerging paradigms propose subselection of a target treatment population, and include the profile of imaging biomarkers such as those defined within the ischemic penumbra formalism. The characteristic features of this population remain controversial, and advanced techniques such as CT perfusion or angiography (CTP, CTA) have met with skepticism compared with faster approaches to triage such as the Alberta Stroke Program Early CT Scale (ASPECTS). Computed tomography perfusion may suffer interpreter-bias engendered by the qualitative nature of most
approaches. We propose the retrospective evaluation of the performance of a high-speed computational tool, providing automated parametric thresholding and segmentation, hypothesizing enhancements compared with traditional approaches to NCCT, CTA, and CTP analysis in widespread use. We report performance and correlation with favorable clinical outcomes in a cohort of AIS patients.

Materials and Methods
Forty-four patients (36 female, age 70 ± 17 years) with AIS (<12 hours) and MCA or intracranial ICA occlusion, were seen at a single institution. Imaging included NCCT, followed by CTA and subsequently two CTP acquisition volumes providing 8 cm supratentorial coverage on a 64 detector-row system (GE Healthcare, Milwaukee, WI, USA). Analysis was performed independently by a neuroradiologist or stroke neurologist blinded to clinical and outcomes data. Perfusion analysis was performed on a fully operator-independent platform (RAPID 2.0, iSchemaView Inc., Stanford, USA). Parametric maps of CBF, CBV, and time-to-maximum of the tissue residue function (Tmax) were computed and followed by automated normalization and segmentation for display purposes (~5 minutes). Estimated ischemic core (rCBV or rCBF) and hypoperfused volumes were established at voxel-wise thresholds, and for Tmax varied at 2s increments between 4-10s. Qualitative analysis included application of ASPECTS methodology to NCCT and CTP (CTP-ASPECTS), and were scored on a descending scale from 10 (normal) to 0 (severe); CTA-collateral score (CS), defined by vascular density overlying the diseased hemisphere, was scored from 3 (normal) to 0 (absent); CTA-clot burden score (CBS), describing clot extent, ranged from 10 (absent) to 0 (complete multisegment occlusion). Variables were analyzed for performance as predictors of favorable outcome (90-day modified Rankin scale (mRS) ≤2) by receiver-operating characteristic (ROC) analysis, after adjustment for baseline differences.

Results
Median admission NIHSS=19 (IQR=12-22); median final infarct volume=37cc. All variables of interest exhibited correlation with dichotomized favorable outcome. Receiver-operating characteristic analysis highlighted disparities in performance. RAPID-derived core estimates (rCBV, rCBF) were found to outperform all qualitative approaches including CTP-ASPECTS (AUC rCBV=0.89 p<0.0001; AUC rCBF=0.81, vs. AUC ASPECTS=0.72 p=0.012). Strongest overall performance was observed with final infarct volume (AUC=0.96 P<0.0001). RAPID hypoperfusion estimates across all Tmax thresholds outperformed all qualitative approaches, with the exception of Tmax>10s (AUC=0.737 p=0.008) versus CBV-ASPECTS (AUC=0.756 p=0.005), which demonstrated the strongest performance among qualitative approaches.

Conclusions
Computed tomography perfusion-ASPECTS, previously shown to outperform NCCT-ASPECTS as outcome predictors, are themselves limited by their inherently qualitative nature. Voxel-wise semiquantitation enhances immunity to such limitations, but generally prove impractical as integrations to clinical workflow. Our findings establish the benefits of high-speed automated analysis in AIS, outperforming conventional methodologies, while avoiding delays in management.

KEYWORDS: Stroke, Thrombolysis
Hyperintense basilar artery on fluid attenuated inversion recovery magnetic resonance imaging: Diagnostic accuracy and clinical impact in patients with acute brain stem stroke

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Purpose
To evaluate the hyperintense configuration of the basilar artery (FLAIR-hyperintense basilar artery – FHBA) as a marker of basilar artery occlusion (BAO) and as a predictor of patient survival.

Materials and Methods
We retrospectively identified 20 patients with BAO who initially received MR imaging (MRI) with subsequent DSA. The diagnostic performance of FHBA was tested by defining a control group: one control patient without BAO that had undergone an MRI for suspected stroke – matched for age, sex and MR tomograph with which the examination was performed – was randomly selected for each patient with proven BAO from the PACS. Only the FLAIR images of the aforementioned 40 patients (20 with and 20 without BAO) were read independently by four readers in one session: two board certified, subspecialized neuroradiologists with 13 and eight years, and two radiologists in training with three and four years of experience. Visual hyperintensity of the basilar artery was graded in a 5-point Likert scale (1 = no; 2 = little; 3 = equivocal; 4 = distinct; 5 = sure). Scores of 4 and 5 were defined as positive FHBA-sign. To grade the extent of FHBA sign in patients with BAO, a score (called FHBA score in the further course of the manuscript) was generated by counting the number of slices from the basilar tip down to the foramen magnum - including the dominant vertebral artery - in which a hyperintense signal in the vessel lumen was present multiplied by the slice thickness (for example three slices with FHBA at a slice thickness of 5 mm would result in a score of 15). These measurements were performed in consensus by two readers who also calculated the posterior circulation-ASPECTS (pc-ASPECTS) scores on DWI sequences.

Results
Assigning visual hyperintensity ratings of 4 and 5 to "positive FHBA sign" and 1, 2 and 3 to "negative FHBA sign" the following sensitivity, specificity and accuracy values for BAO were achieved: 70%, 100% and 85% for reader 1; 65%, 95% and 80% for reader 2; 85%, 95% and 90% for reader 3; 90%, 95% and 93% for reader 4. Substantial to excellent inter-reader agreement measures (using Cohen's κ 0.64 – 0.85) were observed. The FHBA sign was unequivocally present in 17 patients (85%). Mean FHBA score was 18.5 ± 13.3 (median 15.0, range 0–45). Eighteen patients (90%) had DWI lesions on the initial MRI scan with a mean pc-ASPECTS score of 6.2 ± 2.9 (median 7.5, range 0–10). FHBA and pc-ASPECTS scores showed a highly significant negative correlation (r = -0.67; p = 0.01, Figure 1A). There was a tendency towards a moderate correlation between FHBA and mRS scores at discharge (r = 0.41; p = 0.09) and patient survival was associated with significantly lower FHBA values (13.4 ± 11.1 versus 28.3 ± 13.7; p < 0.05; Figure 1B). Whereas ROC analysis for patient outcome prediction (mRS) revealed no statistically significant result (AUC 0.71, p = 0.15), an AUC of 0.81 (p < 0.05) for the prediction of patient death was calculated. An optimal discrimination threshold for the FHBA score of 17.5 or higher was determined which yielded a sensitivity of 83% and a specificity of 77%. The odds ratio for patient death above the mentioned threshold value was 16.7.
Conclusions
The FHBA sign proved to be a reliable, moderately sensitive but specific and robust sign of basilar artery occlusion that may have significant implications for the correct diagnosis of BAO. It might be of particular importance if MR angiography is degraded by artifacts or if MR angiography is primarily not scheduled, for example in patients with atypical neurological symptoms not suggestive of acute stroke. Beside its diagnostic capabilities, the FHBA sign might also have prognostic relevance since high FHBA scores were associated with more extensive ischemic lesion patterns - analogous to hemispheric stroke, the extent of the FHBA sign might be a marker of impaired hemodynamics in BAO with pronounced FHBA meaning larger brain areas being hypoperfused. Furthermore, the FHBA sign may be helpful in the prediction of patient survival.

KEYWORDS: Basilar Artery Occlusion, Diagnostic Accuracy, Fluid-Attenuated Inversion Recovery

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O-561
4:03PM - 4:10PM

CSF flow quantification in acute subarachnoid hemorrhage: a predictor of hydrocephalus?

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Purpose
Hydrocephalus is a frequent complication of acute subarachnoid hemorrhage (SAH), occurring in about 20% of patients. Clinical grade of SAH and intraventricular blood are known predictors of hydrocephalus in SAH. Cerebrospinal fluid (CSF) flow dynamics can be quantified with
phase-contrast MR imaging (MRI). We hypothesized that in the first 72h after SAH, CSF stroke volume and flow velocity could be predictors of acute hydrocephalus.

Materials and Methods
We prospectively included 30 patients with acute SAH, and performed MR on the first 72 hours after symptoms onset. Informed consent and IRB approval were obtained. We obtained CSF dynamic flow studies, and quantified average flow, average velocity, and stroke volume at the level of the aqueduct. We recorded demographic data, Hunt & Hess scale (HH) at admission, Fisher score and acute hydrocephalus on admission CT, and the need of external CSF drainage during hospital stay. Statistical analysis was performed using Student-T test and Wilcoxon Signed Ranks test, as appropriate, to assess the association between CSF parameters and the development of hydrocephalus.

Results
Of these 30 patients 17 were female, and the mean age was 58 years old. Median HH was 2, and mean Fisher was 3.4. Six patients were diagnosed acute hydrocephalus, and four needed CSF shunt. Of the six patients with hydrocephalus, all had Fisher 4 on CT at admission. However, 11 patients with Fisher 4 had no hydrocephalus. A mean 19.9±8.3 μl stroke volume was found in this SAH population. Mean peak velocity was 2.4±2.3 cm/sec, mean average velocity was 0.09±0.13 cm/sec, and mean average flow was 1.92±1.9 ml/min. A lower CSF stroke volume, average velocity and average flow were associated with Fisher grades 3 and 4 (p<0.05). Patients with acute hydrocephalus presented lower CSF stroke volume than those without hydrocephalus (12.5±4 μl versus 23.1±9 μl, p=0.025), as well as higher average flow of CSF (2.8±1.9 ml/min versus 1.7±2.0 cm/sec, p=0.03). Average velocity, although lower in hydrocephalus patients (0.083±0.5 cm/sec versus 0.116±0.8 cm/sec, p=0.106), did not reach a statistically significant difference between patients with and without hydrocephalus. There were no significant differences in CSF flow parameters in patients that needed acute CSF shunting.

Conclusions
Quantitative analysis with phase-contrast MR imaging in acute SAH patients showed lower CSF stroke volume and average velocity and increased average flow in patients with acute hydrocephalus. Lower CSF stroke volume and velocity probably reflect increased resistance to CSF flow in the aqueduct due to the presence of blood mixed with CSF. We speculate that increased average flow might reflect higher intraventricular pressure in acute hydrocephalus. Cerebrospinal fluid flow parameters were not predictors of the need for acute CSF shunting, although the number of shunted patients was probably too small to reach statistical significance.

KEYWORDS: Aneurysmal Subarachnoid Hemorrhage, Cerebrospinal Fluid, Hydrocephalus

O-562
4:10PM - 4:17PM

What is the significance of wall thickening in intracranial vertebrobasilar arteries?

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Purpose
The techniques currently used for intracranial vascular imaging, i.e., computed tomography (CT) angiography, MR angiography and digital subtraction angiography, rely mainly on the imaging of the arterial lumen. However, the direct evaluation of the arterial wall is expected to provide more information than the mere appreciation of the arterial lumen. Here we make a retrospective assessment of the prevalence of wall thickening in the intracranial vertebral and basilar arteries in patients free from known vascular disease.

Materials and Methods
We collected the records of 300 consecutive eligible patients, free from arterial disease, having undergone contrast-enhanced brain MR imaging (MRI) examinations from April to June 2013 as part of routine care (multiple sclerosis, internal auditory canal workup, visual pathway workup, headaches). All MRI examinations included contrast-enhanced 3D turbo spin-echo T1-weighted black-blood sequences. Interobserver agreement, prevalence of wall thickening in the vertebral and basilar arteries and its relationships with the patients’ age and sex were studied.

Results
The interobserver reproducibility of the results was good (Kappa=0.746). Wall thickening in the proximal intracranial vertebral artery was found in 49% of the patients and had occurred in 16% of patients under 40 years of age. In contrast, wall thickening in the distal vertebral and basilar arteries had been noted in only 10% of the patients. None of the patients under 40 years of age had suffered any basilar arterial wall thickening. Multivariate analysis revealed that intracranial arterial wall thickening was more prominent in male than in female patients, with a statistically significant risk of wall thickening increasing with age.

Conclusions
The higher incidence of wall thickening observed in the proximal vertebral arteries than in the distal vertebral and basilar arteries in patients free from any known vascular disease was possibly favored by normal anatomical features. Thus, the finding of proximal intracranial vertebral arterial wall thickening should not automatically lead to the diagnosis of arteritis or any similar pathology. However, distal vertebral and basilar arterial wall thickening may reflect certain pathologic conditions, such as intracranial atherosclerosis, but should be interpreted with caution since it occurs in elderly patients in the absence of any vascular symptoms.

KEYWORDS: Basilar Artery, Vertebral Artery, Vessel Wall
Detection of Ischemic Cerebral Lesions following Left Heart Radiofrequency Ablation: Prospective Analysis including Diffusion-Tensor Trace Imaging.

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Purpose
Catheter-based ablation techniques are a well accepted and increasingly common means of controlling cardiac arrhythmias. An accepted risk of the procedure is producing embolic cerebral infarcts (1-3). In an effort to explore the frequency of these infarcts, a prospective study was conducted to evaluate infarct production using MR imaging (MRI), including diffusion techniques (4). The study included comparison of the frequency with which diffusion abnormalities were detected with routine diffusion-weighted imaging (DWI) and diffusion tensor trace imaging (DTI).

Materials and Methods
Head MRIs, including diffusion-weighted and diffusion tensor-trace imaging were acquired 1 – 2 days prior to and following radiofrequency ablation for atrial fibrillation (n=25) and left ventricular tachycardia (n=3) (age 58 (±8) years, 46% males). Scanning was performed on 1.5 T GE magnets running 16.0 software using an 8 channel head coil. Conventional DWI as well as DTI images were acquired at 4mm and 5mm (respectively), 128 x 128 matrix, and B value of 1000. DWI and DTI included 3 and 25 direction acquisition, respectively. Acquisition time was 0:50 for DWI, 3:50 for DTI. Exams also included sagittal T1, axial T2 FLAIR, axial T2 FSE, axial EPI GRE, and 3D SWAN sequences. Two CAQ certified neuroradiologists independently evaluated the scans, scoring DWI or DTI series and their corresponding ADC maps for presence, location, size, and contrast to noise (CNR) and conspicuity of sites of restricted diffusion. A 5-point incremental scoring system qualitatively evaluating the lesion's DWI versus DTI contrast to noise ratio was employed: +2, +1, =, -1, -2.

Results
New DWI or DTI ischemic lesions (N=12) were detected in 7(25%) patients, with positive cases demonstrating 1-3 lesions, ranging in size from 2-5 mm. None had clinically overt stroke or TIA. Independent neuroradiologist reads of the 12 lesions were in agreement; CNR was judged to be markedly superior in the the DTI versus DWI (score "2+" in six (including some lesions undetectable with conventional DWI); superior in five (score "1+"); and equivalent in one (score ".") . The figure demonstrates increased CNR and conspicuity of a small infarct at the right frontal lobe (arrows) in the DTI image (A) versus the DWI image (B).

Conclusions
This prospective study has demonstrated that, to this point, ischemic cerebral lesions occurred in 25% of patients undergoing catheter-based ablation procedures for treatment of cardiac arrhythmias. Our experience has been that these lesions are typically small, ranging from 2-5 mm. Detectability of these small lesions is enhanced by 25-direction diffusion tensor trace imaging compared with conventional DWI. Improved detection of ischemic lesions with DTI should serve as a basis upon which to improve catheter-based ablation techniques and minimize associated ischemic events. As such, this approach should be generalizable to analyses of cerebrovascular consequences of other invasive procedures.

KEYWORDS: Diffusion MR Imaging, Diffusion Tensor Image, Infarct
Whole brain mean-ADC predicts death in patients after cardiac arrest.

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Purpose
The purpose of this study is to characterize the relationship of whole brain apparent diffusion coefficient (wb-ADC) measurements with regard to rhythm at presentation and follow up scores of outcome, including cerebral performance category (CPC), in patients presenting with cardiac arrest. Our hypothesis is that higher mean wb-ADC values correlate with better outcome (CPC <3) and that specific ADC values can inform clinical prognosis with regard to survival and good outcome.

Materials and Methods
The study was IRB approved. One hundred fifty-two patients presented from 2006-2011 with cardiac arrest (asystole, PEA, VF/VT, unknown rhythm) and were stabilized in the intensive care unit. Routine clinical brain MR imagings (MRIs) including 3-direction diffusion-weighted imaging (DWI) and calculated apparent diffusion coefficient (ADC) maps, were obtained at 1.5 T an average of 4.5 days (+/- 5.4 days, range (1-22 days) postarrest. Cerebral performance category scores were calculated during follow-up visits after discharge. One hundred twenty-five of the 152 MRIs included diffusion-weighted imaging (DWI) and ADC maps free from artifacts. The DWI was skull stripped using the brain extraction tool (FSL, Oxford, UK) and the resulting mask was applied to the ADC map, visually inspected and mean wb-ADC values were determined using FSL, excluding CSF containing spaces with ADC > 1000 mm2/sec. Mean wb-ADC values then were compared based upon the patient demographics, presentation and clinical outcomes. A p-value of <0.05 was considered significant.

Results
Sixty-three men and 61 women ranging in age from 17 to 84 (56 +/- 15.1 years) had usable DWI. Mean wb-ADC was significantly lower for patients that died (761.2 +/- 83.4 mm2/sec) when compared to survivors (812.3 +/- 33 mm2/sec, p<0.00001), and only one patient with mean wb-ADC < 750 mm2/sec survived (n=19), with a clinically bad outcome. There was no significant
difference in mean wb-ADC values between those that survived with good (814.5 +/- 21.6 mm2/sec) versus bad (809.1 +/- 45.0 mm2/sec) outcome (p=0.5) based on CPC scores. Mean wb-ADC was not significantly correlated with age or sex. Patients presenting with asystole trended to a lower mean wb-ADC compared to other rhythms (asystole: 768.9 +/- 85.7, PEA: 796.2 +/- 64.8, VF/VT: 794.4 +/- 53.7, unknown: 804.2 +/- 55.9 mm2/sec), without reaching significance.

Conclusions
Mean wb-ADC shortly after presentation is significantly different for postcardiac arrest patients that die following stabilization and admission to the ICU. A mean wb-ADC value of <750 mm2/sec is highly specific for identifying patients who ultimately die. Age and sex of the patient had no influence on the mean wb-ADC after presentation. Mean wb-ADC did not significantly vary depending on the rhythm of presentation, although there was a trend to lower mean wb-ADC with asystole. Importantly, the mean wb-ADC did not vary between survivors with good or bad outcomes, suggesting region specific injury not characterized by this whole brain calculation. Future studies will investigate region- and vascular territory-specific differences in ADC between these groups.

KEYWORDS: Apparent Diffusion Coefficient, Hypoxia, Ischemia

O-817

BOLD-based MRI reveals relative oxygen extraction fraction changes in patients with stroke or severe arterial stenosis

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Purpose
Hypoxia plays an important role for the outcome in cerebral ischemia. Recently, a new method based on the quantitative blood-oxygenation-level dependent (BOLD) effect and independent measurement of T2, T2* and cerebral blood volume (CBV) was proposed for qualitative mapping of the relative oxygen extraction fraction (rOEF). In this study, we applied this BOLD-based method for assessment of rOEF in patients with stroke or severe arterial stenosis. Purpose of this study was to evaluate whether rOEF maps are an improved predictor for penumbra estimation, compared to the established method of the apparent diffusion coefficient (ADC) and time to peak (TTP) mismatch.

Materials and Methods
Thirty-six patients (63 ± 16 years old; 14 males) with suspected ischemia or severe carotid artery stenosis were examined with a 3 T scanner. Quantitative measurements of T2 multi-echo GRASE and T2* multi-GE were performed with a measurement time of 3.5 minutes. Cerebral blood volume was derived from the routine DSC PWI. For assessment of hypoxic areas, rOEF = R2/(c⋅rCBV) was calculated with R2' = (1/T2*) - (1/T2), relative rCBV and c = 4/3⋅π⋅γ⋅Δχ⋅B0 = 317Hz at 3 T. Relative OEF maps were compared with FLAIR, ADC, TTP and CBV maps and correlated with the clinical outcome in order to evaluate its prognostic value for patient selection regarding therapy.
Results
Twenty-three patients (15 with acute, 3 with subacute ischemia and 5 with severe arterial stenosis) showed areas of prolonged TTP (> 4s) and/or diffusion restriction. On the lesion side in areas with prolonged TTP without diffusion restriction, rOEF presented a signal intensity increase from $0.59 \pm 0.19$ to $1.44 \pm 0.85$ ($p=0.077$). In regions with diffusion restriction this effect was less pronounced ($1.03 \pm 0.62$, $p=0.082$). Relative OEF lesion was associated with TTP lesion in size and location (Figure). Prolonged TTP values correlated with rOEF value increase ($r=0.50$, $p<0.05$). Regional CBV reduction correlated with rOEF value increase ($r=0.54$, $p=0.046$).

Conclusions
In stroke patients, rOEF measurements were able to detect ischemic areas as well as differences between ischemic core and surrounding tissue. Relative OEF values correlate with perfusion prolongation. These results underline the assumption that areas with increased rOEF outside the ischemic core represent tissue with potentially reversible metabolic and functional impairment. Further work is needed to delineate the utility of rOEF for the penumbra concept.

KEYWORDS: MR Imaging Brain, Penumbra, Stroke

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Wednesday 3:00PM - 4:30PM
Palais des congres de Montreal, 520
Purpose
Intravascular papillary endothelial hyperplasia (IPEH), also known as Masson's tumor, is a benign proliferation of endothelial cells that is thought to result from an excessive reaction to normal thrombus reorganization. Although relatively common in the extremities, intracranial IPEH is exceedingly rare. While various theories of pathogenesis have been proposed, an exact mechanism remains elusive. Isolated reports in the literature describe an association between IPEH and arteriovenous malformations (AVM) treated with stereotactic radiosurgery (SRS). We have encountered aggressive lesions arising at the site of prior SRS-treated AVMs that have been diagnosed pathologically as IPEH. We sought to better define the clinical and imaging features of this rare intra-axial entity in an effort to work towards a theory of pathogenesis and elucidate any implications for the treatment of vascular malformations.

Materials and Methods
Four cases of presumed intracranial IPEH arising at the site of a previously SRS-ablated AVM were found at two institutions. Clinical characteristics of the cases, including patient demographics, site of the original AVM, treatment history, type of radiosurgery, radiation dose, latency period for IPEH, and histopathology were reviewed. Available CT and MR imaging data were reviewed in this cohort.

Results
Two cases of IPEH were histologically proven. The third case was diagnosed as AVM with necrosis on histopathology, but exhibited clinical and imaging features consistent with IPEH. A fourth case exhibited clinical and imaging features consistent with IPEH but has not been resected, and is being observed without adverse consequences. There was no gender predisposition. Age at time of SRS ranged from 52 to 71 years (mean 61 years). Three of four patients underwent endovascular embolization of the AVM nidus between one month and three years prior to radiosurgery. Three patients underwent linear accelerator radiosurgery and one patient underwent gamma knife radiosurgery. Radiation doses were similar, with a 90% isodose ranging from 1800-2000 cGy. Latency period between radiosurgery and IPEH presentation ranged from 5 to 13 years (mean 9 years). All lesions arose in the intra-axial compartment, occurred within the irradiated field, and demonstrated similar characteristic imaging features including: hyperdensity on CT; lobulated, circumscribed mass with a T2 hypointense rim, avid enhancement, and extensive vasogenic edema on MRI; and aggressive growth over short term imaging surveillance. Two of four lesions extended across either the tentorium or the falx cerebri, unusual behavior for an intra-axial, non-neoplastic process.
Conclusions
We present the clinical and imaging features of intraaxial IPEH following SRS for AVM, the only reported case series of SRS-associated IPEH. This aggressive entity can be a diagnostic dilemma, given that its imaging features may overlap with radiation necrosis, neoplasia, and cavernoma. The mechanism of radiosurgical ablation of AVMs is thought to relate to endothelial proliferation, hyalinization, and thrombosis leading to vessel occlusion. Interestingly, the histopathology of IPEH seems to reflect an unrestrained form of radiation-related effects. As such, IPEH may represent a complication of SRS and should be considered when an aggressive intra-axial mass is encountered at the site of prior SRS.

KEYWORDS: Arteriovenous Malformation, Radiation, Radiation Effects

O-566

The Supreme Intercostal Artery Includes the Last Cervical Intersegmental Artery (C7) - Angiographic Validation of Dorcas Padget's Intersegmental Nomenclature

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The Johns Hopkins Hospital, Baltimore, MD

Purpose
In 1954, Dorcas Padget settled the debate over the labeling of the intersegmental arteries (ISAs) and the level of origin of the subclavian artery (SubA). Her proposed nomenclature introduced the name of proatlantal artery and confirmed that the SubA was associated with the sixth ISA rather than the seventh. However, a generally unnoticed consequence of this now widely accepted terminology lays in its incompatibility with the traditional view of the costocervical trunk, regarding in particular the anatomy of the supreme intercostal artery (IA). If the SubA derives from the sixth cervical ISA (ISA 6), and the costocervical trunk provides the first and second IAs (ISA 8 and 9), the seventh cervical ISA (ISA 7) then remains unaccounted for. The purpose of this study was to examine Padget's nomenclature in the light of modern angiographic material in order to identify the missing seventh ISA.

Materials and Methods
The topography of the radicular arteries is defined early during development, and their relationships with somitic elements, the intervertebral foramina in particular, remain unchanged at the adult stage. Prominent radiculomedullary arteries, readily visualized with modern angiography, therefore constitute a robust anatomical method to distinguish and correctly label ISAs. Nine angiographic cases are used to define the anatomy of the ISAs 5 to 9. Each observation is documented by a subtracted view depicting the vascular anatomy under consideration, and a native view allowing to correlate the described arterial structures with osseous landmarks for level identification.

Results
Our findings proved entirely consistent with Padget's nomenclature, confirming in particular that vascular elements attributable to the seventh ISA originate from the proximal portion of the supreme IA. The "normal" configuration of the supreme IA includes the last cervical ISA (ISA 7) and the first IA (ISA 8), while the second IA (ISA 9) appears to be a more variable component. As a consequence, in its most rudimentary form, a supreme IA should only consist
of contributions from the seventh ISA, i.e., a radicular artery coursing along the 8th nerve as well as a few small branches aiming for the seventh vertebral body and the upper aspect of the first rib. Figure 1 shows a selective angiogram of a right costocervical trunk: the supreme IA provides the seventh, eighth, and ninth ISAs (C7, T1, and T2), with a prominent anterior radiculomedullary branch originating from the C7 ISA, and passing through the C7-T1 neural foramen along the eight cervical nerve.

Conclusions
Our findings validate the terminology used by Padget, including the addition of a pro-atlantal artery and the identification of the ISA most commonly associated with the SubA as the sixth ISA. They also emphasize the need to redefine the anatomy of the supreme IA to incorporate the seventh cervical ISA.

KEYWORDS: Anatomy, Angiography, Spinal Vascular Disorders
Advanced CT Imaging Predictors of Outcome in Acute Large Vessel Stroke Treated with Stent-Retrievers

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¹The Ottawa Hospital, Ottawa, Ontario, Canada, ²University of Ottawa, Ottawa, Ontario, Canada

Purpose
Recanalization rates are higher in acute anterior stroke patients treated with stent retrievers. Despite faster recanalization, some still have sizeable infarcts and poor outcome. The ASPECTS (Alberta Stroke CT Score) suggests >7 have better outcome. Smaller infarcts and better outcomes have been reported in patients with better computed tomography angiography (CTA) collateral scores (CS). We sought to evaluate imaging predictors of outcome in acute proximal anterior circulation stroke patients undergoing comprehensive stroke imaging with NECT, CTA and CT perfusion and good recanalization with stent retrievers and newer generation intra-arterial therapies.

Materials and Methods
We studied consecutive anterior circulation stroke patients presenting <12 hours onset with good (>TIMI 2) endovascular recanalization in the ICA or M1. An interventional neuroradiologist, blinded to outcome, retrospectively scored ASPECTS on NECT assessing subtle gray-white (GW) blurring (NECT-EI), hypodensity (NECT-hyp), loss of GW on CTA-source images (CTA-SI) and areas of low CBV. The 24-hour NECT ASPECT score was the reference standard. Two neuroradiologists blinded to outcome independently scored CTA collaterals using a four-point (0-3) scale. Intraclass correlation was used to assess agreement in collateral score between reviewers. Good outcomes were defined as mRS less than or equal to 2 and NIHSS>10. Sensitivity, specificity and accuracy by region were calculated. Repeated-measure ANOVA, Bonferroni multiple comparison and linear regression were used.

Results
Of 44 patients, 36(82%) had stent retrievers, 19 had CTP. Mean NIHSS and recanalization time = 17 and 67 mins, 34 (77%) had good outcomes. ASPECTS (IQR) was highest for NECT-EI=9.5 (8.5, 10.0), NECT-hyp=10,CBV=8.0, lowest for CTA-SI mean 6.8 (SD=2.7). Computed tomography angiography (CTA)-SI had highest acc=79%, sens=73%, spec=82% followed by CBV (75%, 62%, 82%). Linear regression correlated CBV and 24-hour CT (R²=0.22,p=0.04) and CTA-SI and 24-hour CT (R²=0.30, p=0.0001). There was good agreement between reviewers for CTA-CS (ICC=0.68, CI =0.4848-0.8088). There was no significant correlation with NECT-EI/Hyp and 24-hour CT or CTA-CS and 24-hour CT. Patients with good outcomes had less infarct (mean 8.2 versus 4.1, p<0.0001) and better CTA-SI (mean7.1 versus 5.1p=0.02) and CBV (mean7.8 versus 5.3, p=0.02). Median CTA-CS was 2.5 versus 2 in patients with good versus poor outcomes (p=0.11). ANOVA revealed differences between all imaging except CTA-SI versus CBV.

Conclusions
Computed tomography angiography-SI performed better than CBV in predicting final infarct in
acute anterior stroke patients undergoing good recanalization. NECT underestimates the amount of infarct. There was a trend towards better CTA-CS in patients experiencing good outcomes after successful recanalization.

KEYWORDS: CT, Stents, Stroke

O-568

Dose Reduction in Contrast-Enhanced MR Angiography of the Head and Neck: Reader Confidence, Quantitative Impact, and Field Strength Dependency

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Purpose
To test the feasibility of dose reduction in contrast-enhanced MRA (CE-MRA). Past studies suggest superiority of CE-MRA compared to noncontrast alternatives; however, concerns over untoward effects of gadolinium preclude use in some settings. We report the systematic comparison of full and reduced-dose CE-MRA at 1.5 and 3.0 T, with attention to reader confidence, signal-to-noise (SNR) and contrast-to-noise (CNR), hypothesizing feasibility and heightened tolerance to dose reduction at 3.0 T.

Materials and Methods
One hundred eight patients (60 female, ages 21-94) were included. Contrast-enhanced MRA protocols included: A-half dose (0.05mmol/kg) 1.5 T (n=23); B-full dose (0.1mmol/kg) 1.5 T (n=29); C-half dose 3.0 T (n=27); or D-full dose 3.0 T (n=29), with the iv power injection (2cc/s) of gadobenate dimeglumine (Multihance, Bracco Diagnostics) on Siemens systems (Siemens Healthcare, Erlangen, Germany). Imaging included 3D FLASH-based CE-MRA employing: 1) 1.5 T, TR/TE(ms)=3.09/1.11, θ=30°, voxel size=1.1mm isotropic, NEX=1, bandwidth=300Hz/Pixel; or 2) 3.0 T, TR/TE(ms)=2.78/1.03, θ=25°, voxel size=1.1x0.9.1.1 mm, NEX=1, bandwidth=650Hz/Pixel. Quantitative analysis included SNR, as well as CNR relative to reference fat (CNRfat) or muscle (CNRmuscle) for the following: aortic arch (AA), common carotids, carotid bifurcations, and cervical ICA. Qualitative assessment of raw and maximum intensity images was performed by two neuroradiologists with attention to overall quality and reader confidence as follows: 3=exceptional; 2=good, diagnostic quality; 1=limited, but diagnosis possible; 0=severely limited. Segments interrogated for qualitative analysis included AA, CCA, ICA, and proximal (V1), intraforaminal (V2) and cervical-extraforaminal (V3) vertebral arteries.

Results
No significant qualitative differences were identified for most segments, with the exception of bilateral V2 and V3 segments (p<0.03). Among these four segments, pair-wise comparison demonstrated significant inferiority of half dose 1.5 T compared with the remaining three protocols, however still meeting diagnostic quality (mean rating V2right=2.44; V2left=2.52; V3right=2.48; V3left=2.52). No differences were present among the remaining protocols. Quantitative analysis comparing SNR and CNR between doses at 1.5 T demonstrated no significant difference at most segments, with the exception of cervical ICA bilaterally for all
three measure (SNR, CNRfat, CNRmuscle p<0.002). By comparison, no significant differences in SNR or CNR were noted among any segments at 3.0 T, irrespective of dose. 

Conclusions
Dose-reduced CE-MRA is achievable at 3.0 T without detriment to reader confidence or vascular enhancement. Even at 1.5 T, dose reduction generally may be tolerated from a qualitative standpoint in most vascular segments, however a negligible general degradation of image quality may be anticipated. These findings suggest that dose reduction is feasible at both field strengths, and may be considered where contraindications to full dose CE-MRA exist.

KEYWORDS: Angiography, Carotid Angiography, MRA
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Purpose
The purpose of this work was to evaluate if the use of chromatic analysis, instead of the use of gray-scale, in the MDCTA study of carotid artery dissection (CAD) modify the observer's diagnostic accuracy.

Materials and Methods
One hundred patients (61 men, 39 women; mean age, 51 years; range, 25 – 78 years) 40 with and 60 without CAD, that underwent MDCTA for suspected CAD formed the study cohort. In this study patients from three different groups were included (patients with MR confirmation of CAD, n = 40; patients with MR confirmation of CAD absence, n = 20; patients that underwent MDCTA of carotid arteries for atherosclerosis analysis, n = 40). Four blinded observers with different level of expertise (expert, intermediate A, intermediate B and trainee) analyzed the randomized basal scan of the MDCTA dataset using a cross-model (one case gray-scale and the following case using the Chromatic-scale) and the presence of CAD was scored on a 5-point scale in order to assess the diagnostic confidence. After three months the four observers evaluated the same datasets by using the same cross-model with the inversion of the reading (one case Chromatic-scale and the following case using the gray-scale). Statistical analysis included receiver operating characteristics (ROC) curve analysis, the Cohen-weighted test and sensitivity, specificity, PPV, NPV, accuracy, LR+ and LR−.

Results
The ROC curve analysis showed that for all observers the use of Chromatic-scale produced an improvement of the diagnostic confidence with AUC values from 0.896 to 0.936; from 0.823 to 0.849; from 0.84 to 0.909 and 0.749 to 0.861 for expert, intermediate A, intermediate B and trainee observers. In particular the variation of diagnostic confidence (between the AUC areas) for the trainee was statistically significant (p = 0.036). Also accuracy, as well as sensitivity, specificity, PPV, NPV, LR+ and LR− were better using the chromatic scale.

Conclusions
Results of our study suggest that the use of chromatic scale instead the classic gray-scale improves the diagnostic confidence of the readers, in particular of the junior ones, by improving also the accuracy, sensitivity and specificity.

KEYWORDS: Carotid Dissection
Assessment of Anemia on Non-contrast Computed Tomography of the Head

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¹Stony Brook University Medical Center, Westbury, NY, ²Winthrop University Hospital, Mineola, NY, ³Stony Brook University Medical Center, Stony Brook, NY, ⁴St Johns University, Westbury, NY

Purpose
We aim to evaluate whether diagnosis of anemia can be made on noncontrast CT of head by measuring attenuation of the intracranial dural venous sinuses.

Materials and Methods
A retrospective IRB-approved analysis of 280 randomly selected patients who underwent noncontrast CT head for various symptoms (headache, syncope, vertigo, etc.) at a tertiary care center in an emergency room or inpatient setting. Regions of interest (ROIs) (approx 3 mm in diameter) were placed on the superior sagittal sinus, confluence of sinuses and bilateral
transverse sinuses. Computed tomography (CT) attenuation values were obtained within a plus-minus of less than five units by two readers. These values were correlated with patients' hemoglobin and hematocrit values. Blood work for all patients was obtained within 24 hours of the CT scan. Patients were excluded from the study due to limitations including motion or streak artifact or unavailability of blood work within 24 hour of the CT scan. The two readers reviewed the studies in different locations and at different times and both blinded to patients' hemoglobin and hematocrit values.

Results

Two hundred forty-three patients (110 males, 133 females) mean age 59 (range 5 – 99 years) had CT attenuation values for all the dural venous sinuses averaged and categorized according to hemoglobin values of less than 8, 8-10, 10-14 and greater than 14, respectively. Mean CT attenuation values for reader A were for Hb < 8, 8-10, 10-14 and > 14 were 3.85, 42.66, 48.18 and 53.43 and with standard deviations of 5.91, 3.43, 3.43 and 4.25 respectively. Mean CT attenuation values for reader B were: 36.75, 42.05, 47.81 and 53.06 with standard deviation of 10.41, 4.87, 5.76 and 5.78, respectively. Linear regression analysis reveal highest positive correlation of hemoglobin and hematocrit values with CT attenuation at the confluence of sinuses with R2 value of 0.63. Interobserver agreement was found to be good using the kappa statistic.

Conclusions

Our study shows a direct positive correlation between attenuation value of the dural venous sinuses with patient's hemoglobin and hematocrit values with good interobserver agreement. Subset analysis reveals the highest positive correlation between patient's hemoglobin and hematocrit with the attenuation values at the confluence of sinuses.

**KEYWORDS:** Dizziness, Dural Sinus, Vertigo

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**Superior Saggital (HU)**

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**Transverse [R] (HU)**

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**Transverse [L] (HU)**

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**Confluence (Torcula) (HU)**

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**MEAN HU**

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<th>Mean HU, Hb 10-14</th>
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<td></td>
<td>35.85</td>
<td>42.66</td>
<td>48.18</td>
<td>53.43</td>
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<tr>
<td>Mean St. Dev</td>
<td>5.91</td>
<td>3.43</td>
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<td>4.25</td>
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</table>
Increased Number of White Matter Lesions in Patients with Familial Cerebral Cavernous Malformations

M Golden¹, L Morrison¹, B Hart¹
¹University of New Mexico, Albuquerque, NM

Purpose

Familial cerebral cavernous malformations (fCCMs) represent an autosomal dominant disorder which results in significant morbidity and mortality in affected patients. The disorder is most prevalent in the Southwest, where the affected families usually are carriers of the Common Hispanic Mutation (KRIT 1 or CCM1). The brain parenchyma is affected by increased numbers of cavernous malformations. Multiple studies have shown abnormalities of endothelial cell junctions and the blood-brain barrier in CCMs. Endothelial cell abnormalities also have been described in pathologic studies of WMHI. We examined WMHI in a population with fCCM.
Materials and Methods
We examined 191 subjects with familial CCMs, enrolled into an IRB-approved study. All carry the same CCM1 mutation. Each subject had 3 T MRI, including GRE, SWI and FLAIR sequences. The number of cavernous malformations was counted, as well as the number of nonhemorrhagic WMHI. Subjects over age 60 years were excluded. The fCCM subjects then were compared to a normal population. Logistic regression was performed for possible correlations of WMHI in the fCCM group with age, gender, headaches, hypertension, hyperlipidemia or seizure history.

Results
Familial CCM1 carriers have an abnormally increased rate of nonhemorrhagic white matter lesions compared to a normal population. Logistic regression showed mild age effect and no statistical association with gender, headaches, hypertension, hyperlipidemia or seizure history.

Conclusions
Familial CCM1 carriers have not only an increased rate of cerebral cavernous malformations, but also have white matter T2 hyperintensities, spatially distinct from CCMs, that exceed that of a normal population. To our knowledge this relationship has not been reported previously. This finding suggests an additional manifestation of endothelial abnormalities in this population.

KEYWORDS: Cavernous Malformation, White Matter Disease

O-572

Ultralow radiation for neck CT angiograms. CTA as a screening test for carotid disease?

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Purpose
The purpose of the study is to develop a neck computed tomography angiography (CTA) protocol that drastically reduces radiation dose while maintaining diagnostic image quality. Computed tomography angiography has became a method of choice for evaluation of carotid artery disease, allowing precise delineation of arterial walls and surrounding tissues, assessment of obstructed lumen and plaque configuration for disease diagnosis, follow up and surgical planning. Widespread use has led to concerns regarding radiation dose, particularly on young patients and repeat examinations, with special consideration of anatomical proximity to the thyroid and lenses, both radiosensitive organ.

Materials and Methods
A new reduced radiation dose scanning protocol for neck CTA (100 Kv, 140 Ma, Pitch 0.5, rot time 0.5 seg) was developed at our institution and applied on 10 patients who underwent the exam with indication of vascular disease. The exams were reviewed by two staff radiologists who assessed image quality and diagnostic capability, both on standard thin slice (0.625 mm) images, orthogonal views and dedicated high resolution individual vessel reconstructions. Total radiation doses were obtained, and compared against the standard of care protocol (120 Kv, 235 Ma, Pitch 0.5, rot time 0.5 seg). Measurements of vessel contrast (Hounsfeld Units), noise (expressed by SD of the vessel ROI measurement), CNR and SNR were calculated on 10
different areas from the aortic arch to the base of the skull, then compared between the two protocols.

Results
All 10 exams were considered satisfactorily regarding image quality and possessed full diagnostic capabilities. Adequate image resolution was obtained for the neck soft tissues. Compared to standard of care protocol, a 62% reduction was obtained for radiation dose (CTDI 42 mGy vs 16 mGy) and estimated dose for thyroid (14.2 mSv versus 5.1 mSv). Objective measurements showed higher contrast (430 HU versus 500 HU), similar noise (19.7 versus 19.4), slightly elevated CNR and SNR (24.1 versus 26.4 and 28.5 versus 29.9, respectively).

Conclusions
With the number of neck CTA exams rising, efforts must be made in order to keep radiation doses in the minimum possible without compromising image quality. This new low dose protocol enables full diagnostic capabilities of vascular disease with significant dose reduction, maintaining the quality of advanced high resolution individual vessel reconstructions. There is potential for further dose reduction, which can be researched and applied in future studies.

KEYWORDS: Carotid Artery, Radiation Dose Reduction, Stroke

<table>
<thead>
<tr>
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<th>Standard Dose</th>
<th>Ultra Low Dose</th>
<th>% Difference</th>
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<tr>
<td>Vessel HU</td>
<td>430.4</td>
<td>500.2</td>
<td>16</td>
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<tr>
<td>Noise</td>
<td>19.7</td>
<td>19.4</td>
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<tr>
<td>CNR</td>
<td>24.1</td>
<td>26.4</td>
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<tr>
<td>SNR</td>
<td>28.5</td>
<td>29.9</td>
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</table>

Table 1: Comparison of vessel contrast parameters between two different protocols.

(Filename: TCT_O-572_dosecomparison.JPG)
Cervical Injury Patterns in Blunt Cerebrovascular Injury

M Booker, J Lammering, M Shiroishi, M Law, J Go

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Purpose
Blunt cerebrovascular injury (BCVI) is thought to occur in 1% of blunt trauma patients and 15% of high-risk patients. While most patients are asymptomatic at presentation, the early identification and treatment of blunt carotid artery (BCAI) or blunt vertebral artery injury (BVAI) can greatly reduce mortality and stroke rates. This study examines the cervical injury patterns associated with BCVI along with the screening efficacy, incidence, and outcome of patients.

Materials and Methods
A retrospective search between January 1, 2009 and June 30, 2013 was conducted at the LAC+USC Medical Center, a level 1 trauma center, to identify all patients either screened for or diagnosed with BCVI. Images were acquired on a Toshiba 64 MDCT scanner reconstructed to 1 mm in all three orthogonal planes. Cervical and skull base injuries were recorded for all patients (Table 1); a documented seatbelt sign was noted for those patients experiencing a motor vehicle collision (MVC). Statistical analysis was conducted with JMP 10 using log and Chi-square Likelihood tests.

Results
There were 14,055 total patients (4,418 post-MVC) evaluated for blunt trauma to the head or neck with 517 (249 post-MVC) screening CTAs performed (screening rate 3.7%). Thirty-seven screened patients were diagnosed with BCVI for a screening yield of 7.2%; additionally, seven unscreened patients later developed BCVI for a total BCVI population of 44 (incidence rate 0.32%). These 44 patients had 25 BVAIs and 32 BCAIs, with multivessel injury occurring in 10 patients. Ten patients suffered stroke (7 of whom were unscreened) with two subsequent deaths (both were unscreened). Of note, BCAI was present in every stroke or death. To our knowledge there were no imaging false negatives. A cervical or skull base injury was recorded in the BCVI, BVAI, and BCAI subgroup in 16 (36%), 14 (58%), and five (18%) cases, respectively. Please see Table 1 for specific injury pattern, age, and gender correlation statistics. A seatbelt sign was documented in 118 of 249 MVC cases (47%) - 4 of 22 (18%) in the BCVI group and 114 of 227 (50%) in the non-BCVI group. Consequently, the seatbelt sign was not predictive of BCVI (p-value 0.99) but, in fact, negatively correlated (OR 0.22)

Conclusions
BCVI is a rare event overall (incidence 0.32%) but relatively common in high-risk patients (screening yield 7.2%). Despite its widespread use, the cervical seatbelt sign had no predictive value in our data. However, the negative correlation is likely a result of statistical bias introduced from its active use as a screening factor at our institution. In addition, many classic BCVI injury patterns were associated only with vertebral artery injury - notably those involving the transverse foramen. Blunt carotid injury remains very difficult to predict as "skull base fracture" was only weakly associated.

KEYWORDS: Carotid Artery, Motor Vehicle Crash, Vertebral Artery
**Table 1: Injury Patterns in BCVI, BVAI, and BCAI**

<table>
<thead>
<tr>
<th>Injury Pattern</th>
<th>BCVI</th>
<th>No-BCVI</th>
<th>All</th>
<th>OR</th>
<th>OR CI (95%)</th>
<th>Uni p-val</th>
<th>M</th>
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</thead>
<tbody>
<tr>
<td>Blunt Cerebrovascular Injury (BCVI)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Displacement into transverse foramen</td>
<td>4 (9.0%)</td>
<td>2 (0.4%)</td>
<td>6 (1.1%)</td>
<td>23.90</td>
<td>4.25-134.5</td>
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<td>Transverse foramina involvement</td>
<td>6 (13%)</td>
<td>13 (2.7%)</td>
<td>19 (3.6%)</td>
<td>5.67</td>
<td>2.04-15.77</td>
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<td>4 (9.0%)</td>
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<td>13 (2.7%)</td>
<td>17 (3.2%)</td>
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<td>1.12-11.53</td>
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<td>16 (36%)</td>
<td>75 (15%)</td>
<td>91 (17%)</td>
<td>3.09</td>
<td>1.59-5.98</td>
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<tr>
<td>C1 - C3 fracture</td>
<td>5 (11%)</td>
<td>20 (4.1%)</td>
<td>25 (4.7%)</td>
<td>2.95</td>
<td>1.05-8.28</td>
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<tr>
<td>Skull base fracture</td>
<td>4 (9.0%)</td>
<td>34 (7.0%)</td>
<td>38 (7.2%)</td>
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<td>0.44-3.88</td>
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<tr>
<td>MVA</td>
<td>22 (5%)</td>
<td>227 (47%)</td>
<td>249 (47%)</td>
<td>1.11</td>
<td>0.60-2.07</td>
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<td>Gender (Female)</td>
<td>14 (31%)</td>
<td>163 (33%)</td>
<td>177 (33%)</td>
<td>0.91</td>
<td>0.47-1.76</td>
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<td>Age</td>
<td>47.9 + 21.8</td>
<td>40.4 + 20.6</td>
<td>41.0 + 20.8</td>
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<th>BVAI</th>
<th>No-BVAI</th>
<th>All</th>
<th>OR</th>
<th>OR CI (95%)</th>
<th>Uni p-val</th>
<th>M</th>
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<tr>
<td>Displacement into transverse foramen</td>
<td>4 (16%)</td>
<td>2 (0.4%)</td>
<td>6 (1.1%)</td>
<td>49.80</td>
<td>8.61-288</td>
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<td>6 (25%)</td>
<td>13 (2.6%)</td>
<td>19 (3.6%)</td>
<td>12.49</td>
<td>4.26-36.6</td>
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</tr>
<tr>
<td>Transverse process fracture</td>
<td>4 (16%)</td>
<td>12 (2.4%)</td>
<td>16 (3.0%)</td>
<td>8.13</td>
<td>2.41-27.5</td>
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<tr>
<td>Any cervical-basilar fracture</td>
<td>14 (58%)</td>
<td>77 (15%)</td>
<td>91 (17%)</td>
<td>7.69</td>
<td>3.30-17.94</td>
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<td>Facet subluxation/dislocation</td>
<td>4 (16%)</td>
<td>13 (2.6%)</td>
<td>17 (3.2%)</td>
<td>7.49</td>
<td>2.24-25.0</td>
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<td>C1 - C3 fracture</td>
<td>5 (20%)</td>
<td>20 (4.1%)</td>
<td>25 (4.7%)</td>
<td>6.32</td>
<td>2.14-18.6</td>
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<td>MVA</td>
<td>14 (58%)</td>
<td>235 (47%)</td>
<td>249 (47%)</td>
<td>1.58</td>
<td>0.69-3.62</td>
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<td>2 (8.3%)</td>
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<td>1.17</td>
<td>0.26-5.18</td>
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<tr>
<td>Gender (Female)</td>
<td>6 (25%)</td>
<td>171 (34%)</td>
<td>177 (33%)</td>
<td>0.64</td>
<td>0.25-1.65</td>
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<tr>
<td>Age</td>
<td>43.9 + 23.6</td>
<td>40.9 + 20.7</td>
<td>41.0 + 20.8</td>
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<tr>
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<th>No-BCAI</th>
<th>All</th>
<th>OR</th>
<th>OR CI (95%)</th>
<th>Uni p-val</th>
<th>M</th>
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<tr>
<td>Blunt Carotid Artery Injury (BCAI)</td>
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<tr>
<td>Skull base fracture</td>
<td>3 (11%)</td>
<td>35 (7.0%)</td>
<td>38 (7.2%)</td>
<td>1.65</td>
<td>0.47-5.75</td>
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<td>Transverse process fracture</td>
<td>1 (3.7%)</td>
<td>15 (3.0%)</td>
<td>16 (3.0%)</td>
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<tr>
<td>Any cervical-basilar fracture</td>
<td>5 (18%)</td>
<td>86 (17%)</td>
<td>91 (17%)</td>
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<td>0.40-2.95</td>
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<tr>
<td>Transverse foramina involvement</td>
<td>1 (3.7%)</td>
<td>18 (3.6%)</td>
<td>19 (3.6%)</td>
<td>1.02</td>
<td>0.13-7.97</td>
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<tr>
<td>Gender (Female)</td>
<td>9 (33%)</td>
<td>168 (33%)</td>
<td>177 (33%)</td>
<td>0.98</td>
<td>0.43-2.23</td>
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<td>MVA</td>
<td>12 (44%)</td>
<td>237 (47%)</td>
<td>249 (47%)</td>
<td>0.88</td>
<td>0.40-1.91</td>
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<td>C1 - C3 fracture</td>
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<td>25 (4.7%)</td>
<td>0.00</td>
<td>1.00</td>
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<tr>
<td>Displacement into transverse foramen</td>
<td>0 (0%)</td>
<td>6 (1.2%)</td>
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<td>1.00</td>
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<tr>
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<td>0 (0%)</td>
<td>17 (3.4%)</td>
<td>17 (3.2%)</td>
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<tr>
<td>Age</td>
<td>52.5 + 20.8</td>
<td>40.4 + 20.6</td>
<td>41.0 + 20.8</td>
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O-574 4:03PM - 4:10PM
Developmental venous anomalies are commonly associated with metabolic abnormality in otherwise normal-appearing brain parenchyma

M Larvie¹, J Thum², D Timerman²
¹Massachusetts General Hospital, Boston, MA, ²Harvard Medical School, Boston, MA

Purpose
Developmental venous anomalies (DVAs) are the most common intracranial vascular abnormality. Although the deleterious effects of large DVAs on brain parenchyma have been well documented, small DVAs typically are regarded as inconsequential and of no clinical significance. We recently have noticed that cortical hypometabolism, as identified on 18F-fluorodeoxyglucose (FDG) PET, commonly is associated even with small DVAs with no other apparent abnormality in the adjacent brain tissues. To better understand the features typical of brain parenchyma associated with DVAs, we analyzed all DVAs that we could identify that have been characterized at our institution with both FDG positron emission tomography (PET) and magnetic resonance imaging (MRI).

Materials and Methods
This study consists of a retrospective analysis of DVAs that have been characterized by both FDG PET and MRI at our institution. A total of 25 DVAs were identified in 22 subjects. These DVAs were characterized qualitatively for degree of metabolic abnormality in the adjacent brain parenchyma (none, mild, moderate and severe) and classified by size (small, medium and large). Abnormalities in the adjacent brain parenchyma were assessed, including MRI signal abnormality, atrophy, calcification, cavernous malformation, hemorrhage and calcification.

Results
Cortical hypometabolism was identified in a majority, 68%, of DVAs. Features correlated with higher degrees of hypometabolism include older age and larger size of the DVA. In contrast, a much smaller fraction of lesions demonstrated brain parenchymal abnormalities that were apparent on structural imaging, including atrophy (12%), T2 hyperintensity (8%), calcification (8%) and cavernous malformation (8%). Of note, one of the DVAs in our sample demonstrated marked hypermetabolism on an FDG PET scan performed at the time of a seizure.

Conclusions
Although most DVAs have no associated brain parenchymal abnormality, we find that a majority of DVAs are associated with hypometabolism as assessed by brain FDG PET. The degree of metabolic abnormality is positively correlated with greater age and size. The common understanding of small DVAs as clinically insignificant deserves reconsideration, and in certain clinical contexts, particularly in patients with epilepsy, further evaluation may be warranted, in particular through FDG PET.

KEYWORDS: Brain Development, Developmental Venous Anomalies, PET

O-575

Admission CTA without additional MRI allows reliable diagnosis of cervical artery dissection.

U Hanning¹, M Schmiedel¹, W Heindel¹, T Niederstadt¹, R Dittrich¹
Purpose
Spontaneous dissections of the cervical arteries are an important etiology of juvenile stroke. The currently accepted diagnostic gold standard is the contrast-enhanced MR angiography of the cervical arteries in combination with fat suppressed T1-weighted axial sequences of the neck. In this retrospective study we sought to find out the diagnostic value of the CT angiography in comparison to the MR-investigation in the acute phase of the disease.

Materials and Methods
One hundred eighty-eight consecutive patients with the diagnosis of cervical artery dissection have been screened for the study within the time period from January 2005 to May 2013. Forty patients with 43 dissected arteries have been included for further analysis since these patients received both imaging modalities CT angiography and MR angiography with fat suppressed axial sequences. All images have been reviewed by two experienced neuroradiologists concerning the occurrence of the following characteristic radiological features: (1) smooth or slightly irregular tapered stenosis (CT/MR), (2) arterial occlusion (rattail-shaped tapered, flame-like) (CT/MR), (3) lumen irregularity, irregular dilatation (CT/MR), (4) pseudoaneurysm (saccular or fusiform aneurysmal dilatation) (CT/MR), (5) intimal flap (CT/MR), (6) wall thickening (e.g., suboccipital rind sign) (CT), (7) crescent sign (methemoglobin of the intramural hematoma in axial T1-weighted fat-suppressed images) (MR).

Results
In 29 cases a dissection of the internal carotid artery and in 14 cases a dissection of the vertebral artery have been found. The mean time from symptom onset to hospitalization was four days. In 39 patients, the CT angiography was the first diagnostic procedure followed by the MR investigation with a mean delay of 3.6 days. Characteristic radiological features of a cervical artery dissection could be detected in all arteries with both imaging modalities namely the smooth or slightly irregular tapered stenosis/occlusion and the lumen irregularity or irregular arterial dilatation.

Conclusions
Both imaging modalities have a high diagnostic sensitivity in the detection of cervical artery dissection with an equivalent diagnostic value. Even if the pathognomonic intramural hematoma is visible by MRI only, other characteristic features of cervical artery dissection can be detected by very reliably CT angiography. With the typical clinical presentation in the absence of severe atherosclerosis it is possible to make the diagnosis of cervical artery dissection with CT angiography.

KEYWORDS: Carotid Dissection, Dissection, Vertebral Artery Dissection

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<th>ACI (40 patients – 27 ACI)</th>
<th>CT</th>
<th>MRI</th>
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<tr>
<td>1. smooth or slightly irregular stenosis</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>2. arterial Occlusion</td>
<td>26%</td>
<td>26%</td>
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<tr>
<td>Features</td>
<td>CT</td>
<td>MRI</td>
</tr>
<tr>
<td>----------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>3. lumen irregularity, irregular dilatation</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>4. Pseudoaneurysm</td>
<td>22%</td>
<td>22%</td>
</tr>
<tr>
<td>5. intimal flap</td>
<td>7%</td>
<td>7%</td>
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<tr>
<td>6. wall thickening (only CT)</td>
<td>81%</td>
<td>X</td>
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<tr>
<td>7. crescent sign (only MRI)</td>
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<td>93%</td>
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**VA (40 patients – 13 VA)**

<table>
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<tr>
<th>Features</th>
<th>CT</th>
<th>MRI</th>
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<tr>
<td>1. smooth or slightly irregular stenosis</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>2. arterial Occlusion</td>
<td>69%</td>
<td>77%</td>
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<tr>
<td>3. lumen irregularity, irregular dilatation</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>4. Pseudoaneurysm</td>
<td>0%</td>
<td>8%</td>
</tr>
<tr>
<td>5. intimal flap</td>
<td>0%</td>
<td>0%</td>
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<td>6. wall thickening (only CT)</td>
<td>46%</td>
<td>X</td>
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<tr>
<td>7. crescent sign (only MRI)</td>
<td>X</td>
<td>92%</td>
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Spots and Swirls: Relationship between Hematoma Heterogeneity, CTA Spot Sign, and Hematoma Expansion

T Huynh¹, D Connor¹, A Demchuk², D Dowlatshahi³, D Gladstone¹, S Subramaniapillai¹, S Symons¹, R Aviv¹
¹University of Toronto and Sunnybrook Health Sciences Centre, Toronto, ON, Canada, ²University of Calgary, Calgary, AB, Canada, ³University of Ottawa, Ottawa, ON, Canada

Purpose
Hematoma heterogeneity on noncontrast CT(NCCT) in acute intracranial hemorrhage (ICH), characterized both by qualitative and quantitative means, has been shown to be predictive of hematoma expansion and mortality. This may be partially related to the presence of active extravasation in which uncoagulated blood appears iso- or hypodense relative to the surrounding clot, previously coined the 'Swirl Sign'. Recently the quantitative CT densitometry (qCT) parameter coefficient of variation was found to be the best predictor of absolute hematoma volume expansion. Analysis of qCT parameters may be automated to further improve rapid and
reliable prediction of expansion in the acute setting. Noncontrast CT predictors of expansion may be helpful in identifying patients who may benefit from hemostatic therapy without the need of intravenous contrast administration. We sought to evaluate the ability of hematoma heterogeneity, characterized by the Swirl Sign and qCT parameters, to predict hematoma expansion and the presence of a CT angiography (CTA) Spot Sign.

Materials and Methods
This retrospective study reviewed all primary ICH patients entered into a departmental stroke database between September 2006 and December 2012. Study inclusion criteria were all patients presenting to a tertiary hospital emergency department with stroke symptoms attributable to ICH. Patients with secondary ICH were excluded. Patients underwent standard institutional acute ICH CT protocol including noncontrast CT, CTA, and postcontrast CT. A semi-automated region of interest algorithm was applied to determine hematoma boundaries originating from a user-defined seed. Low density regions were included in the region of interest (ROI) only if they were surrounded by hematoma. Hematoma volumes and qCT parameters including mean, standard deviation, coefficient of variation, skewness, and kurtosis were calculated from hematoma regions on NCCT. Each hematoma was assessed by a blinded staff neuroradiologist for the presence of Spot Signs and to dichotomize cases into homogeneous or heterogeneous. Heterogeneous hematomas were defined as those with enclosed regions which were iso- or hypodense relative to brain parenchyma on NCCT. Those cases with heterogeneities were examined to determine whether the heterogeneity was a Swirl Sign. Logistic regression analyses were performed to assess predictors of hematoma expansion (>6 ml or >33% hematoma expansion) and CTA spot sign presence.

Results
In total, 71 patients were included in the study. Mean (SD) age and gender of included patients were 68.2 ± 15.6 years and 46/71 (65%) male respectively. Median (interquartile range, IQR) NIHSS, TTS, time from baseline to follow-up CT, baseline and follow-up hematoma volumes were 10 (6 – 16), 1.9 (1.3 – 4.6) hours, 23.0 (17.8 – 27.2) hours, 18.1 (5.3 – 37.6) mL, and 18.7 (7.6 – 39.6) mL respectively. Intraventricular hemorrhage was present in 36 (51%) patients. A Swirl Sign was present in 33 (47%) hematomas and 36 (51%) were characterized as heterogeneous. Hematoma expansion of >6 ml or >33% occurred in 21 (30%) patients. A CTA spot sign was present in 26 (37%) patients and in patients with a spot sign present, median (IQR) number of spots was 2 (1 – 3). Univariate predictors of hematoma expansion included the Swirl Sign (p=0.031), qCT standard deviation (p=0.029), Spot Sign presence (p=0.020), and Spot Sign number (p=0.009). Trend associations were noted for time from onset < 3 hours (p=0.059), INR>1.5 (p=0.057), hematoma heterogeneity (p=0.062), mean density (p=0.052), and coefficient of variation (p=0.059). Backwards stepwise logistic regression excluding variables obtained on CTA identified that Swirl Sign and standard deviation of hematoma density were independent predictors of expansion. Including CTA variables, Spot Sign number was the best predictor of expansion. Univariate predictors of Spot Sign included time to scan < 3 hours (p=0.045), Swirl Sign (p=0.002), heterogenous hematomas (p=0.002). Multivariable regression identified that time to scan and Swirl Sign were independent predictors of expansion.

Conclusions
Noncontrast CT predictors of expansion include Swirl Sign, hematoma heterogeneity, and qCT standard deviation. Swirl Sign and hematoma heterogeneity also were predictive of Spot Sign presence. Time from symptom onset < 3 hours was predictive of both hematoma expansion and
Spot Sign presence. Noncontrast CT may be helpful in identifying patients at risk for hematoma expansion and demonstrating a Spot Sign.

KEYWORDS: Intracerebral Hemorrhage

O-577

Hereditary Hemorrhagic Telangiectasia: Spectrum of CNS Manifestation

D Lin¹, G Robinson², A Zessler³
¹The Johns Hopkins University School of Medicine, Baltimore, MD, ²Johns Hopkins Hospital, Baltimore, MD, ³Johns Hopkins University, Baltimore, MD

Purpose
Patients with hereditary hemorrhagic telangiectasia (HHT), an autosomal dominant disease, present with epistaxis, mucocutaneous telangiectasia and visceral vascular malformations. While brain arteriovenous malformations (AVMs) occur in HHT at a lower frequency than pulmonary and GI vascular malformations, the potentially life-threatening risk of cerebral hemorrhage makes an early and accurate diagnosis of cerebral AVMs particularly important. Current recommendation is for all patients with the diagnosis of HHT to undergo a screening brain MRI. The purpose of this presentation is to review the spectrum of central nervous system (CNS) manifestations revealed by current standard MR imaging (MRI)/MR angiography (MRA) protocol.

Materials and Methods
Between 2009 and 2012, 191 patients were evaluated in our HHT Clinical Center and fulfilled Curaçao diagnostic criteria. One hundred fifty-one of these patients had screening brain MRI with contrast and MRA, and five had MRI of the spine in addition to the brain.

Results
Forty (26%) of the 151 patients had imaging abnormalities. Eleven (7%) had cerebral AVMs, majority of which were micro AVMs (< 1cm). Nine had developmental venous anomalies, in some cases with multiplicity. Eight had old infarcts, six had old hemorrhage or punctate hemosiderin deposit, two had cerebral aneurysms, one had infundibulum, and one had brain abscess related to pulmonary AVM. There were two cases of spinal perimedullary arteriovenous fistulas (AVF) that were large at presentation, both occurring in children (at age 2 and 6).

Conclusions
A spectrum of CNS vascular abnormalities occur in patients with HHT at a rate of 26%, similar to what is recorded in the literature. Of note, spinal AVF is currently not part of the diagnostic criteria, but should raise the suspicion in a child presenting with back symptoms as the current screening MRI does not routinely include evaluation of the spine.

KEYWORDS: AVF, AVM

O-578
Susceptibility MRI Clot Width - Normalized to Thin Slice CT Hyperdense Clot Width – is a Highly Accurate Marker for the Development of Any Intra-parenchymal Hemorrhage Following Intra-arterial Clot Retrieval Therapy in Acute MCA Stroke

S Kamalian¹, A Yoo¹, S Kamalian¹, J Romero², J Hirsch¹, M Lev¹
¹Massachusetts General Hospital, Boston, MA, ²Massachusetts General Hospital, Harvard Medical School, Boston, MA

Purpose
We previously have shown that MCA clot susceptibility artifact width <5 mm on admission GRE T2* (and/or PWI) may identify acute stroke patients at very low-risk (NPV 98%) for developing parenchymal hematoma (PH), following intra-arterial clot-retrieval therapy. Our current purpose is to determine if a more refined measure of the precise degree of susceptibility "blooming" artifact – specifically, the ratio of clot susceptibility width (CSW) to that of corresponding hyperdense MCA clot width on thin-slice CT scans – could more accurately correlate with the risk of developing ANY intraparenchymal hemorrhage (IPH) following endovascular clot retrieval.

Materials and Methods
From a dataset of 125 consecutive AIS patients who received intra-arterial therapy (IAT) between 1/1/2010 to 12/1/2013, and had available admission THIN-SECTION noncontrast CT (ts-NCCT) for review, we identified 62 who met the following additional inclusion criteria: (1) MCA M1 or M2 occlusion; (2) Available admission gradient recalled echo (GRE); and (3) Follow-up noncontrast CT. We measured both the maximum width of clot-related susceptibility artifact (CSW) and the corresponding width of hyperdense MCA clot width at the same location on thin-slice CT scans. Clot susceptibility width was normalized to CT clot-width ("nCSW"). SCW, CT clot-width, and nSCW were compared in three groups according to the degree of IPH as defined by the ECASS classification.

Results
There were 40 patients without IPH (Group 1), 14 patients with hemorrhagic infarction (HI1 and HI2 petechial hemorrhage), and eight patients with parenchymal hematoma (PH1 and PH2). Both SCW and nSCW were significantly higher in Groups 2 (medians 6.5 mm, 2.5 mm) and 3 (medians 7.6 mm, 2.8 mm) compared to group 1 (medians 3.9 mm, 1.3 mm; Mann-Whitney all P< 0.01). SCW and nSCW were not significantly different when comparing Group 2 to Group 3 (Mann-Whitney, P< 0.01). CT clot-width was not significantly different between any combination of Groups (Kruskal–Wallis, P>0.05). ROC curve analysis for distinguishing between patients with and without hemorrhage (Group 1 versus Groups 2 & 3) using SCW showed: AUC = 0.83, optimal threshold = 5.5, sensitivity= 80% and specificity = 77%. Receiver operator characteristic (ROC) curve analysis for nSCW showed: AUC = 0.92, optimal threshold = 1.8, sensitivity = 86% and specificity = 89%.

Conclusions
In acute MCA stroke patients, the width of maximal MRI clot susceptibility blooming artifact - normalized to the corresponding clot width on thin-slice unenhanced CT, with a threshold of approximately 2 - is highly accurate for determining the risk of developing any IPH following intra-arterial clot-retrieval therapy. We speculate that blooming artifact may not only be a marker for overall clot burden, but also may reflect the degree of regional vessel wall injury and blood-brain barrier breakdown – both risk factors for PH development.
**Purpose**
Given the social and language impairments common in autism spectrum disorder (ASD), research has focused on cortices and white matter related to the temporal lobe structures. Prior studies have examined the structure of the superior temporal gyrus and arcuate fasculus in autism and discovered developmental abnormalities including abnormal lateralization (1). The auditory radiation provides sensory input to the superior temporal gyrus, but can not be studied reliably with diffusion tensor imaging because of the presence of crossing fibers. High angular resolution diffusion imaging is necessary to reliably perform tractography of the auditory radiation tracts and generate tract-specific metrics of microstructure (2). This study applies HARDI tractography to quantitatively assess the auditory radiation and to probe microstructural differences in ASD.

**Materials and Methods**
Imaging was performed on 34 right-handed children (11 controls, 23 with ASD, mean age 11.3 years) at 3 T. Whole-brain HARDI acquisition included 64 gradient directions at b=3000s/mm²; TR 16.9s; TE 110ms; voxel size 2x2x2mm. Eight children received two HARDI acquisitions to access reproducibility. Probabalistic HARDI tractography (2) of the auditory radiation was performed to generate tract-specific measures of generalized fractional anisotropy (GFA) and traditional DTI parameters including FA, mean, axial, and radial diffusivities. Left to right hemispheric asymmetry of diffusion metrics was measured as a percent difference. Group differences in the marginal means of the diffusion measures were assessed with age and perceptual reasoning index covaried in a general linear model.

**Results**
Measurements of the auditory radiation had a reproducibility intraclass correlation coefficient of 0.92 for mean diffusivity and 0.74 for FA. Significant changes of hemispheric asymmetry in ASD was observed with FA and GFA, but not mean, axial, or radial diffusivities (see Figure). Fractional anisotropy (FA) asymmetry was biased towards the left hemisphere in controls 7.58% and slightly towards the right 0.25% in ASD, with a significant difference between the two groups (p=0.033). Generalized FA asymmetry was biased towards the left 4.11% in controls and 3.02% towards the right in ASD, with a significant difference between the two groups (p=0.016). Linear regression of the diffusion metrics with social responsiveness scores (SRS) showed a significant positive correlation with volume of fiber tracks (p=0.021).
Conclusions
HARDI tractography is capable of quantifying the entire auditory radiation which is inaccessible with diffusion tensor imaging (DTI) tractography because of crossing fibers. The pattern of diffusion anisotropy asymmetry in ASD indicates an alteration of the auditory radiation's structure. This study contributes evidence of the biological basis of autism's symptoms. The structural abnormalities previously observed in Heschl's gyrus and cortico-cortico connections also are present in the core thalamocortico tracts. The structural abnormalities to the auditory sensory tract are expected to be closely linked to the auditory and language dysfunctions common in ASD.

KEYWORDS: Autism Spectrum Disorder, Diffusion MR Imaging, Fiber Tracking

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Patterns of Structural Co-Variance Associated with Autism Spectrum Disorder in Extremely Preterm Neonates: A Novel Voxel-Wise Graph Theoretic Approach

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Purpose
Evidence is growing that there is structural co-variance between spatially distributed areas of the brain, such that cortical thickness in one region affects thickness in other regions that are functionally connected (1). We hypothesize that brain structural co-variance will be present at voxel-wise magnetic resonance imaging (MRI) resolution, and can be evaluated using graph theoretical analysis to identify patterns of spatially distributed volumetric brain abnormality associated with autism spectrum disorder in extremely preterm neonates.

Materials and Methods
Conventional high-resolution T1-weighted structural MRI was acquired at term-equivalent age from 25 extremely preterm neonates (<27 weeks of gestation), and 15 healthy term controls born in Stockholm, Sweden between January 2004 and March 2007. Six of the 25 preterm neonates were diagnosed with autism spectrum disorder based upon Social Responsiveness Scale and/or clinical diagnosis at a 6.5-year follow-up examination. Automatic segmentation of 3D T1-weighted images using neonatal probabilistic atlases and VBM-DARTEL in SPM8 was performed. Processed gray matter volume images from all subjects in each group were concatenated into a 4D image data file that was used to construct a group-specific voxel-wise 60,542 x 60,542 correlation matrix. Binarized adjacency matrices then were generated at a cost of 0.1 from which modularity maps were computed, with each color representing a different module containing voxels of similar gray matter volume.

Results
Modularity maps from graph theoretical analysis demonstrated qualitative whole-brain differences in patterns of structural co-variance in preterm neonates with autism spectrum disorder compared to nonautistic preterm and term controls (Figure 1). Specifically, between-group differences were identified in regions comprising the frontal, occipito-parietal, and temporal cortices, where gray matter volumetric differences have been described in other MRI studies of extremely preterm neonates. The maps also reveal between-group differences in the spatial organization of modules, with a less complex pattern of modularity in extremely preterm neonates compared to term-born controls. Such findings may reflect abnormal cortical differentiation associated with extremely preterm birth.

Conclusions
Graph theoretic techniques applied to voxel-wise structural brain MRI data can reveal whole-brain patterns of structural co-variance that differ between extremely preterm neonates with autism spectrum disorder and nonautistic preterm and term controls. Additional investigation, however, is necessary to determine if this approach can be used to identify novel biomarkers of abnormal cortical differentiation associated with autism spectrum disorder in extremely preterm neonates.

KEYWORDS: Autism Spectrum Disorder, MR Imaging Brain, Preterm
Figure 1. Modularity maps (sagittal views) from graph theoretical analysis of neonatal template brain. Each color represents a different module containing similar gray matter volume covariance.

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O-581

Volumetric Interpolated Breath-hold Examination (VIBE) of Pediatric Orbit - Initial Experience and Qualitative Analysis

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Purpose
Volumetric interpolated breath-hold examination (VIBE) has been utilized in thoracic and abdominal imaging for over a decade, but there is scant literature describing its usefulness in orbital imaging. Its potential utility lies in its volumetric acquisition with multiplanar reconstruction as well as the relatively short acquisition time. We studied its usefulness in contrast-enhanced imaging of the pediatric orbit and compared it to a routine T1-weighted imaging (T1WI) technique [fast low angle shot (FLASH)].

Materials and Methods
After Institutional Review Board approval, 73 consecutive pediatric orbit examinations (each with VIBE and FLASH imaging in the same encounter) performed on a 3 T magnet over a nine-month period were independently scored by three reviewers, with the sequences reviewed independent from each other. The VIBE sequences consisted of a volumetric acquisition at 1 mm slice thickness (acquisition time of about 4 minutes), which then were reconstructed into axial and coronal planes at 3 mm thickness. The FLASH sequences were obtained in axial and coronal planes at 3 mm thickness (4 minute acquisition time per plane). Qualitative parameters then were analyzed, including fat suppression (intraconal, extracranial, and preseptal), degree of artifacts, and definition of structures (orbital musculature, vasculature, and orbital apex). A Wilcoxon Ranked Sum Test was performed to compare the two sequences’ performance for each parameter.

Results
All three reviewers rated the VIBE T1WI sequence superior with regard to fat suppression of extracranial, intraconal, and preseptal fat (p≤0.05). All three consistently scored VIBE as having a lower degree of intraorbital artifact as compared to FLASH, although only two readers achieved statistical significance (p<0.05), while one did not (p=0.078). Visualization of the ophthalmic artery was rated better on FLASH by all three readers; however, only two readers reached statistical significance (p<0.05), while one did not (p=0.248). Regarding the conspicuity of structures at the orbital apices, the findings were mixed, where one reviewer consistently rated VIBE with higher scores (p<0.05), the second rating FLASH with higher scores (p<0.05), and the third as having no statistical difference between the two sequences. There were no statistically significant differences in scores of contrast enhancement, definition of the superior ophthalmic vein, or conspicuity of the superior oblique muscle between the two sequences (all p>0.05).

Conclusions
This preliminary qualitative evaluation of contrast-enhanced VIBE for pediatric orbital imaging indicates that VIBE has consistently better fat suppression than FLASH and likely a lesser degree of artifact. This was despite the fact that the native 1 mm slice thickness VIBE volumetric data sets were reformatted to 3 mm planar images to ensure direct comparability with 3 mm FLASH images. Further analysis (currently under progress by our group) comparing the source VIBE images and the FLASH images may demonstrate further superiority of VIBE in orbital imaging vis-à-vis FLASH sequences, and prospective studies are pending.

KEYWORDS: Orbits, Pediatric Head And Neck, Volumetric Interpolated Breath-Hold
Initial Evaluation of Three Dimensional Fluid Attenuated Inversion Recovery (3D FLAIR) and Three Dimensional Double Inversion Recovery (3D DIR) MR Sequences in Pediatric Neuroimaging at 3T

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Purpose
Lesion detection can be challenging in pediatric neuroimaging due to the evolving state of myelination. The FLAIR sequence which is utilized widely for lesion detection often is plagued by cerebrospinal fluid (CSF) flow artifacts in young children and the poor gray white differentiation inherent to the technique, especially in the setting of incomplete myelination, can make lesion detection and localization difficult. Double inversion recovery (DIR) is a technique that recently has been implemented in adult patients suffering from multiple sclerosis due to its improved lesion detectability. The utility of the DIR sequence in lesion detection has not been evaluated yet in children. We performed the FLAIR and DIR sequences as 3D and conducted a quantitative and qualitative evaluation of these techniques at 3T across a range of pediatric age groups.

Materials and Methods
We conducted a retrospective evaluation of 25 children aged 6 months to 17 years. IRB approval was obtained for this HIPAA-compliant study with waived informed consent. The pathology
included nonspecific gliosis, neoplasia, migration anomalies, and infectious/inflammatory etiologies. The 3D DIR and 3D FLAIR sequences were performed on a 3 T scanner during the same MRI evaluation using the same slice thickness and similar spatial resolution and matrix. Lesions were categorized into gray matter (GM) only, white matter (WM) only, and mixed (MX) GM/WM. Three-dimensional FLAIR and 3D DIR sequences of all subjects were evaluated independently on a workstation by two pediatric neuroradiologists to determine image quality, extent of artifacts, lesion detectability and conspicuity. Before conducting the evaluation, the two readers underwent a training data set and agreed on the interpretations and scores for each of the evaluated parameters. This training data set was not included in the study. The reviewers were blinded to the clinical information and the images were de-identified. Qualitative assessment was performed for lesion detectability and conspicuity, GM/WM conspicuity, CSF/parenchymal conspicuity, and image artifact using a 4-point scale. Signal intensity measurements were obtained using region-of-interest analysis of the lesions, normal GM, and normal WM. Quantitative evaluation of contrast ratios between the lesion and GM/WM was performed. All quantitative measurements were performed by a pediatric neuroradiologist in conjunction with a medical physicist after the qualitative analysis was completed. Inter-rater agreement was assessed using Kappa statistics. The 3D FLAIR and 3D DIR sequences were compared using a Mann Whitney test.

Results
Our results showed statistically significant inter-rater agreement for lesion detection and lesion conspicuity (p<.001) on both 3D FLAIR and 3D DIR sequences. Artifact on the 3D FLAIR images was significantly lower than on the DIR (p<.001). Parenchymal/CSF conspicuity was significantly less on DIR than FLAIR (p<.001). FLAIR GM/WH conspicuity was significantly lower on the DIR (p<.001). Lesion conspicuity was not significantly different between the two sequences (p=.359). Lesion to WM contrast ratios were greatest on the 3D DIR. The lesion to GM contrast ratios were similar on the FLAIR and DIR sequences.

Conclusions
Our study demonstrates that both 3D FLAIR and 3D DIR sequences have their strengths and limitations in pediatric neuroimaging. The 3D technique has virtually eliminated the CSF flow artifacts that often are seen on 2D FLAIR images. Overall, artifacts were greater on the DIR than the FLAIR sequence. Gray matter/WM conspicuity was greatest on the DIR sequence; however, performing DIR in children that aren't completely myelinated (less than 24 months old), is difficult. The second inversion recovery pulse is variable and needs to be adjusted accordingly to the degree of myelination. Double inversion recovery offers the greatest lesion to WM contrast and this can aid in lesion detection. Lesion conspicuity was improved on DIR and lesions could be localized more accurately to GM or WM.

KEYWORDS: Fluid-Attenuated Inversion Recovery, Inversion Recovery, Pediatric Brain

O-583

Abnormal Iron Levels in the Brain of Pediatric Sickle Cell Disease Patients: a Study using Quantitative Susceptibility Mapping (QSM)

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Purpose
Pediatric sickle cell disease (SCD) patients with high cerebral blood flow receive chronic blood transfusion to reduce the risk of stroke. As a result they suffer from systematic iron overload that affects multiple organs. While iron overload of the liver and heart has attracted much interest, the effects of blood iron overload on brain iron level of these patients have received less attention. Quantitative susceptibility mapping (QSM) is a recently developed MR method that measures tissue magnetic susceptibility from phase images and is sensitive to iron content in the brain. In the current study, we used QSM to quantify iron store in the brain of patients with SCD and compare the findings with age-matched normal subjects.

Materials and Methods
Twenty-five sickle cell patients and 23 age-matched healthy normal volunteers were recruited for the study. The mean/SD of age was 13.3/2.8 and 14.0/3.3 years for the patient and the control groups respectively. MR imaging (MRI) scan was performed using a Siemens 3 T scanner, and included a 3D multi-echo gradient-echo sequence for QSM (FOV=256x192mm, matrix=256x192, slice thickness = 2mm, 72 slices, TR = 50 ms, first TE = 3.7ms, 12 echoes, echo spacing = 3.8ms) and a T1-weighted (T1W) structural imaging sequence using MPRAGE for anatomical identification and image normalization. Only the even echoes were used for QSM processing since the even echoes are flow-compensated in the readout direction. The processing was performed using a software package developed in-house. The phase image from each echo was first unwrapped using a Laplacian method followed by spherical mean filtering to remove the background field to generate the filtered field map. The filtered field maps from each echo then were averaged to increase the signal-to-noise ratio. An L1-norm optimization-based method was used to reconstruct the susceptibility map from the mean field map. All QSM images were normalized to a standard brain template in SPM using the T1W image as a medium, and the mean susceptibility image was created. Regions of interest (ROIs) were drawn on the mean susceptibility map and included bilateral caudate nucleus (CN), putamen (PT), globus pallidus (GP), red nucleus (RN), substantia nigra (SN), dentate nucleus (DN) and choroid plexus (CP). The mean susceptibility value (SV) was calculated as the mean value of all voxels with positive susceptibility values within a ROI as defined above; the restriction to positive voxels was imposed to improve the sensitivity and avoid the inclusion of neighboring white matter. General linear model analysis was performed to compare differences in the susceptibility value of the ROIs between the patient and control groups using age as a covariate.

Results
Qualitatively, QSM nicely depicts regions known with high iron concentration, including the globus pallidus, substantia nigra and dentate nucleus. Table 1 shows the mean and standard deviation of the susceptibility values of different ROIs between the patient and control groups. After controlling for the effect of age, significantly higher susceptibility values were found in the patient group in choroid plexus, red nucleus and dentate nucleus, suggesting high iron loading in these regions. The analysis also showed significantly increasing susceptibility values with age in many of the regions including caudate nucleus, putamen, globus pallidus, substantia nigra, red nucleus and dentate nucleus.

Conclusions
Quantitative susceptibility mapping is sensitive to iron deposition in the brain, and can nicely visualize areas with high concentrations of iron. We found significantly increasing susceptibility values in multiple ROIs examined, which is consistent with the literature. After controlling for
the effect of age, significantly higher iron concentration was found in SCD patients in the choroid plexus, red nucleus and dentate nucleus. The former recently has been proposed as having an important role in brain iron transport, while the latter two are known sites of iron deposition. A possible contributing factor to the increased iron content in these regions is the high systemic iron level of these patients due to their blood transfusion therapy. The ability to image brain iron level with QSM provides valuable information that may permit customized treatment strategy for individual patients. In conclusion, QSM is sensitive for measuring iron concentration in the brain of sickle cell patients and provides a valuable tool for iron assessment for both clinical trials and individual evaluations.

KEYWORDS: Iron Deposition, Sickle Cell Disease

O-584

Comparison of Diagnostic Value of CT-Venography and MR-Venography in Diagnosis of Neonatal Sinus Vein Thrombosis.

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Purpose
Pediatric cerebral sinovenous thrombosis (CSVT) occurs most commonly in neonates. The subsequent morbidity, mortality and adverse neurodevelopmental sequelae highlight the importance of establishing an early diagnosis, which primarily is based on imaging findings. The aim of our study is to compare the diagnostic value of CTV and time of flight (TOF) MRV in the diagnosis of neonatal CSVT. In contrast to most studies on pediatric CSVT, which include children of all ages, our study is dedicated to imaging of CSVT exclusively in neonates.

Materials and Methods
We undertook a retrospective review of the medical records and brain MRI/MRV, CT/CTV studies of the neonates (0–28 days old, term and preterm) with presumed CSVT, presented between January 1994 and December 2011, who underwent both MRV and CTV - in total 63 neonates. We excluded patients who had more than a 24-hour time interval between the two exams. The final study population included 16 neonates (12M: 4F). Computed tomography venography technique: unenhanced and contrast-enhanced scans were performed in 15 patients and direct contrast-enhanced scan in one patient. Magnetic resonance venography technique: DWI, Ax. and Sag. T1, Ax. and Cor. FSE T2 and cor. Two-dimensional time-of-flight MRV + 3D MIPs were performed in all patients, additional GE images and susceptibility-weighted imaging (SWI) were performed in nine patients. Independent review was performed by two certified pediatric neuroradiologists, blinded to clinical data. We used Kappa Statistics to measure agreement between rater and modality.

Results
Clinical findings: The majority of our patients (62.5%) had early presentation of the disease during the first postnatal week. Seizures, either isolated or in combination with other symptoms, were the most common clinical presentation, found in 75% of our patients. Two patients (12.5%) died from the disease. Imaging findings: The majority of patients (75%) had involvement of
multiple venous structures. Superficial venous structures were involved more often than deep venous structures. Intracranial bleeding was found in 12 (75%) patients. Statistical results: Overall, there was a substantial agreement between CTV and MRV (kappa=0.5639 for rater 1 and kappa=0.6988 for rater 2) as well as between raters (kappa=0.6092 and 0.6435 for CTV and MRV, respectively).

Conclusions
CT venography is as accurate as MR venography in the diagnosis of neonatal CSVT. Clinicians should be informed that both studies have a similar ability to depict CSVT in neonates and that other parameters, such as the clinical status of the neonate, the risk of radiation and iodinated contrast material and the availability of MRI, should be considered in making a choice between these two modalities.

KEYWORDS: Neonatal, Neonatal MR Imaging, Venous Sinus Thrombosis

O-585

Radiologic-Based Algorithmic Approach to Surveillance Cranial MRI and MRA in Sickle Cell Anemia

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Purpose
Purpose: Currently, evidence-based appropriateness criteria for magnetic resonance imaging (MRI)/magnetic resonance angiography (MRA) surveillance are needed to guide clinicians when monitoring sickle cell anemia (SCA) patients with high risk of stroke. The purpose of this study is to evaluate the interrelationship of subtypes of infarction and vessel stenosis, using a numerical scoring system that recapitulates the presence of stenosis within the circle of Willis vessels, infarction within their known vascular territories, and radiologic progression on follow-up imaging. This scoring system allows statistical evaluation of progression in vessel stenosis and/or infarction and thereby attempts to aid in identifying patients benefitting most from surveillance MRI/MRA.

Materials and Methods
IRB approval was obtained. A retrospective review of MRI/MRA reports in patients with SCA(SS/S beta0) linked to a database containing patients undergoing chronic transfusion therapy was performed noting the presence of chronic white matter disease (CWMD), basal ganglia and large territory infarcts, vessel stenosis and progression between exams. Exclusion criteria included blood disorders other than SCA and patients older than 21 years. For each study performed, a value of 1 was given to each of the three aforementioned infarct subtypes if present (0 if absent). Each major vascular territory to include the ACA, MCA, ICA, PCA/PCOM and vertebrobasilar system was scored similarly with an additional point added for each vessel territory found to be bilaterally affected. Additional points (1 for each) were added for advancement of area of infarction and for worsening of stenosis, thereby yielding a total potential score of 13 for each MRI/MRA. A total score per exam and average score per patient was calculated. Data were analyzed for both descriptive and inference-based statistics.
Results
Five hundred ninety-five MRI/MRA reports in 140 patients were reviewed. Forty patients had progression of stenosis, and 19 patients had progression of infarcts. The presence of CWMD and basal ganglia infarction was positively related to the presence of ACA stenosis (p-value=0.007 and 0.002, respectively) and MCA stenosis (p-value=0.003 and 0.002, respectively) but not with posterior circulation stenosis. Large territory infarcts were positively related to the presence of ACA (p-value<0.001), MCA (p-value<0.001), and PCA/PCOM (p-value=0.008) stenosis. The mean point total in the group was 2.56 (SD 2.6, range 0-10.1). In patients with a total score in the first quartile (e.g., highest), 14 patients had progression of stenosis (44% of total cases of progression) and 11 had progression of infarcts (58% of total cases of progression). Conversely, in patients with total score in the 4th quartile, eight patients had progression of stenosis (16% of total cases of progression) and 0 had progression of infarcts (0% of total cases of progression).

Conclusions
The radiologic point system proposed herein is able to broadly identify a significant population at high and low risk for temporal progression of infarction and/or arterial stenosis and therefore may be a complement to a honed algorithm to identify SCA patients ideal for long-term MRI/MRA surveillance. Further analysis via a prospective trial is needed especially to arrive at the specific clinical and radiologic factors that ought to prompt MRI/MRA screening.

KEYWORDS: Infarct, Sickle Cell Disease, Stenosis

O-586

High-Angular Resolution Diffusion Tractography of Emerging Cerebellar Pathways from Newborns to Young Adults

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Purpose
To describe the evolution of the cerebellar pathways of the superior (SCP), middle (MCP), inferior peduncles (ICP) and the deep nuclei (DN) in developing human subjects ranging from newborn to adult, using high angular resolution diffusion imaging (HARDI) tractography (1-3).

Materials and Methods
For 90 apparently healthy individuals, aged 30GW to 28Y, we performed T1-weighted MPRAGE imaging, T2-weighted turbo spin-echo imaging, and an isotropic diffusion-weighted spin-echo echo-planar imaging. Thirty diffusion-weighted measurements (b = 1,000 sec/mm2) and five nondiffusion-weighted measurements (b= 0 sec/mm2) were acquired on a 3 T Siemens MR system with TR= 10 sec; TE= 88 msec; small delta= 12.0 ms; large delta= 24.2 ms; field of view= 22 x 22 cm; slice thickness= 2.0 mm; matrix size= 128 x 128, iPAT= 2. DiffusionToolkit and TrackVis (trackvis.org) were used to reconstruct and visualize tractography pathways. A streamline algorithm with a 45° angle threshold was applied for the fiber reconstruction using all HARDI-detected local maxima. A coordinate-based tractography atlas was used to guide region of interest (ROI) placement in order to delineate the pathways of interest (4). Fractional
anisotropy (FA), apparent diffusion coefficient (ADC), number, length, and volume of tracts per pathway were quantified in each subject.

**Results**

An example of cerebellar tracks for a 6Y subject is provided in Figure 1. 1. Starting from the earliest ages, the MCP could be divided into two distinct subgroups: a rostral pons to caudal cerebellum group (MCP-1) and a caudal pons to rostral cerebellum group (MCP-2). These two pathways were distinctly identifiable starting from the earliest ages, and the volume of MCP-1 was consistently greater than the volume of MCP-2 (2-way ANOVA, p < 0.05). 2. Number and volume of all studied pathways increased progressively with age with an initial plateau varying across pathways (DN at 2Y, MCP-2 at 3Y, MCP-1 at 5Y, ICP at 6Y, SCP at 8Y,) (chi-square test, p < 0.05). 3. Mean apparent diffusion coefficient (ADC) for all studied pathways decreased in the first five years post-term then plateaued, while mean FA increased until adult ages (chi-square test, p < 0.05).

**Conclusions**

This work may add to our understanding of cerebellar track development and represent an initial step towards the creation of an atlas for the developing cerebellar tracts as viewed by diffusion tractography. Such an atlas would serve as a reference when looking for abnormalities of cerebellar connectivity in many cognitive disorders.

KEYWORDS: Cerebellar, DTI Tractography, Pediatric Brain

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**O-587**

3:56PM - 4:03PM

Does Apparent Diffusion Coefficient Scalars Correlate with Near Infrared Spectroscopy as Marker of Brain Autoregulation in Neonates Who Were Treated with Brain Cooling for Perinatal Hypoxic Ischemic Injury?

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Purpose

Despite therapeutic hypothermia (TH), incidence of neurologic morbidity remains high in
neonates with perinatal hypoxic-ischemic injury (HII). Diffusion tensor imaging (DTI) gives qualitative and quantitative information about the brain micro-architecture while near infrared spectroscopy (NIRS) measures the brain autoregulation at bedside. We hypothesized that lower apparent diffusion coefficient (ADC) values correlate with worse autoregulation.

Materials and Methods
Thirty neonates with perinatal HII were included in this institutional review board approved study. MR imaging (MRI) was done at day of life (DOL) 4-14 after completion of TH. Apparent diffusion coefficient scalars were measured in the anterior and posterior centrum semiovale (ACS and PCS), basal ganglia, thalamus, posterior limb of the internal capsula (PLIC), pons and cerebellar white matter. NIRS autoregulation data were collected during TH, rewarming, and normothermia. The optimal mean arterial blood pressure (MAP) with most robust autoregulation was identified. To account for pseudonormalization of ADC values, data were dichotomized into neonates who received MRI before and after day of life 10. Autoregulation and ADC scalars were analyzed with Spearman correlations.

Results
Low ADC scalars of the PCS and PLIC correlated with worse autoregulation during hypothermia ($r = \neg-0.83; p = 0.006$ and $r = \neg-0.68; p = 0.04$), and in basal ganglia during rewarming ($r = \neg-0.71; p = 0.05$) in neonates that had MRI at DOL $\geq10$. No statistically significant correlation between ADC scalars and autoregulation were identified in neonates who had MRI done DOL $<10$.

Conclusions
Low ADC scalars correlated with worse autoregulation in PCS and PLIC during TH, and in basal ganglia during rewarming in neonates who had MRI at DOL $\geq10$. Optimizing blood pressure during TH and rewarming may decrease the risk of brain injury. Performing MRI until DOL 10 could be considered.

KEYWORDS: Autoregulation, Diffusion Tensor Image, Hypothermia

O-588

4:03PM - 4:10PM

Readout-Segmented EPI for Diffusion-Tensor Imaging in the Evaluation of Tumors Involving the Pediatric Spine.

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Purpose
Diffusion-weighted imaging (DWI) is a helpful MR tool in central nervous system (CNS) tumor imaging. A new technique, readout-segmented (RS) echo planar imaging (EPI), also known as RESOLVE (Readout-segmentation of long echo trains), can produce high quality diffusion tensor images of the spine that have not been attainable with other types of DWI. In this study, we used (RS) EPI as a DWI technique in magnetic resonance imaging (MRI) of the spine in children with tumors in an effort to identify specific applications in which it would be useful.

Materials and Methods
IRB approval was obtained. Readout-segmented EPI was performed on a 1.5 T Avanto and a 3 T Trio scanner with five segments, a parallel imaging factor of two, a b factor of 500 s/mm² and an
in-plane resolution of 1.25 mm². A sagittal slice orientation was chosen in nearly every case, as it allowed an entire section of the spine to be assessed with a single acquisition. This sequence was added to standard protocols for imaging children being evaluated for tumors of the spine. A total of 223 spine DWI studies of 104 children were performed. Diffusion imaging was added to standard imaging protocols for either drop metastases or primary tumors involving the spine. Of the 104 subjects, 41 had medulloblastoma. Other tumors included ependymoma (n=12), germ cell tumor (GCT) (n=9), glioblastoma multiforme (n=6), primitive neuroectodermal tumor (n=5), disseminated neuroepithelial tumor (n=5), juvenile pilocytic tumor (JPA) (n=5), neuroblastoma (n=4), atypical teratoid rhabdoid tumor (ATRT) (n=4), glioma (n=2), choroid plexus carcinoma (n=2), ganglioglioma (n=2), rhabdomyosarcoma (n=2), epidermoid (n=2), anaplastic astrocytoma (n=1), acute lymphoblastic leukemia (n=1), and Ewing’s sarcoma (n=1).

Results

Of the 94 subjects evaluated for drop metastases, 32 were positive for cerebospinal fluid (CSF) metastases to the spine. Diffusion-weighted imaging correctly identified drop metastases from primary brain tumors that restricted diffusion in every case where metastases were seen on conventional sequences. In at least five cases where metastases were not visible on conventional images, drop metastases were clearly identified with DWI (ATRT, GCT, and medulloblastoma). Drop metastases measuring only a few millimeters were discernable. In 23 scans for medulloblastoma, diffusion imaging was very helpful in excluding questionable metastatic disease, especially in the distal thecal sac. In paravertebral and bony lesions such as neuroblastoma, rhabdomyosarcoma, and Ewing’s sarcoma (small round blue cell tumors), DWI allowed good definition of the tumor margins and aided in detection of marrow abnormalities. In all evaluations of primary spinal tumors, DWI was helpful to narrow the differential diagnosis. Diffusion-weighted imaging was not found to be helpful in detecting drop metastases from primary CNS tumors that do not restrict diffusion (neuroepithelial tumors, JPA, gliomas) In one case, hemorrhage was misinterpreted as a drop metastasis on DWI.

Conclusions

Diffusion-weighted imaging of the spine using (RS) EPI was not found to be very helpful in evaluating tumors that did not restrict diffusion. However, it was found to have exquisite sensitivity for identifying drop metastases from CNS tumors that restrict diffusion, especially those that demonstrate no or minimal enhancement with contrast (as in some medulloblastomas, ATRTs, and germ cell tumors). Metastases from these types of tumors were much more conspicuous with DWI than T1- or T2-weighted sequences. Furthermore, DWI was helpful when there were questionable findings on conventional images, allowing a more confident diagnosis of metastases when restricted diffusion was present. Diffusion-weighted imaging was useful to exclude metastases, especially when there was vague enhancement in the distal thecal sac, contrast leakage into the CSF, and arachnoiditis. As in the brain, DWI was helpful in grading spinal cord tumors. Paraspinal and vertebral small round blue cell tumors were well delineated. The results of our study support (RS) EPI to be a promising DWI technique for imaging the pediatric spine in the evaluation for tumor.

KEYWORDS: Diffusion Tensor Image, Pediatric Spine, Spinal Neoplasm
Hippocampal biometry in the normal and abnormal fetal brain

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Purpose
By 15 gestational weeks (GW) the hippocampus appears as vertically oriented "S" shaped structure. During the second trimester it gradually looses this orientation and is finally positioned horizontally in the depth of the temporal horn. As this process is arrested in cases of various developmental brain pathologies, we aimed to systematically quantify differences in hippocampal positioning between normal fetuses and cases with lissencephaly using fetal magnetic resonance imaging (MRI).

Materials and Methods
Standardized coronal T2-weighted fetal MR (1.5 T) sequences of 19 cases with the neuropathological/imaging diagnosis of lissencephaly were compared to 36 normal fetuses (age range 20-39 GW. The boundaries of the hippocampi were segmented using ITK Snap in order to define four lines, using four characteristic hippocampal landmarks and 3D Slicer. The angles (I-IV) between these lines were correlated between both sides (paired t-test), normal and abnormal fetuses. A midline served as a reference line to assess the positioning of the hippocampus as a whole.

Results
Normal age-related reduction of hippocampal angles ($r^2$: 0.387; Sig.: 0.000) and positioning ($r^2$: 0.278; Sig.: 0.001; regression analysis linear) could not be observed in fetuses with lissencephaly ($r^2$: 0.010; Sig.: 0.674 and $r^2$: 0.045; Sig.: 0.369). Significant left right differences occurred in healthy patients in angle 2 (p-value 0.009; T-test for dependent samples), whereas side differences were found in angle 1, 2, and tilting angle (p-value 0.031; 0.021; 0.045; T-Test for dependent samples) in lissencephaly patients. In lissencephaly the angles were significantly wider than in normal age-matched controlled (p-value 0.000; Welch's Test). Already two angles discriminated healthy from lissencephaly fetuses with a sensitivity of 80% and a specificity of 94.4%.

Conclusions
Normal and abnormal developmental positioning of the hippocampal formation can be quantified by biometry of various angles, geometrically describing its vertical axis. These can be used to support the neuroradiologic detection of major developmental brain pathologies.
Quantitative Evaluation of Thickened Lumbar Spinal Nerves in Krabbe Disease: Preliminary Findings and Clinical Implications

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Purpose
Krabbe disease is an autosomal recessive lysosomal storage disease known for its rapidly progressive and fatal clinical course. Early diagnosis is crucial as advanced therapeutic interventions such as umbilical cord blood transplantation have shown promising results. Of note, the screening criteria for Krabbe disease utilizes the modified Loes scoring system which encompasses the central but not the peripheral nervous system changes, despite the accepted knowledge that myelin loss occurs in both the central and peripheral nervous systems. We show for the first time quantitative evaluation of thickened lumbar spinal nerve roots in Krabbe patients which has potential implications in improving the current screening system and therapeutic guidance.

Materials and Methods
Lumbar spine MR images (MRIs) obtained between March 2013 and September 2013 of 16 symptomatic infants (ages ranging from 3 to 24 months) with Krabbe disease were evaluated retrospectively. Retrospective review was performed after approval by the Institutional Review Board at the University of Pittsburgh Medical Center. Of these, 15 cases were analyzed with the exclusion of one case due to severe scoliosis noted on imaging. As controls, 10 normal spine MRIs of infants of similar ages and with initial MRI indications for evaluation of tethered cord were evaluated retrospectively. Quantitative evaluation of the terminal nerve roots was performed on the axial plane obtained approximately 5 mm below the conus medullaris. The spinal canal was divided into anterior and posterior quadrants, after which the anterior quadrant was further divided into right and left quadrants. Given the technical challenge of measuring the area of smaller posterior quadrant nerve roots on an axial plane, only the anterior quadrant nerve roots were evaluated. Areas of the largest nerve root in anterior right and left quadrants were acquired, in addition to the area of the anterior thecal sac.

Results
The average values for the area (cm²) of anterior right and left nerves in Krabbe patients were 0.014 and 0.017 (average 0.016) while that of controls were 0.006 and 0.007 (average 0.007). The average area of the anterior thecal sac in Krabbe cases was 1.09 while that of controls was 0.94. Our results demonstrate that terminal nerve roots of Krabbe infants are more than twice as thick as that of controls on average. The area of the anterior thecal sac also was slightly larger in Krabbe infants than in controls.

Conclusions
We present for the first time thickened terminal spinal nerves in 15 infants with Krabbe disease as confirmed by quantitative evaluation on spine MRI. Interestingly, the average anterior thecal
sac area was slightly larger in Krabbe patients than in controls. Of note, preliminary evidence using the Twitcher mice model of Krabbe disease showed widening of the spaces between axons in the dorsal and ventrolateral spinal cord white matter due to perineural edema (Hofling, Kim et al., 2009). Whether this explains the peripheral nerve thickening in Krabbe patients is yet unknown, but we can begin to study the mechanism in vivo with advanced imaging techniques such as diffusion tensor imaging (Morisaki, Kawai et al., 2011; Cauley and Filippi, 2013). Further studies with a larger cohort while evaluating for the effects of disease course and therapeutic intervention on the peripheral nerve manifestations undoubtedly will improve the current screening system for Krabbe disease which fails to account for the imaging findings of peripheral nerve abnormalities.

KEYWORDS: Congenital Anomalies, Pediatric Spine, Spinal Imaging
Representative Krabbe Patient’s Axial Slice 5 mm Below the Conus

Representative Control Patient’s Axial Slice 5 mm Below the Conus

(Filename: TCT_O-590_KrabbevsControlFigure.jpg)

O-591

Birth Injuries of the Brachial Plexus: MR Neurography and Tractography with Clinical Correlation

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Purpose
To assess the utility of MR neurography and tractography in birth injuries of the brachial plexus. We will present our 13-year institutional experience with pediatric cervical MR neurography/tractography and correlate with patient age at presentation, clinical history, neurologic examination, electromyography (EMG)/nerve conduction studies (NCS), intraoperative findings, and clinical outcomes.

Materials and Methods
We queried the radiology information system for cervical MR neurograms performed between January 2000 and December 2013. Inclusion criteria were pediatric patients (< 18 years) referred for birth-related injury and/or upper extremity paralysis. Exclusion criteria were history of nonbirth-related trauma, suspected infection, brachial neuritis, malignancy, and prior surgery. A neuroradiology attending and neuroradiology fellow concurrently reviewed images for presence and location of brachial plexus enlargement, signal changes, enhancement, pseudomeningocele, and neuroma formation. In cases with diffusion-weighted imaging (DWI)/diffusion tensor imaging (DTI), apparent diffusion coefficient (ADC) values were measured at sites of nerve injury, and tractography was performed to assess nerve fiber integrity. Imaging findings were correlated with data from the medical record including presenting history, neurologic examination, EMG/NCS, intraoperative findings, and degree of functional recovery.

Results
Our study included 26 pediatric patients (ages: 6 weeks - 10 years, median: 6 months). Gender was 54% (14/26) male and 46% (12/26) female. Affected side was right in 54% (14/26) and left in 46% (12/26). Neurologic examination suggested Erb palsy in 73% (19/26) of cases and total brachial plexus injury in 27% (7/26). Electromyography/NCS was performed in 15 patients, showing high correlation with MR findings in 53% (7/15) and moderate correlation in 47% (8/15). MR neurography demonstrated nerve enlargement in 81% (21/26), T2-hyperintense signal in 85% (22/26), and pseudomeningocele formation in 50% (13/26). Gadolinium contrast was administered in 18 patients, of which 89% (16/18) showed abnormal nerve enhancement in the region of injury. Diffusion-weighted imaging/DTI was performed in 18 patients, demonstrating complete nerve fiber transection in 56% (10/18). In the region of injury, apparent diffusion coefficient (ADC) was less than 1.0 in 50% (9/18), between 1.0-1.2 in 22% (4/18), and greater than 1.2 in 28% (5/18). Treatment involved physical therapy in 62% (16/26), neuromuscular stimulation in 4% (1/26), and peripheral nerve surgery in 23% (6/26) of patients. Follow-up data were available in 23 patients, with mean time interval of 1.1 years (range 2 months - 5 years). Clinical recovery was near-complete in 57% (13/23), partial in 35% (8/23), and minimal in 9% (2/23).

Conclusions
Pediatric brachial plexus injury is an important cause of upper extremity paralysis following difficult delivery. Although the majority of patients recover spontaneously, complex cases may necessitate surgical intervention. MR neurography and tractography are useful in assessing the extent and severity of injury, and correlate well with neurologic examination and EMG/NCS. At imaging, nerve enlargement, edema, and enhancement serve as general markers of injury. When there is concern for nerve transection, DTI fiber tracking, ADC measurements, and morphologic evaluation for pseudomeningocele/neuroma are promising metrics for prediction of patient prognosis and therapy.

KEYWORDS: Brachial Plexopathy, MR Neurography, Pediatric Spine
High Resolution CT of Ossicular Abnormalities in Children with Limited Stenosis of the External Canal Associated with a Normal or Minimally Malformed External Ear.

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Purpose
To describe clinical presentation, audiometric and high resolution CT findings in patients with limited congenital external auditory canal (EAC) stenosis associated with normal or minimally abnormal pinna.

Materials and Methods
This was a retrospective case series at a tertiary referral center. A PACS search was performed with Boolean function combining "external canal", "external auditory canal" and "stenosis" or "stenotic". Inclusion criteria were patients with congenital EAC stenosis of less than 50% diameter on CT and a normal pinna or grade I microtia. Exclusion criteria included syndromic ear malformations, EAC greater than 50% stenosis, and grades II or III microtia. Clinical presentation, audiometry and CT studies were reviewed. Intra-operative findings and success of reconstruction were reviewed when available. Clinical data and surgical results were reviewed by an experienced (8 years) fellowship trained neuro-otologist. Imaging studies were reviewed by an experienced (16 years) pediatric neuroradiologist and a neuroradiology fellow. The images were evaluated for normal or abnormal shape and size of the ossicles, presence of fixation as well as widening or narrowing of their associated joints. The distance of the inferior handle of the malleus to the cochlear promontory was measured on both abnormal and the contralateral normal ear. The oval/round windows were classified as normal, stenotic, or atretic. The facial nerve was evaluated for normal position with the posterior genu at or posterior to the round window. The inner ear also was evaluated for anomalies of the osseous labyrinth and a normal or stenotic cochlear nerve canal.

Results
Nine patients were found with 20 excluded (12 moderate to severe stenosis, 7 grade II/III microtia, 1 syndromic). M:F ratio = 5:4 and mean age was seven years (range 3 – 12 years). All patients presented with unilateral conductive hearing loss (CHL) with seven patients having isolated CHL as the given history. On physical examination, five of the patients had normal pinna and clinically normal EACs. Four patients had grade I microtia. The mean pure tone average was 49.4 dB (SD 14.2, range 28-68), and the mean air-bone gap was 49.4 dB (SD 12.9, range 25-65). Computed tomography (CT) showed the mean EAC axial diameter to be 5.1 mm on the affected side and 7.7 mm on the normal hearing ear. Computed tomography demonstrated ossicular abnormalities in all patients. Abnormal orientation of the handle of the malleus with abnormal increased distance to the cochlear promontory was present in all ears. Average distance of the cochlear promontory to inferior aspect of the malleus handle was significantly increased 3.9mm versus 1.6 mm (p<.0001). Fixation of the handle of the malleus to the anterior tympanic annulus was seen in 8/9 ears. Posterior fixation of the long process of the incus was present in 2/9 ears. Other ossicular abnormalities include decreased size of malleus head (7/9), narrowed
incudomalleal joint (7/9), widening of the incudostapedial joint (5/9), and abnormal appearance of the stapes (1/9). The facial nerve was essentially normal in position in all ears with only mild anterior displacement of the vertical segment of the facial nerve seen in two ears. The oval and round windows were normal in all ears. No inner ear anomalies were found. Surgical correlation was present in 3 patients with agreement in most findings on CT. Tympanoplasty was performed in all with ossiculoplasty performed in two ears. Ossicular chain reconstruction in 1 ear. Significant improvement in hearing was noted in 2 patients on postoperative audiogram and 1 patient was lost to follow up.

Conclusions
Anomalies of the pinna commonly are absent or subtle in children with limited congenital EAC stenosis. These children typically present with unilateral conductive hearing loss and characteristic ossicular malformations. The EAC should be evaluated carefully in all children presenting with unilateral CHL, even in the absence of anomalies of the pinna. Surgical outcome is good in this cohort of patients.

KEYWORDS: Conductive Hearing Loss, Congenital Anomalies, Temporal Bone
Axial CT image at the level of the long process of the incus. Abnormal posterior fixation of the long process on the left side. Normal ossicles are present on the left side.

Wednesday
3:00PM - 4:30PM
Palais des congres de Montreal, 524

70 - PARALLEL PAPERS: Radiology Practice: Quality, Safety and Economics
O-593
3:00PM - 3:07PM

Radiation protection of different lens protection systems in cranial CT-scans

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Purpose
The purpose of this phantom study was to evaluate the potential dose-attenuation of different eye lens protectors for patients undergoing various cranial computed tomography (CT) scans at different scanners.

Materials and Methods
Radiation exposure of the eye lens of seven common CT algorithms at two different CT scanners [(SOMATOM® Definition AS (CT 1) and SOMATOM® Definition Flash (CT 2)] was measured (α-Al2O3:C thermoluminescence dosimeters TLD-500) using two different lens protectors (Somatex (SOM) and Medical Imaging Systems (MIS)).

Results
Dose attenuation accomplished by the different lens protectors is summarized as follows: for CT 1 (a) unenhanced CT (nCT) with gantry angulation: SOM (0%), MIS (0%); (b) CT angiography (CTA): SOM (37%), MIS (9%); (c) CT perfusion (CTP): SOM (61%), MIS (64%); for CT 2 (d) nCT without gantry angulation: SOM (19%), MIS (9%); (e) CTA Safire®: SOM (61%), MIS (26%); (f) dual energy CTA without Safire®: SOM (31%), MIS (7%); (g) CTP: SOM (56%), MIS (31%). Depending on the CT protocol but independent from the scanner used, lens protector SOM attenuated the dose up to 1.9 times more effectively compared to MIS. Physical analysis revealed that the two lens protectors differ with respect to their density and thickness.

Conclusions
The efficacy of the two evaluated lens protectors differs widely due to various material properties but also is highly dependent from the applied CT protocol. Lens protectors are most effective in CTA protocols when reducing direct dose exposure. Considering both CT protocol and material of the lens protectors is mandatory to reduce radiation exposure of the eye lens of patients undergoing CT scans.

KEYWORDS: Dose Reduction

O-594

High Negative Predictive Value of a Negative Spot Sign Can Potentially Reduce Subsequent Imaging in Acute Intracranial Hemorrhage.

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Purpose
A positive spot sign, the presence of active extravasation at computed tomography angiography (CTA), has been shown to be associated with an increased risk of significant hematoma expansion in nontraumatic intracerebral hemorrhage. The purpose of the current study is to determine the negative predictive value of a negative spot sign for significant hematoma expansion in acute nontraumatic intracranial hemorrhage, evaluate the clinical course of patients with a negative spot sign who subsequently developed significant expansion of the intracranial hematoma and to determine whether routine follow-up head CTs after intracranial hemorrhage can be reduced in patients with a negative spot sign in the absence of clinical deterioration.
Materials and Methods
An IRB approved retrospective review of patients who presented to the Massachusetts General Hospital Emergency Department with acute nontraumatic intracranial hemorrhage and a negative spot sign on a CT angiogram within 24 hours of presentation was performed, with a focus on patients with a negative spot sign who subsequently developed significant hematoma expansion (defined as an increase in the volume of greater than 33%), excluding those with intraventricular hemorrhage. The results were tabulated and the negative predictive value of a negative spot sign for significant hematoma expansion was calculated from the database. A chart review focusing on the clinical course of those patients with a negative spot sign who subsequently developed significant hematoma expansion was performed. Medical records were reviewed for International Normalized Ratio (INR), history of hypertension and antiplatelet therapy at the time of presentation. The administration of fresh-frozen plasma, vitamin K, and platelet transfusions on admission was recorded, as well as any changes in the clinical status of the patient leading up to the hematoma expansion. Additionally the average number of follow-up head CTs in patients with a negative spot sign was calculated.

Results
Of the 159 patients with a negative spot sign on CTA, four patients subsequently developed significant hematoma expansion. The negative predictive value of a negative spot sign on CTA for subsequent hematoma expansion was calculated at 97%. Three of the four patients were on anticoagulation therapy on presentation or shortly before presentation. The fourth patient had hepatocellular carcinoma with an elevated PT. On average patients with negative spot sign on initial CTA had three head CTs during the course of their hospitalization.

Conclusions
The high negative predictive value of a negative spot sign for expansion of an intracerebral hematoma in the absence of anticoagulation on admission could allow for a reduction in routine follow-up head CTs in the absence of clinical deterioration. Reducing the number of head CTs would not only reduce the unnecessary patient exposure to radiation but also would be cost effective as the average Medicare reimbursement for a noncontrast head CT is approximately $191.89, and on average this group of patients had three follow-up head CTs over the course of their hospitalization.

KEYWORDS: Hemorrhage

O-595

Assessment of Adverse Reaction Rates to Gadobenate Dimeglumine: Review of over 140,000 Administrations over The Last 7.5 Years

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Purpose
To determine the incidence of adverse events with gadobenate dimeglumine at a major hospital system, consisting of both academic and community-based centers, over the last 7.5 years.

Materials and Methods
As part of regular and continuous prospective approved quality assurance project, MR
technologists contemporaneously recorded all gadolinium-based contrast administrations and any associated adverse reactions to those administrations, including the type of reaction and treatment rendered, since July, 2007. Weekly data review was performed by the institutional director of MR services, and were evaluated both by site as well as in comparison to results obtained from other participating hospitals and sites with our institution's health system. Comparison between reaction rates at different sites was performed using a Chi Squared test.

Results
Over 7.5 years, 142,929 doses of gadobenate dimeglumine were administered. Two hundred forty-seven reactions were recorded (0.17% of contrast-enhanced examinations), of these, 135 cases (54.7% of all adverse reactions) required treatment and 14 (5.6% of reactions) qualified as serious. Reaction rates were significantly different between the academic and community hospital (0.2% versus 0.1% respectively, p<0.001). Further, reaction rates were higher in the initial years of the study and tapered to a lower baseline rate which has been maintained over the last three plus years of the study. These findings are consistent with the reported Weber and Lalli effects noted in the literature on other agents as well.

Conclusions
Adverse reaction rates to gadobenate dimeglumine recorded over 7.5 years were comparable to those reported and published for other gadolinium-based contrast agents examined over smaller time ranges and populations. The findings again reinforce the relatively robust safety profile of this agent. The Weber and Lalli effects seemed to have been observed within our population as a whole as well as within individual participating hospitals/sites, reinforcing the observations of Davenport (1) and others. Considering the low incidence of all adverse events observed, a statistically but likely not clinically significant difference was observed between academic and community hospitals.

KEYWORDS: Contrast Agents, MR Contrast Agents

O-596

Analysis of Medicare Referral Network Size for Neuroradiologists.

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Purpose
Recent trends in healthcare, such as reductions in reimbursements, consolidation and increased self-referral behavior, are impacting the business of radiology. Given radiologists' unique dependence on referrals, it is critical they understand referral networks so they can begin to actively manage them. An important part of understanding referral networks is to recognize there may be differences among medical specialties. We define network size as the number of unique referrers. We hypothesize that neuroradiologists may have smaller referral networks than other radiologists.

Materials and Methods
In this IRB exempt retrospective study, we analyzed the publicly available Docgraph data set.
The Docgraph data set is one of the largest known directed social graph networks, based on 2011 Medicare claims data, containing over one million entities or nodes which provide Medicare services. The graph is a 1.3 gigabyte text file with each line of the file representing a relationship (vertex) between two providers (nodes) and a weighting number representing the number of patients that were billed for in a rolling thirty-day window by both providers. National provider identifier (NPI) numbers identify the provider nodes. The National Plan & Provider Enumeration System (NPPES) file contains additional details of all providers including geographic location and specialty taxonomy codes. Utilizing all available taxonomy codes for radiology, 37,993 relevant NPI numbers were identified. Radiology facilities and institutions were excluded and filtered from this search. The name, city and location from the NPPES were then cross-referenced against the American Board of Radiology (theabr.org) public search tool utilizing city and state location information in the NPPES data file. Data then were imported into Excel (2010) NodeXL software (version 1.0.1.245) for analysis. Results then were plotted utilizing R (version 3.0.2).

Results
There were 26,649 radiologists that were not matched and 11,275 that were matched. Of the 11,275 matches, 1,393 were identified as CAQ certified neuroradiologists. One thousand two hundred and seventy-four of those neuroradiologists also were identified in the Docgraph file. In all, 8,990 ABR verified radiologists were identified in the Docgraph file. One thousand two hundred and seventy-four NPI neuroradiology nodes were identified within 674,964 vectors/referrals within the dataset representing 13.9% out of the 4,823,135 vectors in which a radiologist was identified. Neuroradiologist in-degrees or inbound referrals average 275 with a standard deviation (SD) of 197. Out-degrees or outbound referrals average 258 with a SD of 194. Among all radiologists, the average in-degrees are 281 SD 216 and out-degrees are 269 SD 211, and when excluding neuroradiologists in-degrees 282 SD 219 and out-degrees 270 SD 214. The most common in-degree referrer physician taxonomy code for all radiologists was internal medicine (62,447). A geographic plot of this data shows the geographic distribution of neuroradiologists correlates strongly with major U.S. population centers.

Conclusions
Neuroradiologists have a slightly smaller referral network based on the in-degree averages and standard deviations as compared to all radiologists. Interestingly, the 1,274 neuroradiologists identified represented approximately 12.3% of the total radiologists verified and a proportional 13.9% of all the radiologist connections or vectors identified, suggesting a linear relationship. This also may indicate that many subspecialty neuroradiologists practice general radiology. Not surprisingly, the docgraph data show that radiologists and neuroradiologists have very large referral networks. In a separate analysis, the only groups of providers in the graph with a larger number of referrers are medical institutions. High quality referrers are preferable to a high quantity since care must be taken to manage the relationships with other physicians. Failure to do so may contribute additionally to the commoditization of radiology services caused by the national trend of increased study volumes.

KEYWORDS: Medicare
Utility of Head and Neck MRA in Addition to Brain MRI in the Emergency Department Evaluation of Suspected Stroke

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Purpose
Concerns over healthcare spending and in particular, imaging costs, have become more acute. As radiologists, we are well positioned to identify areas of overutilization in imaging. We
hypothesize that routine addition of magnetic resonance angiography (MRA) of the head and neck to magnetic resonance imaging (MRI) of the brain in the Emergency Department (ED) evaluation of "acute stroke" is an area in which overutilization may occur. Our goal is to examine the frequency with which the two additional MRA examinations add important information in the ED setting when no infarct is present on MRI of the brain, and to determine whether significant cost savings could be achieved by omitting the MRA examinations when diffusion-weighted imaging (DWI) of the brain is negative for acute infarct.

Materials and Methods
A series of over 500 consecutive patients in whom MRI of the brain and MRA of the head and neck were performed from the ED were included in the study. Patient demographic information, presenting symptoms, known stroke risk factors, and findings on initial computed tomography (CT) of the head were recorded. The presence or absence of acute infarct on MRI, as well as significant findings on the MRA examinations, reported by the interpreting neuroradiologists, also was recorded. We then compared the frequency with which significant MRA findings were identified in patients with and without acute infarct on DWI. Within the subcategory of patients without acute infarct on MRI, we sought to discover whether any demographic factors, stroke risk factors, presenting symptoms, or initial head CT factors predicted a higher likelihood of significant findings on MRA.

Results
Preliminary review of the data showed that approximately 35% of the MRIs of the brain were positive for acute infarct. In the 65% of patients without acute infarct, 2% of the MRAs demonstrated a moderate or severe cervical internal carotid stenosis. An additional 7% of these patients had occluded cervical or intracranial internal carotid or vertebral arteries. A larger number of patients in this group without acute infarct on MRI had cervical or intracranial stenoses not specified in severity, in many cases related to technical limitations of the exam.

Conclusions
Up to 9% of patients without acute infarct on MRI were found to have a moderate or severe internal carotid stenosis on MRA, or an occluded cervical or intracranial artery. While this information is clinically relevant to subsequent management of patients with suspected cerebral ischemia, the benefit, relative to cost of obtaining head and neck MRAs can be questioned in the absence of acute ischemia. Additional review of the data might identify a constellation of presenting symptoms, risk factors, or demographic information which serve as positive predictors of a higher likelihood of significant findings on MRA. These criteria, once identified, would allow for more careful patient selection for MRAs in the absence of acute infarct on MRI.

KEYWORDS: Cost-Effective, Stroke, Utilization Management

O-598

Differences in Neuroradiology Training Programs Around the World.

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Purpose
The USA considers itself a leader in medical education and training amongst nations. Along with most subspecialties, radiology residency and fellowship programs are known for being well structured, highly competitive and outstanding in teaching. At a national level, radiology residents and fellows in the United States are obliged to take yearly in-training examinations as well as board certification examinations, but it is virtually impossible to realistically compare the quality and the outcome of various international radiology training schemes. In order to better understand foreign program concepts in neuroradiology, we analyzed differences in training program variables between one USA department and a variety of the departments abroad.

Materials and Methods
The parameters of radiology residency and fellowship training at foreign institutions were analyzed. Information about the respective departmental organization (number of trainees and attendings), structural concepts (length of program, case logs), teaching schedules (number of weekly lectures, case reviews, etc.), and national examinations were collected for eight countries and the USA spanning four continents.

Results
While many countries do not provide fellowship training in Neuroradiology (Italy, Greece, Lithuania, Guatemala, Pakistan), others have formal post residency curriculums, including Belgium, Sweden, Germany, Brazil, Saudi Arabia, Thailand, Japan, and South Korea. Additionally there are some countries, such as Portugal, that offer a program following medical school that is focused solely on neuroradiology. Compared to the USA program, all countries have fewer fellows and lectures, but the duration of training is almost equal (1-2 years). Big differences were observed regarding the type and the complexity of national examinations at the end of a residency or fellowship program.

Conclusions
Regarding international neuroradiology training, there is a wide variety in terms of fellowship offering, teaching quantity and assessment of learning progresses. The results of our study suggest that the general diagnostic radiology residency and neuroradiology fellowship program in the USA is more specialized and tends to focus on highly defined goals and learning objectives.

KEYWORDS: Fellowship, Neuroradiology Training

| GENERAL |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Country         | USA             | Belgium         | Sweden          | Germany         | Brazil          | Saudi Arabia    | Thailand        | Japan           | South Korea     |
| Hospital name   | Johns Hopkins University Baltimore | Universit y Hospital KU Leuven | Uppsala Akademi ska Sjukhuset | Charité Berlin | Beneficência Portuguesa de São Paulo | King Faisal Specialist Hospital Riyadh | Siriraj Hospital Bangkok | -                       | Chungnam National University Hospital |
| Years of medical school | 4+4            | 3+3            | 5.5             | 6               | 6               | 6               | 6               | 6               | 6 or 2 – 4 + 4 |
Sequence Reduction for Emergency Lumbar Spine MR Imaging

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Purpose
In emergency room settings with MR imaging (MRI) availability, lumbar spine MRI is a commonly performed diagnostic procedure. The purpose of this study is to determine the
efficacy of a screening lumbar spine MRI protocol (comprised of sagittal T1 and sagittal fat-suppressed T2-weighted sequences) for emergency lumbar spine MRI indications.

Materials and Methods
IRB approval was obtained for this HIPPA compliant retrospective study. Two hundred consecutive emergency room patients who underwent lumbar spine MRI examinations from January 2011 – January 2013 were chosen. Exclusion criteria included: prematurely aborted examinations, total spine survey examinations not dedicated to the lumbar spine, and patients scanned on an alternate MRI machine outside of the emergency department. All relevant clinical data for each patient (age, gender, history, physical exam findings, laboratory findings, and prior imaging) were recorded. Two neuroradiologists evaluated only the sagittal T1 and sagittal fat-suppressed T2-weighted sequences of each study, and documented the imaging findings. Readers could recommend axial imaging and/or postcontrast imaging if warranted. All imaging findings and recommendations of each reader were recorded. The readers' findings were compared with the final reports of each study and any relevant clinical follow up to determine discrepant findings. Major discrepancies were assigned if a missed finding might have changed clinical management. Minor discrepancies were assigned if a missed finding would not have changed clinical management. Clinical metrics were correlated with axial and/or postcontrast imaging recommendations and reader discrepancies utilizing a step-wise multivariate logistic regression.

Results
Of the 200 patients, 107 were female and 93 male, with average age of 60 ± 20 years. Of the 200 lumbar spine MRIs, 117 were performed without contrast and 87 were performed with contrast. The underlying lumbar spine pathologies included: 169 cases with degenerative disease; 22 cases with acute fracture; 19 cases with primary neoplasm or metastases; 10 cases with infection; one case with epidural hemorrhage. Reader 1 recommended no further imaging in 136 cases, axial imaging in 53 cases, and postcontrast imaging in 43 cases. Reader 2 recommended no further imaging in 134 cases, axial imaging in 41 cases, and postcontrast imaging in 46 cases. In 57% of contrast-enhanced MRIs, reader 1 did not recommend contrast. In 54% of contrast-enhanced MRIs, reader 2 did not recommend contrast. Known lumbar spine metastases [(p=0.0007), adjusted OR 11 (95%CI: 2.7 to 42.5)] and prior lumbar spine surgery [(p=0.003), adjusted OR 3 (95%CI: 1.5 to 6.3)] were significant predictors of axial imaging recommendation. History of malignancy [(p=0.0004), adjusted OR 3.9 (95%CI: 1.8 to 8.4)], radicular pain [(p=0.007), adjusted OR 0.35 (95%CI: 0.16 to 0.75)], and prior lumbar spine surgery [(p=0.048), adjusted OR 2.2 (95%CI: 1.005 to 4.9)] were significant predictors of postcontrast imaging recommendation. Reader 1 had two major discrepancies (missed leptomeningeal metastasis, missed infected facet joint) and seven minor discrepancies. Reader 2 had one major discrepancy (missed lymphoma marrow infiltration) and eight minor discrepancies. In the missed cases of leptomeningeal metastasis and lymphoma marrow infiltration, the patients had a known history of malignancy (metastatic squamous cell carcinoma and lymphoma respectively) prior to imaging. In the missed case of infected facet joint, the patient presented with fever, elevated ESR/CRP, and low back pain prior to imaging. The clinical metrics demonstrated no statistically significant correlation with discrepancies.

Conclusions
Lumbar spine MRI protocol comprised of sagittal T1 and sagittal fat-suppressed T2-weighted sequences serves as an effective screening imaging examination for emergency indications, demonstrating very low rates of major discrepancies and the potential for marked reduction in imaging time and cost. To avoid missed findings utilizing this protocol, we have developed an
algorithm to identify the need for additional sequences. Education in interpreting studies with limited sequences and active radiologist monitoring of the studies also are required.

KEYWORDS: Low Back Pain, Lumbar Spine MR

O-600

Co-branding of Radiology Practices and Large Academic Medical Centers: Can't We All Just Get Along?

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Purpose
Branding of a radiology practice is essential to establish an identity in the marketplace and to compete with alternative options for imaging services. The purpose of this abstract is to demonstrate the seemingly insurmountable barriers but tremendous opportunities in co-branding radiology practices with large academic institutions in order to provide a formidable force in the outpatient imaging market.

Materials and Methods
This study is a primer for introducing the concept of co-branding, establishing a framework for building a brand recognition and marketing plan, and successfully implementing the concepts in the market place in the setting of an academic institution with strict prohibition of individual departmental brand initiatives. The development of a tag line, unique recognizable logo, collateral marketing material, individual business web site separate from the academic website and a radiology-specific marketing campaign within the confines of marketing guidelines of the parent institution will be delineated. The radiology department branding initiative occurred over a two-year period from 2011-2013 culminating in the initial introduction of the new brand proposition to the market in late 2013 and 2014. Optimization of service and access benchmarks in the parent academic medical center and the assessment of change in radiology imaging volumes over this time period were documented during the project and upon initial roll out into the market.

Results
Optimization of scheduling and access benchmarks to levels surpassing aggressive private practice standards was attained in a large academic institution and served as a framework of a radiology-specific marketing campaign emphasizing service to referring clinicians and patients as a primary distinguishing feature of the radiology practice in the local marketplace. Pre-existing institutional brand identity of best practices in terms of regional clinical expertise and quality care also were successfully emphasized in the marketing campaign. Co-branding of the two entities, promotion of two brand concepts and improvement of service barriers to the institution yielded an increase in the radiology practice's identity, ultimately increasing imaging volumes 15% over a two-year period by allowing the radiology department to effectively compete in an aggressive private marketplace and shed previous preconceived notions of difficult access and less than optimal service. The co-branding technique also provided a separate recognizable radiology identity, thereby reducing commoditization of radiology services.
Conclusions
Although seemingly an insurmountable task, individual unique branding of a radiology department within an academic institution is not only possible but gives both the radiology practice and the parent institution a competitive advantage in the marketplace. Co-branding academic radiology practices with the larger parent academic medical centers is essential in creating a unique identity for the radiology department in the marketplace. The established identity allows the practice to develop marketing and service campaigns with the parent institution that surpass outpatient imaging market standards and ultimately increase radiology imaging volumes and revenue to the benefit of both entities.

KEYWORDS: Economics, Utilization Management

O-601

Modified Neuroradiology Reports: What are the Critical Neuroradiological Findings that Trainees Miss or Misinterpret?

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Purpose
Trainees' initial interpretations of neuroradiological studies typically are reviewed and finalized by neuroradiologists on staff. Our critical findings (CF) policy requires urgent communication and electronic documentation of certain critical neuroradiology imaging findings that can have an effect on patient care. When a trainee has missed or misinterpreted a CF, that report is corrected by a faculty and electronically flagged as modified, and the change is communicated to the referring clinician. In this study we set out to identify which critical neuroradiological pathologies our trainees tend to miss or misinterpret most frequently.

Materials and Methods
Study protocol was approved by our internal review board (IRB). Using our radiology information system (RIS) database, we searched for all neuroradiology reports electronically marked to indicate a missed or misinterpreted CF by a trainee during Jan-Oct 2011. These reports were reviewed to determine what CF was amended to the report. Our CF policy includes the following 17 items: airway compromise, brain edema, child abuse, congenital variant, cord compression, cord infarction, fracture, globe/retina injury, hardware malfunction, hemorrhage, herniation, hydrocephalus, infection, mass, stroke, spinal instability, and vascular abnormality. The training level of the trainee was noted as a resident or fellow. The imaging modality was recorded as CT or MRI. Two months-worth of neuroradiology reports (Jan-Feb 2011) were reviewed to establish the baseline rate of CF entities seen at our institution. Summary statistics were calculated. The relative frequency of all individual CFs was compared between the baseline measurement and modified reports for all trainees combined and residents and fellows separately using Fisher's exact test. Statistical significance was rated at p<0.05.

Results
332 modified reports with CFs were identified. These included 143 (43.1%) CT and 189 (56.9%) MRI exams and contained 352 missed or misinterpreted CFs. 130 (39.2%) reports were ready by residents and 202 (60.8%) were ready by fellows. During Jan-Feb 2011, 12,607 neuroradiology
reports contained 755 CFs. The baseline practice CF rates were: hemorrhage 154/755 (20.4%), stroke 145/755 (19.2%), fracture 88/755 (11.7%), vascular abnormality 68/755 (9%), mass 65/755 (8.6%), herniation 53/755 (7%), hydrocephalus 50/755 (6.6%), infection 48/755 (6.4%), brain edema 29/755 (3.8%), cord compression 19/755 (2.5%), spinal instability 15/755 (2%), globe/retina injury 13/755 (1.7%), hardware malfunction 3/755 (0.3%), child abuse 3/755 (0.3%), congenital variant 1/755 (0.1%), cord compression (0.1%), and airway compromise (0.1%). Modified reports, CF rates were: mass 52/332 (15.7%), hemorrhage 46/332 (13.9%), vascular abnormality 40/332 (12%), fracture 38/332 (11.4%), infection 35/332 (10.5%), stroke 26/332 (7.8%), brain edema 16/332 (4.8%), hydrocephalus 11/332 (3.3%), cord compression 6/332 (1.8%), hardware malfunction 4/332 (1.2%), herniation 3/332 (0.9%), and globe/retina injury 2/332 (0.6%). Not a single case of spinal instability, child abuse, congenital variant, cord compression, and airway compromise were found. Stroke, herniation, and spinal instability were found at a lower rate in modified reports than what was seen in our practice at baseline (p<0.0001, p<0.0001, and p=0.016, respectively), whereas vascular abnormality and mass were found at a higher rate (p=0.024 and p<0.0001, respectively). In modified cases read by the fellows only, stroke (p<0.0001) and herniation (p=0.0002) occurred at a lower rate than expected and vascular abnormality (p=0.027), mass (p=0.0001), and infection (p=0.001) were missed at a higher rate. For residents, herniation occurred at a lower rate (p=0.036) and mass was overlooked at a higher rate (p=0.025), compared to the baseline.

Conclusions
Our analysis of the modified neuroradiology reports identified mass, hemorrhage, vascular abnormality, fracture, infection, and stroke as the most common missed or misinterpreted CFs. Compared to the baseline CF frequency in our practice, residents disproportionately erred in cases with intracranial mass, and fellows in cases with vascular abnormality, mass, and infection. These data can be helpful in exposing trainee deficiencies and can be used to facilitate educational interventions.

KEYWORDS: Quality Control, Quality Improvement

O-602

Is duplicated content an indicator of article quality and acceptance or rejection?

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Purpose
Duplicated and/or plagiarized contents are well accepted indicators of poor quality in scientific articles. Here we tried to determine the relationship between duplicated contents and acceptance or rejection of articles submitted to a major journal. Additionally, we sought to determine if duplications are more common in articles from different parts of the world. Thus, we tested our hypothesis that duplicated content percentage is an indicator of acceptance/rejection and indirectly of the quality of an article.

Materials and Methods
Retrospectively we used a commercially available duplication/plagiarism web-based program
(iThenticate) to examine duplicated content rate in 120 randomly selected articles published in AJNR to serve as a control (accepted) group. We then examined 120 rejected articles in the same fashion. We divided each group equally according to geographic region of article origin as: Asia, North America, and Europe (Turkey was counted in Europe data, India in Asia data, Mexico in North American data; Australia, Brazil, Egypt, Iran, and Israel were not included). Calculated duplications for each group were compared with those of other groups and we arbitrarily set a 15% rate of duplicated content from a single source as significant. Results: Two of 120 accepted articles (1.7%) had a >15% duplication rate based on iThenticate analysis. One published article from Asia showed a 23% duplication rate and one from Europe scored 17%. No published articles from North America exceeded the 15% limit. Four of 120 rejected articles (3.3%) had a >15% duplication rate. Three rejected articles from Asia were over the limit of 15% from any one source (36%, 42%, and 43%) and one from Europe scored 15%. No rejected articles from North America exceeded the 15% limit.

Conclusions
Articles arising from Asia, accepted and rejected, contain higher duplication rates than those from Europe and North America. Duplication rates in rejected articles were nearly twice as high as those found in accepted articles. Thus, a priori detection of high duplication rates may be an indication of article quality and may predict acceptance or rejection.

KEYWORDS: Outcomes, Quality Control, Quality Improvement

O-603

Frequency and Severity of Allergic-Like Reactions to the Gadolinium-Based Contrast Agent Gadobutrol: A Three Year Study at a Single High Volume Center

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Purpose
Gadobutrol (Gadovist/Gadavist) is a nonionic macrocyclic gadolinium-based magnetic resonance imaging (MRI) contrast agent. The drug has been approved for use in the United States since 2011, Canada since 2004, and in some European countries since 1998. Practice guidelines suggest that gadobutrol may pose a lower risk of nephrogenic systemic fibrosis (NSF) than some other agents (1). Allergic-like reactions to gadolinium-based agents are rare, but they do occur, and reported reaction rates vary among the agents (2, 3). Most of the allergic-like reaction literature pertains to drugs other than gadobutrol. The literature for gadobutrol is mainly from
postmarket surveillance and a post-hoc meta-analysis of clinical trial data, which reported widely discrepant adverse reaction rates of 0.02% and 4%, respectively (1). Surveillance results are biased by reliance on physician reporting, and the meta-analysis includes fewer than 5,000 patients gathered from 34 different trials. The purpose of our study was to determine the frequency and severity of allergic-like reactions to gadobutrol in a single high volume center.

Materials and Methods
We prospectively recorded details of every allergic-like reaction to gadolinium-based MRI contrast agents at a single center from January 1, 2010 to December 31, 2012. Each event was graded as mild, moderate, or severe, according to previously published criteria (3, 4). Physiologic reactions such as nausea and vomiting were not included as they are not allergic-like reactions (3). The frequency of mild, moderate and severe reactions was calculated, as well as the frequency of allergic-like reactions occurring despite prophylaxis. Treatments administered for the allergic-like reactions were recorded. We also calculated the frequency of delayed reactions, with symptom onset after the patient had left the medical imaging department. The delayed reaction data was limited to reactions for which the patient contacted the department.

Results
There were 25,603 gadolinium-enhanced MRI examinations during the study period, and 80 (0.31%) allergic-like reactions. Gadobutrol was the most commonly used contrast agent (91.1% of injections) and it accounted for 76 (0.33%) of allergic-like reactions. Three of the gadobutrol reactions were moderate (dyspnea n=2, soft-palate swelling n=1) and the remainder were mild. The frequency of specific symptoms in the 76 adverse reactions is listed in the accompanying table. No treatment was administered for 37 (48.7%) reactions. Diphenhydramine was given for 35 (46.1%) reactions. Prednisolone (oral) was given for two (2.6%) reactions. There were two reactions (2.6%) for which medication was administered outside our center for a delayed reaction and the medication details were not recorded. In no case was epinephrine given, and no patients were transferred to the Emergency Department or admitted for observation. Allergic-like reactions despite corticosteroid prophylaxis, so-called "breakthrough reactions," accounted for 12 (15.8%) of the 76 adverse reactions. Delayed reactions accounted for 11 (14.5%) of the 76 reactions.

Conclusions
The frequency of allergic-like reactions to gadobutrol is low, and most are mild and self-limiting. Our rate of 0.33% is more than ten-fold lower than the 4% previously reported from post-hoc meta-analysis of clinical trials, and greater than the 0.02% from postmarket surveillance data. Breakthrough reactions and delayed reactions are relatively common, occurring in approximately 15% of cases.

KEYWORDS: Allergic, Contrast-Enhanced MR Imaging, MR Contrast Agents

Table: Frequency of symptoms characterizing the 76 contrast reactions which occurred in the 23,313 gadobutrol enhanced MRI examinations performed over a 3 year period.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Frequency of Symptom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hives/Urticaria</td>
<td>53</td>
</tr>
<tr>
<td>Rash</td>
<td>16</td>
</tr>
</tbody>
</table>
Pruritis 14
Limited erythema 9
Localized facial edema 3
Itchy eyes 3
Dyspnea 2
Coughing 2
Soft palate swelling 1
Nasal congestion 1
Sneezing 1
Scratchy throat 1

O-604 4:17PM - 4:24PM

Integrated Sinus CT Protocol for Diagnostic Imaging and Intraoperative Navigation: Potential for Cost Savings and Radiation Dose Reduction

J Hoxworth¹, D Lal¹
¹Mayo Clinic, Phoenix, AZ

Purpose
The use of computed tomography (CT)-based surgical navigation during endoscopic sinus surgery (ESS) has become standard of care. Traditionally, this was acquired as an incremental CT scan after the patient previously had undergone a routine diagnostic sinus CT. The objective of this retrospective review was to determine the potential for cost-savings and radiation dose reduction that results from using a common sinus CT protocol for diagnostic imaging and intra-operative navigation.

Materials and Methods
This HIPAA-compliant study was approved by the Institutional Review Board, and the need for informed consent was waived. Effective October 1, 2010, sinus CT at the authors’ institution began using a common imaging protocol that was deemed mutually acceptable by neuroradiologists and sinus surgeons for both diagnostic imaging and intraoperative navigation (Fusion ENT Navigation System, Medtronic, Inc.). Images were acquired on a 64-detector CT scanner (Lightspeed VCT or Discovery CT750HD, General Electric) using 120 kVp, 180 mA, 0.5-second rotation time, 0.531 pitch, and 0.625-mm section collimation. An axial fusion-compatible data set (standard reconstruction algorithm, 22 cm field of view) was created and archived for all patients. The electronic patient medical records for all sinus CT scans performed between October 1, 2010 and October 1, 2013 were reviewed to determine the number of sinus CT scans performed, the specialty of the referring physician, the percentage of CT scans used for intra-operative navigation, and the amount of time that elapsed between CT and ESS.

Results
A total of 4,658 sinus CT scans were performed during the study period (F:M 2,050: 2,608; age
53.9 +/- 16.2 years). During this time, 427 ESS cases utilized intraoperative CT guidance with 401 of these CT scans having been acquired at the authors' institution. Of the 2,848 sinus CT scans ordered by non-ENT providers, 115 ESS (4.0%) ultimately were performed and did not require a new CT for surgical navigation because of the combined CT protocol. As illustrated in Figure 1, a higher percentage of sinus CT scan referrals from ENT (15.8%) and sinus surgeons (22.2%) were used for ESS (p<0.001). The time interval between sinus CT and ESS was greater for non-ENT providers compared with ENT (45.1 versus 63.1 days, p<0.01).

Conclusions
Using a combined sinus CT protocol for diagnostic imaging and surgical navigation prevents a significant number of patients from incurring the added cost and radiation exposure of a repeat CT. However, this approach requires neuroradiologists and sinus surgeons to agree on the CT imaging parameters, which may not be practical at centers that perform very low dose screening sinus CT.

KEYWORDS: Cost-Effective, Radiation Dose Reduction, Sinonasal Disease
Multiple Procedure Payment Reduction (MPPR): How are Neurodiologists Affected

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Purpose
To understand the basics tenets of multiple procedure payment reduction (MPPR) and
mechanisms by how it may affect the future of healthcare. To outline in comprehensible terms MPPR's effect on neuroradiologists and on the specialty of radiology at large.

Materials and Methods
The MPPR legislation was studied extensively and key elements are summarized. The history, implementation and potential future impact also was studied.

Results
Imaging-specific MPPRs have been applied to advanced diagnostic imaging services, which the federal government defines as computed tomography (CT), MR imaging (MRI), and Ultrasound (US). Furthermore, imaging MPPRs apply when multiple diagnostic imaging services are administered to the same patient, by the same physician, during a single health care encounter. With an MPPR, Medicare fully reimburses the most expensive procedure; however, the second and all subsequent procedures are reduced by a specific percentage. MPPR has evolved over time with multiple legislations including Deficit Reduction Act (DRA), 2006 Medicare Physician Fee Schedule Final Rule, The Patient Protection and Affordable Care Act (PPACA) and 2011 Medicare Physician Fee Schedule Final Rule. In the beginning it only involved technical component but now has expanded to Professional Component. CMS recently applied the 25% decrease to the professional component (PC) and 50% cut to the technical component (TC) to multiple physicians within the same practice for a second imaging done within the same day.

Conclusions
There is a general lack of awareness regarding the implementation of MPPR and unanswered questions about how MPPR will impact radiology. After detailed study of the legislation, there are specific key points which can help simplify the understanding of MPPR for neuroradiologists and allow them to be better prepared for the future.

KEYWORDS: Economics

O-606

Patient Protection And Affordable Care Act (PPACA): Overview, Study Of The General Effects On Radiology, How Far Have We Come And The Future

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Purpose
To understand the basics of health care reform, mechanisms by which patient protection and affordable care act (PPACA) expands health care coverage, how PPACA pays for its coverage and the future. To outline in comprehensible terms PPACA's effect on consumers, on neuroradiologists specifically and radiology at large and understand what is yet to come.

Materials and Methods
The PPACA legislation was studied extensively and key elements of health reform are summarized. The pertinent legislation that has a potential to directly impact radiologists was studied. The roll out and the legislations, which will impact in the future, were studied.
Results
PPACA expands coverage to nearly all U.S. citizens and legal residents through two principle mechanisms: a mandate to require most U.S. citizens and legal residents to purchase health insurance; and an expansion of Medicaid. Each of these mechanisms achieves approximately half of the 30+MM people who will be newly insured due to the Act. The insurance products are made available on a state by state basis through insurance exchanges and the mandate is enforced through the tax code. Individuals who do not meet the expanded criteria for Medicaid and who meet other income eligibility criteria (from 133%-400% of federal poverty level) will be given subsidies for purchase of insurance on the exchange. Other important components of PPACA include cost controls, incentives to form Accountable Care Organizations and health plan regulation. Specific to radiology is legislation that includes utilization rate, self-referral, appropriateness criteria and a 2.3% excise tax on medical devices.

Conclusions
There is a general lack of awareness regarding the implementation of PPACA and unanswered questions about how health reform will impact radiology. After detailed study of the legislation, there are specific key points which can help simplify the understanding of PPACA for neuroradiologists and be better prepared for the future in healthcare.

KEYWORDS: Economics

Wednesday
4:45PM - 6:15PM
Palais des congres de Montreal, 517bc

71 - SNIS SESSION - INTERVENTIONAL NERORADIOLOGY - A LOOK TO THE FUTURE
O-607

The ARUBA Trial and the Interventionalist

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Abstract/Presentation Summary
Brain arteriovenous malformations (BAVM) are heterogeneous lesions known to produce intracerebral hemorrhage. There is little controversy in offering treatment to prevent recurrent hemorrhage for individuals whose hemorrhagic presentation carries a high re-rupture risk 1. On the other hand, uncertainties regarding risks associated with unruptured BAVM, coupled with increasing imaging diagnosis prompted the organization of "A Randomized Trial of Unruptured Brain Arteriovenous Malformations" (ARUBA), comparing expectant medical management of unruptured BAVM to a strategy of interventional management aimed at obliteration of the BAVM2. This multicenter, prospective, randomized, non-blinded trial compared the risks of death and symptomatic stroke between the two groups where interventional management paradigms consisted of any combination of microsurgical resection, embolization or radiation therapy. The trial was halted early after 7 years of enrollment when interim analysis of the 223
participating subjects suggested higher rates of the primary outcome, death or symptomatic stroke, in the interventional group (31% vs. 10%, hazard ratio 0.27). While not surprising that higher rates of the primary outcome occurred over the relatively short mean follow-up of 33 months in the interventional group exposed to procedural morbidity and mortality, the difference was striking. The study, its design, conduct and results have introduced controversy among physicians caring for patients harboring unruptured BAVM, with some calling for widespread applicability of the results and others questioning the trial’s external validity. Embolization as an intervention was heavily represented in the trial, applied in 58/96 (60.4%) of the treated patients in the interventional arm, 30 of whom had embolization as the only form of interventional therapy. While endovascular treatment of BAVM with embolization has long provided an adjunct to microsurgical resection or radiation therapy, modern agents such as ethylene vinyl alcohol copolymer (EVOH) and n-butyl cyanoacrylate (n-BCA), as well as innovative embolization techniques have enabled application as primary treatment for BAVM. Large series and registries recently report AVM angiographic obliteration rates ranging from 23.5-51%, with reported peri-procedural rates of morbidity/mortality ranging from 8.1% to 9.4%. The relatively high rates of death and symptomatic stroke in the interventional cohort in ARUBA (31% over 33 months of follow-up), where embolization was applied in such a large percentage of subjects, presumably aiming to obliterate the BAVM, raise questions about individual treatment modality contribution that are not elucidated in the trial report. Planned potential extension of follow-up to 5 or 10 years may add more information, although the study was not powered to evaluate individual treatment modalities. Heterogeneity of BAVM patients clinically, AVM angioarchitecture and treatment modality nuance may dictate better analysis through organized prospective multicenter registries and studies examining structural and flow determinants of individual AVM risk. Information gathered through these types of studies may offer opportunity to answer questions left wanting in the wake of ARUBA. This talk will summarize the results of the ARUBA trial, discuss its application to current treatment paradigms, highlight limitations in applicability and discuss future directions in AVM treatment with emphasis on the contribution of endovascular therapy.

O-608

Endovascular Simulation: Benefits and Should it be Used for Credentialing

Brook, A.
Montefiore Medical Center
Bronx, NY

Abstract/Presentation Summary
Simulation in Endovascular training is becoming not only a training tool similar to the aviation industry, but with high fidelity units and technology it is allowing for feedback and the ability to consider credentialing. Decision algorithms, preparation time and practice, as well as rehearsing calamity reversal are some of the advantages of utilizing this technology. The ease and growing computer simulated anatomically correct cases will ultimately allow for testing new equipment and the skills of the operator at various tasks. The growing haptic accuracy is not perfect but allows for sufficient feedback and guides expertise and training. The validation of these high fidelity systems is improving rapidly and numerous peer reviewed papers are documenting the
necessity for trainees to practice on these simulators prior to patients. The goal is clearly to decrease human error and to decrease complications. The Government has mandated this when carotid stenting was introduced and as part of FDA approval. It is only time that will add this criteria as new devices are utilized by different disciplines using endovascular techniques. No other field like cerebrovascular highlights this as neurologists, radiologists, and surgeons treat the same diseases, in the same patient populations, with different skill sets and training backgrounds.

O-609

SNIS President's View of the Future of Interventional Neuroradiology

Meyers, P.
Columbia University
New York, NY

Wednesday
4:45PM - 6:15PM
Palais des congres de Montreal, 517d

72 - GENERAL PROGRAMMING - EMERGENCY NEURORADIOLOGY

O-700

Neurography in the Emergency Setting

Chin, C.
University of California, San Francisco
San Francisco, CA

O-701

Cranio-Cervical Injuries in the Elderly

Nunez, D.
Yale-New Haven Hospital
Orange, CT

Abstract/Presentation Summary
Older age is a variable that contributes to negative outcome in patients who sustain traumatic injury to the brain, as well as the spinal column and cord. This presentation will illustrate the trauma mechanics and anatomic changes that predispose this patient population to specific injury patterns that are well depicted by CT and MR imaging. Contra coup type lesions and varied presentation of subdural hematomas are more prevalent in the elderly, in whom a higher frequency of co-morbidities and anticoagulation contribute to a more rapid progression and
severe manifestations of primary and secondary traumatic brain events, including cerebral herniation syndromes and ischemic complications. Likewise, the altered biomechanics associated with spinal lesions that are more prevalent in the elderly such as degenerative spondyloarthopathy, ankylosing spondylitis and central canal stenosis, contribute to a group of injury patterns that differ from the general population, typically associated with hyperextension of the neck. Elderly patients have a higher incidence of: 1. Injuries of the proximal cervical spine as well as lesions of the craniocervical and cervicothoracic junctions, 2. Fractures that are transversely oriented with frequent extension to the posterior elements, 3. Lesions of the spinal cord resulting from alleged trivial trauma and often without obvious osseous injury, 4. Associated cranial and facial fractures, 5. Injuries at multiple levels of the spine.

O-702

MR in Spine Trauma

Kubal, W.
University of Arizona Medical Center
Tucson, AZ

Abstract/Presentation Summary
We will consider how to most effectively image acute spinal trauma. Specifically, we will consider appropriate use of both CT and MR utilizing guidelines developed by the American College of Radiology. We will review basic anatomy and introduce the concept of stability as described by the three column model. We will discuss the potential advantages of obtaining a spinal MR. We will illustrate the CT and MR appearance of various spine injuries utilizing a case-based approach. The case material will illustrate several types of ligamentous injury. The case material will also illustrate the difficulty in predicting the extent and severity of cord injury from the bony injury as detailed by CT. The MR appearance of various cord injuries will be illustrated and the prognostic significance of these injuries will be reviewed. We will consider newer imaging techniques for the evaluation of spinal trauma which may not yet be part of the clinical mainstream. Specifically, we will consider diffusion tensor imaging in the evaluation of cord injury.

O-703

Imaging of Spinal Trauma: Pearls and Pitfalls

Rothman, S.
TBD
Los Angeles, CA

Abstract/Presentation Summary
Over the last 25 years I have had the opportunity to review more than 15,000 patients imaging studies on people involved in litigation. These include plain films, MR and CT scans. Those imaging studies were performed for the evaluation of the traumatized patient. The ultimate issues in these cases from a radiologic standpoint were to determine the presence or absence of
traumatic injury. In many of those cases radiologic reports of those films incorrectly diagnosed or suggested traumatic injury when none were present. In some cases injuries were missed which should not have been missed. This talk presents a variety of commonly misdiagnosed lesions and defines some "pearls and Pitfalls" in the assessment of the allegedly traumatized patient. The anatomic bases for the missed diagnoses will be discussed wherever possible.

Wednesday
4:45PM - 6:15PM
Palais des congres de Montreal, 517a

73 - GENERAL PROGRAMMING: IMAGING GENOMICS
O-704

Geonomic Imaging of Human Glioma-State of the Art: Associating Genotypes with Imaging Phenotypes

Colen, R.
MD Anderson Cancer Center
Houston, TX

O-705

Imaging Genomics in Psychosis and Other Neuropsychiatric Diseases: The Psychiatric Genetics Consortium

Szeszko, P.
The Zucker Hillside Hospital
Glen Oaks, NY

Abstract/Presentation Summary

The field of psychiatric genetics has evolved quickly over the last several years. A growing list of replicable risk alleles for severe psychiatric disorders has emerged following many unsuccessful attempts. This progress has been facilitated by the Psychiatric Genomics Consortium (PGC), which was established to conduct meta-analyses of genome-wide genetic data for psychiatric disorders, including schizophrenia and bipolar disorder. There is considerable evidence, however, that the underlying genetics and brain pathophysiology of these disorders do not respect traditional DSM-5 diagnostic boundaries, and have substantial overlap. For example, recent data from large scale genome-wide association studies have identified more than two dozen independent loci that have attained genome-wide significant criteria for one or both disorders and the number is rapidly climbing as sample sizes increase. Based on forthcoming work of the PGC, it is anticipated that the number of loci meeting genome-wide significance for schizophrenia and bipolar disorder will exceed 100, with perhaps hundreds more soon to be discovered. Recent progress in psychiatric imaging-genetics has laid the groundwork for characterizing the structural and functional significance of these risk genes using magnetic resonance imaging. For example, imaging associations with these disorders have been reported
with putative risk single nucleotide polymorphisms in ZNF804A, DISC1, MIR137, DTNBP1 and CACNA1C among others. With the recent explosion in potential risk alleles to be discovered, there will, however, be a considerable gap in the imaging-genetics literature. Moreover, a current challenge in the field of imaging-genetics is the interrogation of circuit-based measures using multimodal imaging approaches including structural, functional and diffusion tensor imaging. Such studies will inform the molecular basis of psychotic phenomenology and have significant implications for translational psychiatry. Specifically, a critical next step in the field will be to characterize the biological implications of these risk alleles to identify biomarkers for treatment response to ultimately identify new treatment targets. Understanding how a particular polymorphism affects brain structure and/or function could further enhance treatment strategies such as dosing, the use of medications with different pharmacologic properties and neurobiological mechanisms underlying individual differences in treatment response.

O-706

5:45PM - 6:15PM

How to Conduct an Imaging Genomic Analysis: Overview of Publicly-Available Tools and Datasets

Gutman, D.
Emory University
Atlanta, GA

Abstract/Presentation Summary
With the rapidly diminishing costs of obtaining detailed genomic data, increasing interest has focused on identifying imaging based features that are associated with genetic analysis. The Cancer Genome Atlas (TCGA) in conjunction with the Cancer Imaging Archive (TCIA) provided a rich (and public) data set to begin exploring these associations. In this presentation, we will describe how to obtain and manipulate these data sets. Using Glioblastoma as an example, we will also illustrate the basic steps needed to conduct an analysis identifying gene sets that correlative with specific imaging features (e.g. extent of necrosis) as an example workflow.

Wednesday
4:45PM - 6:15PM
Palais des congres de Montreal, 520

74 - SOCIOECONOMIC PROGRAMMING: QUALITY (SAM)

O-707

4:45PM - 5:15PM

Update on ACA

McClellan, M.
Engelberg Center for Health Care Reform, Brookings
Washington DC, Washington DC
Quality Scorecard in a Multi-Specialty Group Practice: Emphasizing the Needs of the Customer

Krecke, K.
Mayo Clinic
Rochester, MN

Abstract/Presentation Summary
Quality and safety are cornerstones of medical professionalism. We strive to improve the lives of our fellow women and men and we commit to the bedrock principle "...first, do no harm". In 1999, the Institute of Medicine (IOM) published To Err is Human: Building a Safer Health System (1). The report's authors estimated as many as 100,000 preventable deaths at medical centers each year caused by errors of omission, commission, communication and other sources. The IOMs 2001 publication Crossing the Quality Chasm identified the six aims of safety, effectiveness, patient-centeredness, timeliness, efficiency, and equity (2). We need to accelerate the industry's steady evolution from skilled independent craftspeople to deeply connected interdependent team members with a common vision and systems smarts. Twenty-first century quality and safety will be built on standardization, process improvement, and evidence-based, patient-centered care (3). Rugged individualism among health care providers is not necessarily a virtue. This fall, RSNA 2014, will mark the tenth anniversary of the Sun Valley Group. The primary purpose of this think-tank was to develop a forum to "share quality improvement experiences, consider a strategy for promoting quality improvement initiatives within the radiology community, and begin efforts for benchmarking quality data.......Without timely action, our specialty runs the risk of the government and payers dictating quality metrics and defining what represents a quality radiology practice" (4). Mayo Clinic Radiology's activities spring from this group's vision. Our first pass at quality was creating a concise process map that focused on our primary customers and Radiology Department roles and responsibilities (5). Desire to understand physical flow of patients, and information flow to providers, led to process metrics reflecting our perception of value to those customers. We have successfully measured and improved access times, wait times, standard imaging protocols, performance outcomes, patient satisfaction, templated reports, and report finalization times. We have struggled to assess and improve appropriateness and global outcomes, in part because these items have significant components that begin or end well outside the walls of the department. Collection and display of data points and trends has value in assessing the stability of our workflow and our baseline efficiencies. Over time we will continue to improve our median values, narrow the outliers, and create flags of eroding processes. Obsession with errors and mistakes is a critical trait of high reliability organizations. Equally critical is the principle of process flaws leading to human errors. Admonishing our colleagues to try harder is a limited-value strategy. Fixing process flaws that lead humans into ambiguous situations requiring rework, work-arounds or guessing is the target. Our error data comes from two sources. The first is the institution's Sentinel Event reporting process. Secondly, the department has its own Safety Event Reporting Form (SERF) which relies on frontline staffs to document errors, near-misses and "good catches" revealing process vulnerabilities below the threshold of Sentinel Events. I will share information on several years of Sentinel Event and SERF experience. We cherish the engagement of our front line staffs.
and the growth in SERF reporting is emblematic of high engagement and our no-blame culture of event/opportunity analysis (6). A Culture of Safety is necessary to improve immediate and future patient care. Each individual, irrespective of role, MUST feel empowered and obliged to flag a situation placing the patient or team at risk (7). Metrics are not answers. Measures can become lazy and tired if not viewed and reviewed with healthy skepticism and wide perspective. While it is true that one manages what one measures, it is equally true that one gets what one measures - frequently leading to unintended imbalance or "gaming". Quality and safety metrics are highly useful to counterbalance productivity and pure process efficiency metrics. The voice of the customer needs to be heard above the hum of the shop floor. We are in the infancy of process-oriented quality improvement in medicine. Patients and families are not sheets of steel to be molded or widgets to be shipped. Manufacturing deals little with the ill-defined pedigree and psychosocial aspects of its raw materials or the once- and twice-removed payment for goods delivered. Patient, family, provider, gatekeeper and government make each health care situation unique but it is equally evident that medical knowledge allied with process science makes our patients safer and our contributions more efficacious.

Questions and Answers

Wednesday
4:45PM - 6:15PM
Palais des congres de Montreal, 524

75 - CSI: MONTREAL PROGRAMMING: BASIC INFORMATICS
O-709

Basic Informatics for the Neuroradiologist

Quigley, E.
University of Utah
Salt Lake City, UT

Abstract/Presentation Summary
"An introduction to informatics: How Neuroradiologists interact with Patients, Information, and Information Systems to deliver health care."

O-710

Value Added Medicine: Implementing Appropriateness Criteria and Imaging Decision Making in an Electronic Environment
Phillips, C.
Weill Med. College Of Cornell/NY Presby'n
New York, NY

Abstract/Presentation Summary
The current reimbursement environment is reasonably entitled "hostile". More than ever, it is falling to the radiologist to insure billable indications for studies that are ordered by our clinical colleagues. The weight of responsibility for obtaining pre-authorization or pre-certification for the studies we perform has fallen to us. Clearly, it is too late to find that a study is not appropriate or reimbursable after the exam has been performed. Currently, there are a number of techniques to assist the ordering physician regarding indications for "high tech" imaging exams. Order-entry decision support has become a buzz word for clinical organizations to improve diagnostic algorithms and also to insure a reimbursable indication for an exam. It can also be very important for the radiologist to have information present regarding authorization and billing when protocoling examinations. For example, if a study without contrast is the authorized examination and a study with contrast has been ordered, early communication with either an ordering physician or with the insuring organization can work through a potential reimbursement issue.

O-711

3D Printing: Basics and Application for the Neuroradiologist

Javan, R.
Duke University
Durham, NC

Abstract/Presentation Summary
3D Printing: Basics and Application for the Neuroradiologist Ramin Javan, MD 1. Introduction • What is 3D printing? • Why all the hype? • Connecting the dots as radiologists… 2. Rapid Prototyping Techniques • Stereolithography • Fused deposition modeling • Polyjet technology • Laser sintering • 3D printing technology • 3D bio-printing 3. 3D reconstruction and CAD software • 3D mesh (STL file format) • Open source software • Commercial software 4. Postprocessing and digital optimization • 'Manifoldness' of meshes • Creating hollow objects • Minimum wall thickness • Polygon count reduction • Skull stripping • Optimal CT algorithm (bone vs soft tissue) and window/level • Creating mechanical or fitting parts • Creating multicolor models 5. Materials and Cost • Polyamide • Multicolor • Rubber-like • Resin • Metals 6. Buying 3D printers vs commercial on-demand services • Cost • Troubleshooting • Materials 7. Practical Applications in Neuroradiology a) Educational i. Anatomic (Base of skull anatomy with cranial nerves, Pterygopalatine fossa and contents, Fiber tractography, Circle of Willis, Brain surface for gyral and sulcal anatomy in fMRI, Neck anatomic divisions) ii. Interventional phantom (Lumbar spine for CT-guided pain management interventions, Neck phantom for CT- and US-guided procedures consisting of cervical spine vertebrae, spinal cord with nerve roots, neck vessels, airway, thyroid and skin mold) iii. Surgical and interventional phantoms (Base of skull disposable surgical models, Cerebral aneurysm with hollow vessels) b) Clinical i. Surgical
planning and interdisciplinary consulting (Craniosynostosis repair, Scoliosis, Facial plastic reconstruction, Conjoined twins, Practicing complicated surgeries beforehand e.g. facial vascular malformations) ii. Patient and parental counseling and consenting (Dermatome distribution for symptomatology of radiculopathy, Craniosynostosis) iii. Intraoperative drill guides (Craniotomy, Spinal fusion) iv. Implants (Cranioplasty, zygomaplasty, post-traumatic mandibular reconstruction) c) Research and Quality Control i. Fluid dynamics in vessels ii. Imaging phantoms iii. Efficacy of custom 3D printed educational models

Thursday
7:00AM - 8:30AM
Palais des congres de Montreal, 517d

77 - MINI SYMPOSIUM ACUTE STROKE IMAGING: PART I: WHAT IMAGING SHOULD WE BE DOING?
O-714

The MGH Algorithm and Experience for Acute Stroke Imaging?

Gonzalez, R.
Massachusetts General Hospital
Boston, MA

Abstract/Presentation Summary
The MGH Stroke Imaging Algorithm is a high-precision medical tool for patients with major anterior circulation acute ischemic strokes. It is an experience and evidence-based clinical triage tool that uses advanced imaging to identify INDIVIDUAL patients most likely to benefit from endovascular stroke therapy. It was based on over a decade of using advanced imaging (CT, CTA, CT perfusion, DWI, MR perfusion) in acute stroke patients and a critical review of the literature. The key questions and optimal imaging to answer them include: 1. Is there a hemorrhage? Noncontrast CT 2. Is there an occlusion of the distal ICA and/or proximal MCA? CTA 3. Is irreversible brain injury below a specific threshold (e.g. <70ml)? DWI Perfusion imaging is not employed unless patients cannot undergo MRI, or they do not meet the criteria for intervention. Investigations to understand the reasons for the unsuitability of perfusion CT to substitute for DWI revealed that the most likely reason is the low signal-to-noise (SNR) ratio of CT perfusion that results in a poor contrast-to-noise (CNR) ratio in severely ischemic brain. In a comparison between DWI and CTP in over 50 consecutive patients with acute anterior circulation occlusions, the mean CNR of DWI was >4 while it was <1 for CTP derived CBF. The poor CNR results in large measurement error: using Bland-Altman analyses it was found that the 95% confidence interval was ~+/- 50 ml for ischemic lesion volume measurements in individual patients. The Cleveland Clinic adopted a nearly identical algorithm and their results were recently published. They reported that after the new algorithm was adopted, there was a ~50% reduction in mortality and a ~3-fold increase in good outcomes, despite a ~50% decrease in the number of procedures.

O-715

7:15AM - 7:21AM
SPAN-100 Predicts Vascular Imaging Profiles in Acute Ischemic Stroke

P Krishnan¹, G Saposnik², B Ovbiagele³, S Symons¹, R Aviv¹
¹University of Toronto and Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada, ²St. Michael’s Hospital, University of Toronto, Toronto, Ontario, Canada, ³University of South Carolina, Charleston, SC

Purpose
Stroke Prognostication using SPAN-100 facilitates stroke outcomes. We aimed to assess imaging markers associated with SPAN-100 and their additional impact on outcome determination.

Materials and Methods
Of 273 consecutive patients with acute ischemic stroke <4·5 hours, 55 were characterized as SPAN-100 positive (age + NIHSS score ≥ 100). A comprehensive imaging review evaluated the differences: presence of hyperdense vessel sign, ASPECTS, clot burden score (CBS), collateral score, planimetric blood flow, volume, and transit time (CBV, CBF, MTT) volumes. The primary outcome assessed was favorable outcome (modified Rankin score; mRS ≤2). Secondary outcomes included recanalization, lack of neurological improvement and hemorrhagic transformation (HT). Uni- and multivariate analysis assessed factors associated with favorable outcome. AUC evaluated predictors of favorable clinical outcome.

Results
Compared to SPAN-100 negative group, SPAN-100 positive patients (55/273; 20%) demonstrated larger cerebral blood volumes (CBVs) (<0·001), poorer collaterals (p=0·0002) and increased HT rates (56·0% versus 36%, p=0·02) despite earlier time to rtPA (p=0·03). Favorable outcome was less common among SPAN-100 positive compared to SPAN-100 negative (10·9% versus 42·2%; p<0·0001). Multivariate regression revealed poorer outcome for SPAN-100 [(OR) 0·17; 95% CI 0·06-0·38; p=0·0001], CBS [(OR) 1·14; 95% CI 1·05-1·25; p=0·0025] and CBV [(OR) 0·58; 95% CI 0·46-0·72; p=0·0001]. The addition of CBS and CBV improve the predictive value of SPAN-100 alone for a favorable outcome from 60% to 68% and 74% respectively.

Conclusions
SPAN-100 predicts lower likelihood of favorable outcome and increased HT. Cerebral blood volume and CBS contribute to poorer outcomes among high risk patients and improve stroke outcome prediction.

KEYWORDS: Imaging Biomarker, Ischemia, Stroke

<table>
<thead>
<tr>
<th>Imaging Parameters and Outcome in SPAN 100 positive and SPAN 100 negative patients</th>
<th>SPAN 100 Negative</th>
<th>SPAN 100 Positive</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperdense Sign</td>
<td>114 (52.53)</td>
<td>35 (63.64)</td>
<td>0.1395</td>
</tr>
<tr>
<td>ASPECTS Median (IQR)</td>
<td>7 (6-9)</td>
<td>7 (5-8)</td>
<td>0.3969</td>
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<tr>
<td>Clot Burden score</td>
<td>6 (4-9)</td>
<td>6 (5-9)</td>
<td>0.2902</td>
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<tr>
<td>Collateral score</td>
<td>2 (2-3)</td>
<td>2 (1-2)</td>
<td>0.0002</td>
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<tr>
<td>CBVvol (median IQR)</td>
<td>14·7 (4·7-34·7)</td>
<td>34·7 (13·8-60·5)</td>
<td>&lt;0·0011</td>
</tr>
<tr>
<td>CBF volume</td>
<td>101·6 (55·3-133·1)</td>
<td>98·2 (74·6-129·5)</td>
<td>0.7503</td>
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<tr>
<td>MTT volume</td>
<td>104·5 (58·5-133·4)</td>
<td>98·4 (74·7-130·5)</td>
<td>0.6903</td>
</tr>
</tbody>
</table>
### Imaging Parameters and Outcome in SPAN 100 positive and SPAN 100 negative patients

<table>
<thead>
<tr>
<th>Outcome</th>
<th>SPAN 100 Negative</th>
<th>SPAN 100 Positive</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recanalization</td>
<td>119 (55·35)</td>
<td>33 (61·1)</td>
<td>0·4451</td>
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<td>mRS (at follow-up)</td>
<td>3 (1-4)</td>
<td>5 (4-6)</td>
<td>0·0001</td>
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<tr>
<td>MRS&lt;=2</td>
<td>92 (42·2)</td>
<td>6 (10·9)</td>
<td>&lt;·0001</td>
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<tr>
<td>NIHSS improve &gt; 3 24hrs</td>
<td>101 (46·3)</td>
<td>27 (49)</td>
<td>0·7139</td>
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<tr>
<td>Hemorrhagic transform'n</td>
<td>78 (38·6)</td>
<td>28 (56-0)</td>
<td>0·0258</td>
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<tr>
<td>Hemorrhage Infarct</td>
<td>64 (29·4)</td>
<td>23 (41·8)</td>
<td>0·0764</td>
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<tr>
<td>Parenchymal Hemorrhage</td>
<td>26 (11·9)</td>
<td>9 (16·4)</td>
<td>0·3791</td>
</tr>
</tbody>
</table>

(Filename: TCT_O-715_Image.jpg)

### O-716

**A Six Minute MRI Protocol for Evaluation of Acute Ischemic Stroke: Pushing the Boundaries**

K Nael¹, R Khan¹, G Choudhary¹, A Meshksar¹, K Drake¹, J Tay¹, C Kidwell¹, B Coull¹

¹University of Arizona, Tucson, AZ

**Purpose**

Multimodal cerebrovascular computed tomography (CT) and MR imaging (MRI) now can provide information about tissue viability, site of occlusion, and collateral status in patients with acute ischemic stroke (AIS). If MRI is to compete with CT for evaluation of AIS, there is need
for further improvements in acquisition speed. The purpose of this study was to establish the feasibility of a fast MR protocol with a six-minute acquisition time for evaluation of AIS.

Materials and Methods
The inclusion criteria for this prospective study were patients with suspicion of AIS and absence of MRI contraindications. A combination of echo-planar imaging (EPI) and parallel acquisition technique was used on a 3 T MR scanner (Skyra, Siemens) to accelerate the acquisition time. The imaging protocol included: diffusion-weighted imaging (DWI) (TR/TE 4600/65 ms, 1 min acquisition), EPI-FLAIR1 (TR/TE/TI: 10000/88/2500 ms, 52 sec acquisition), EPI-GRE (TR/TE: 1860/48 ms, 50 sec acquisition), contrast-enhanced MR angiography (CE-MRA) of the entire supra-aortic arteries (TR/TE: 3.4/1.2 ms, 20 sec acquisition), and dynamic susceptibility contrast (DSC) perfusion (TR/TE: 1450/22 ms, 120 sec acquisition). Using a modified 2-phase contrast injection scheme, high spatial resolution CE-MRA of the supra-aortic arteries and DSC perfusion were accomplished without the need for additional contrast (2). Image analysis was performed independently by two neuroradiologists and interobserver agreement was calculated using Kappa test.

Results
A total of 50 patients (29 M, age 42-91 years old) met our inclusion criteria. The NIH stroke scale ranged from 4-19. Diagnostic image quality was achieved in 100% of DWI, 97% EPI-FLAIR, 98% EPI-GRE, 90% neck MRA and 96% of brain MRA, and 94% of DSC perfusions. Thirty-six patients (72%) had acute infarction. Using Tmax perfusion maps and applying DEFUSE criteria, 36% of patients had perfusion-diffusion mismatch with interobserver agreement of k=0.90. The mean of the signal-intensity-ratio values of the DWI lesion on EPI-FLAIR was 1.12 for patients with time of onset to MR imaging of < 4.5 hours and 1.40 for patients with time of onset to MR imaging of > 4.5 hours concordant with prior reports (1). Three patients had intracranial hemorrhage detected on noncontrast CT confirmed by EPI-GRE. In addition, five microhemorrhages were detected by EPI-GRE that were undetected by CT. Contrast-enhanced MRA showed 12 segmental stenoses of the extracranial arteries and 19 segmental stenoses of the intracranial arteries with interobserver agreement of k= 0.84 and 0.78 respectively.

Conclusions
Described multimodal MR protocol is feasible for evaluation of patients with AIS and can result in significant reduction in scan time rivaling of the multimodal CT protocol.

KEYWORDS: Echo Planar Imaging, MR Imaging Brain, Stroke

O-717

7:30AM - 7:45AM

Imaging Evidence for Acute Stroke Patients Who Are Candidates for IV Thrombolysis

Sanelli, P.
Weill Cornell Medical College
New York, NY

Abstract/Presentation Summary
Stroke is a leading cause of death and disability worldwide. Imaging plays a critical role in evaluating patients suspected of acute stroke and transient ischemic attack (TIA), especially prior
to initiating treatment. Over the past few decades, major advances have occurred in stroke imaging and treatment, including Food and Drug Administration (FDA) approval of recanalization therapies for treatment of acute ischemic stroke. The primary goal of imaging patients with acute stroke symptoms is to distinguish between hemorrhagic and ischemic stroke. In ischemic stroke patients, secondary goals of imaging prior to initiating revascularization interventions with intravenous (IV) thrombolysis or endovascular therapies include identification of the location and extent of intravascular clot as well as the presence and extent of "ischemic core" (irreversibly damaged tissue) and "penumbra" (hypoperfused tissue at risk for infarction). In addition, early identification of the stroke etiology or mechanism (e.g., carotid atherosclerotic disease, vascular dissection or other treatable structural causes) is critical to treatment decisions and long-term management. A wide variety of imaging techniques have become available to assess vascular lesions and brain tissue status in acute stroke patients. In addition to scientific evidence of effectiveness, important variables that influence imaging choices include constraints of time, cost, access to imaging modalities, preferences of treating physicians, availability of expertise, and availability of endovascular therapy. Thereby, it has become challenging to standardize and optimize the imaging evaluation of patients with suspected acute stroke across sites. A simple, pragmatic approach will be presented to assist in developing an optimal imaging algorithm for stroke patients at individual institution. The strength of the available evidence supporting various imaging options is presented, as well as considerations of available resources. This review and its recommendations will provide a foundation for optimizing the value of imaging in the acute stroke patient.

O-718

7:45AM - 7:51AM

The Role of Imaging in Clinical Stroke Scales that Predict Functional Outcome.

F Soliman¹, A Gupta¹, H Kamel¹, A Pandya¹
¹New York Presbyterian Hospital, Weill Cornell Medical College, New York, NY

Purpose
Numerous stroke scales have been developed to predict functional outcome following acute ischemic stroke. Such prediction models have the potential to contribute prognostic information in both the clinical and research settings. The complexity of these models varies, with the simplest including solely a scale of stroke severity [National Institutes of Health Stroke Scale (NIHSS)] and others including a combination of factors related to stroke severity, demographics, clinical presentation and medical history, and/or neuroimaging. The goal of this study was to compare the numerous prognostic stroke models, both with and without imaging, to determine whether imaging should play a role in predicting functional outcome status.

Materials and Methods
A comprehensive systematic literature search was performed to identify stroke prognosis scoring systems using multiple reference databases including PubMed. We included studies which describe stroke prognosis models or scoring systems that incorporate baseline patient stroke clinical data on presentation to predict functional outcome. Risk scores for transient ischemic attacks and specific risk scores for stroke risk in atrial fibrillation were excluded. Those models which included neuroimaging data as a predictor of prognosis were identified separately. Scores
were evaluated based on area under the receiver operator characteristic (ROC) curve and statistical significance of neuroimaging predictors.

Results
Our initial search in PubMed yielded over 5000 articles. After manually searching the titles and abstracts of these references, we identified 26 risk scores that were derived from stroke cohorts to predict functional outcome and mortality; 14 of these included CT or MRI imaging results along with clinical variables as predictors and three were dedicated imaging scales. Specific neuroimaging variables used in stroke prognosis scales included lesion volume on diffusion-weighted imaging (DWI) or computed tomography (CT), CT hypodensity, and presence of arterial occlusion on MR angiography (MRA) or CT angiography (CTA). Neuroimaging variables were statistically significant predictors in 10 out of the 17 scores that evaluated these parameters. AUC results ranged from (0.72-0.90), mean 0.84 and (0.68-0.90), mean 0.81 for scores that did and did not include neuroimaging predictors, respectively, with no difference between the groups (p<0.16).

Conclusions
The stroke models that incorporate neuroimaging predictors demonstrate mixed results in terms of their utility in outcome prediction, while many scales without imaging are equally or more effective. Despite previous evidence that neuroimaging improves stroke prediction after transient ischemic attack, it is unclear whether imaging-based scores should be favored over simpler approaches for predicting post-stroke function.

KEYWORDS: Outcome, Stroke

O-719

Admission Insular Infarction >50% Identifies Acute Stroke Patients Most Likely to Clinically Benefit from Robust Reperfusion

R Hu\textsuperscript{1}, S Kamalian\textsuperscript{1}, S Kamalian\textsuperscript{1}, G Harris\textsuperscript{1}, S Aneesh\textsuperscript{1}, P Schaefer\textsuperscript{1}, F Karen\textsuperscript{1}, R Gonzalez\textsuperscript{1}, O Wu\textsuperscript{1}, M Lev\textsuperscript{1}

\textsuperscript{1}Massachusetts General Hospital, Boston, MA

Purpose
The goal of our prospective, multi-center, Specialized Programs of Translational Research in Acute Stroke (SPOTRIAS) project has been to determine reliable, practical, imaging markers to help select patients for advanced stroke therapies. Although large admission diffusion-weighted imaging (DWI) (>70 ml) is an established marker for treatment exclusion (i.e., "risk"), no validated markers exist to identify patients likely to deteriorate absent early, robust reperfusion (i.e., "benefit"). We previously have shown that admission percent insular infarction in proximal anterior-circulation occlusive stroke patients correlates with both (i) infarct growth into "at-risk" penumbra, and (ii) poor clinical outcome. Our goal was to establish - in a more generalized cohort - the value of percent admission insular infarction as a marker of the potential benefit from reperfusion.

Materials and Methods
We studied 65 consecutive acute MCA territory stroke patients who received both CTP/DWI within 9 hours of onset and follow-up perfusion imaging (CTP/MRP) within 30 hours.
Reperfusion was defined as >90% improvement in admission DWI-MTT mismatch volume; 14 patients without mismatch were excluded. Percent insula infarction was rated as > or < 50% on admission DWI. Images were rated by consensus of two independent readers. Clinical outcome was determined by 90-day modified Rankin score (mRS) and clinical worsening as the change between pre-admission (all mRS<2) and 90-day mRS (delta-mRS).

Results

With respect to absolute clinical outcome (final mRS), the 23 patients with admission insula infarction >50% had significantly better outcomes with reperfusion (n=3/23, median mRS=1) versus without reperfusion (n=20/23, median mRS=3.5, p=0.005). Of the 28 patients with admission insula-infarction <50%, there was not a significant difference in outcome between patients with (n=13/28, median mRS=1) versus those without (n=15/28, median mRS=2, p=0.097) reperfusion. With respect to delta-mRS from a pre-admission baseline as the outcome measure, the results were similar (p=0.01 for the reperfusion group and p=0.16 for the nonreperfusion group). In the subgroup with admission DWI volume <70 ml, there was similarly a significantly better outcome with versus without reperfusion for insular infarction >50% patients (median 3 versus 1, respectively, p = 0.02), but not in insular infarction <50% patients (median 2 versus 1, p = 0.10). Using a threshold of anterior insula infarction < or > 50%, the difference between 90-day clinical outcome in patients with compared to without reperfusion also was highly significant (median 3.5 versus 1, p=0.03).

Conclusions

For patients with acute MCA territory acute stroke, the percentage of insula infarcted at admission strongly correlates with the likelihood of clinical worsening and poor outcome in the absence of reperfusion. When assessing the risks-versus-benefits of IV and/or IA thrombolytic treatments (i.e., those with DWI<70 ml), patients with large insular infarctions at presentation (>50% insula) are likely to derive the greatest benefit from robust reperfusion.

KEYWORDS: Insula, Penumbra, Stroke
Imaging Evidence for Acute Stroke Patients who are Candidates for Endovascular Revascularization

Wintermark, M.
University of Virginia
Charlottesville, VA

Abstract/Presentation Summary
In acute stroke patients who are candidates for endovascular therapy, vascular imaging (CTA, MRA, DSA) is strongly recommended during the initial imaging evaluation. Perfusion imaging may be considered to assess the target tissue "at risk" for reperfusion therapy. However, the accuracy and usefulness of perfusion imaging to identify and differentiate viable tissue have not been well established. 1. Acute large-vessel intracranial thrombus is accurately detected by CTA, MRA, and DSA. 2. Patients with large infarctions tend to have poor outcomes. The ischemic core is determined most accurately with DWI. Appropriately thresholded PCT-CBV and PCT-CBF can also be used to identify the ischemic core despite immediate reperfusion. 3. A poor collateral pattern has a high specificity for poor tissue and clinical outcome.
Flow weighted and volume weighted collateral vessel signal in MR-angiography independently predicts efficacy of reperfusion in acute proximal occlusive anterior circulation stroke

M Ernst¹, L Brehmer¹, N Forkert¹, G Thomalla², J Fiehler¹, A Kemmling³
¹Department of Diagnostic and Interventional Neuroradiology, Hamburg, Germany, ²Neurology, Hamburg, Germany, ³University Medical Center Hamburg-Eppendorf, Hamburg, Germany

Purpose
In proximal anterior circulation occlusive strokes collateral flow is essential for good outcome. Vessel intensity in time of flight (TOF) and contrast-enhanced (CE) MR angiography (MRA) is variable due to acquisition method. The purpose was to quantify collateral supply including both, flow-weighted signal from TOF-MRA and volume-weighted signal from CE-MRA, and determine each predictive contribution to tissue outcome.

Materials and Methods
Consecutively (2009 to 2013), 44 stroke patients with acute proximal anterior circulation occlusion met inclusion criteria with available TOF- and CE-MRA and penumbral imaging. Collateralized vessels were separately measured in TOF- and CE-MRA employing two methods: 1) a visual 3-point collateral score (CS) to rate the relative abundance of MCA vascularity in the ischemic hemisphere. 2) a rater-independent automated atlas based collateral index (CI) to quantify the relative collateral signal intensity in the ischemic hemisphere. Collateral measures were tested by receiver operating characteristic (ROC) curve and multivariate analysis against good outcome based on final infarct volume (FIV) and percentage of penumbra saved (PPS).

Results
Visual CE-MRA CS were significantly negatively correlated with FIV (Spearman’s rho = -0.44, P<0.003) but not PPS. Visual TOF CS did not correlate significantly with each tissue outcome parameters. For good FIV (< 90 mL), the overall independently best discriminator was CICEMRA (AUC 0.94). For effective reperfusion (PPS >50%) both, CITOF and CICEMRA, were independent contributors and CI combined was the best overall discriminator (AUC 0.89, P<0.001).

Conclusions
Visual collateral assessment by CE- but not TOF-MRA is useful for discriminating good infarct outcome in patients with proximal occlusive strokes. Our study suggests an independent predictive utility for penumbral reperfusion using combined flow-weighted vessel signal from TOF-MRA and volume-weighted signal from CE-MRA for collateral assessment.

KEYWORDS: Collateral Circulation, MR Imaging/MR Angiography, Stroke

Table 3 ROC curve analysis of visual and automated collateral measured for discriminating good tissue outcome (FIV <90ml and PPS >50%)

<table>
<thead>
<tr>
<th>Collateral measure</th>
<th>Final Infarct &lt;90ml</th>
<th>P</th>
<th>Penumbra saved &gt;%50</th>
<th>P</th>
</tr>
</thead>
</table>
## Visual scoring (CS)

<table>
<thead>
<tr>
<th></th>
<th>AUC (±SD)</th>
<th>Optimal criterion</th>
<th>Youden index</th>
<th>AUC (±SD)</th>
<th>Optimal criterion</th>
<th>Youden index</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE-MRA</td>
<td>0,81(0,07)</td>
<td>&gt;= 1</td>
<td>0,53</td>
<td>&lt; 0,01</td>
<td>0,67(0,10)</td>
<td>&gt; 1 0,27</td>
</tr>
<tr>
<td>TOF</td>
<td>0,53(0,02)</td>
<td>&gt;= 1</td>
<td>0,07</td>
<td>0,15</td>
<td>0,53(0,05)</td>
<td>&gt;= 1 0,09</td>
</tr>
<tr>
<td>TOF + CE-MRA</td>
<td>0,81(0,07)</td>
<td>&gt;= 1</td>
<td>0,53</td>
<td>&lt; 0,01</td>
<td>0,65(0,10)</td>
<td>&gt;= 1 0,30</td>
</tr>
</tbody>
</table>

### Atlas based collateral index (CI)

<table>
<thead>
<tr>
<th></th>
<th>AUC (±SD)</th>
<th>Optimal criterion</th>
<th>Youden index</th>
<th>AUC (±SD)</th>
<th>Optimal criterion</th>
<th>Youden index</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE-MRA</td>
<td>0,94(0,04)</td>
<td>&gt; 0,62</td>
<td>0,80</td>
<td>&lt; 0,01</td>
<td>0,83(0,10)</td>
<td>&gt; 0,64 0,70</td>
</tr>
<tr>
<td>TOF</td>
<td>0,74(0,08)</td>
<td>&gt; 0,37</td>
<td>0,43</td>
<td>0,01</td>
<td>0,86(0,06)</td>
<td>&gt; 0,41 0,64</td>
</tr>
<tr>
<td>TOF + CE-MRA</td>
<td>0,95(0,03)</td>
<td>&gt; 1,13</td>
<td>0,80</td>
<td>&lt; 0,01</td>
<td>0,89(0,08)</td>
<td>&gt; 1,51 0,76</td>
</tr>
</tbody>
</table>

AUC, Area under the ROC curve shown with associated significance level P. Optimal criterion defines collateral parameter cut off for maximized sensitivity and specificity by Youden index.
Role of Arterial Tissue Delay derived from Bayesian Probabilistic Method to Predict Recanalization in Patients with Acute Stroke: A comparison with Normalized Collateral Flow Index

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¹University of Arizona Medical Center, Tucson, AZ, ²University of Arizona, Tucson, AZ

Purpose
The normalized collateral circulation index (nCCI) derived from DSC-time to maximum (Tmax) recently has been proposed to determine the status of collateral flow in patients with acute stroke and a predictive measure of recanalization after thrombolysis (1). Arterial tissue delay (ATD) calculated by Bayesian probabilistic method (2) can be a more accurate estimate of collateral flow and actual tissue perfusion delay in ischemic regions. In this study, we evaluate the potential role of ATD derived from Bayesian method to predict recanalization in patients with acute stroke who underwent thrombolysis and compare the result with nCCI index derived from block-circulant singular value deconvolution (cSVD).

Materials and Methods
Twenty-four patients (15 M, 9 F, mean age 66.2 years old) with acute ischemic stroke who underwent MR imaging (MRI) stroke protocol and had proximal arterial (M1) occlusion were enrolled. All patients underwent thrombolysis. Dynamic susceptibility contrast (DSC) perfusion was performed using a gradient-EPI sequence (TR/TE: 1450/22 msec) after iv injection of 0.1 mmol/kg of gadolinium contrast. Using a FDA approved software (Olea Medical, La Ciotat, France), all prethrombolysis DSC scans were processed with cSVD and Bayesian probabilistic method. The nCCI was calculated from cSVD derived Tmax using previously reported method (1). Volume of tissue with severe ATD (>6 sec) also was calculated from Bayesian derived ATD maps. Data were compared and analyzed by unpaired t-test.

Results
Seventeen patients (70%) had successful recanalization after thrombolysis. There was only modest correlation between nCCD and volume of ATD>6s (r=0.512). There was statistically significant difference (P=0.04) between ATD volume (mean ± SD) of recanalized (50.1 ± 29.7 cc) versus nonrecanalized (28.7 ±19.4 cc) patients. There was no statistically significant difference (P= 0.86) between the nCCI of recanalized (172.8± 205) and nonrecanalized patients (188.3 ± 139).

Conclusions
In comparison to the nCCI index, the ATD >6s volume is more accurate and a better predictor of recanalization after thrombolysis in patients with acute ischemic stroke.

KEYWORDS: Acute Stroke, Deconvolution, Dynamic Susceptibility Contrast-Enhanced
FLAIR Vascular Hyperintensities in Acute Ischemic Stroke: a Surrogate Marker of PWI-DWI mismatch?

L Legrand1, M Tisserand2, G Turc1, W Ben Hassen1, O Naggara1, M Edjlali1, C Mellerio1, J Baron3, J Mas1, J Meder1, C Oppenheim4

1Centre Hospitalier Sainte-Anne, Paris, France, 2Sainte-Anne Hospital, Paris, France, 3Neurology, Paris, France, 4CH Sainte-Anne, Université Paris Descartes, INSERM U894, Paris, France

Purpose
FLAIR vascular hyperintensities (FVH) are defined as linear or serpentine hyperintensities corresponding to typical arterial courses (1). They frequently are encountered in acute ischemic stroke (AIS) (2) and are related to slow retrograde flow in leptomeningeal collaterals (3). Our goal was to evaluate the usefulness of FVH beyond the boundaries of the diffusion-weighted imaging (DWI) lesion (FVH-DWI mismatch) and its ability to predict perfusion-weighted imaging (PWI)-DWI mismatch in AIS before thrombolysis.

Materials and Methods
Two independent observers retrospectively analyzed 141 consecutive AIS patients with a proximal middle cerebral artery (MCA) occlusion who had MR imaging (MRI) before and after iv thrombolysis. They evaluated the presence of FVH-DWI mismatch, i.e., FVH on FLAIR seen beyond the DWI lesion on MRI before treatment. Pre- and post-treatment characteristics were compared between patients with or without FVH-DWI mismatch in univariate analyses. The association between FVH-DWI mismatch and PWI-DWI mismatch, examined as a continuous or a categorical variable (PWIvol>1.8×DWIvol, Tmax>6s), was studied.

Results
All patients had FVH next to the insular region. The interobserver reliability for FVH-DWI mismatch was excellent (κ=0.91). Patients with FVH-DWI mismatch (72% of patients) had smaller initial infarcts and larger infarct growth (p<0.001) than those without FVH-DWI mismatch, even though their final infarcts remained smaller (p<0.001). FVH-DWI mismatch detected PWI-DWI mismatch with a sensitivity of 92% (CI95%: 85-99%) and a specificity of 64% (CI95%: 47-80%). The positive and negative predictive values were 82% and 81%, respectively.

Conclusions
Flair vascular hyperintensities are consistently present within the first 4.5 hours after proximal MCA occlusion. The FVH-DWI mismatch, i.e., presence of FVH beyond the infarct’s boundaries, could be used as a surrogate marker of PWI-DWI mismatch and help identify tissue at risk before treatment decision, when PWI is missing.

KEYWORDS: Fluid-Attenuated Inversion Recovery, Mismatch, Stroke
Thursday
7:30AM - 8:30AM
Palais des congres de Montreal, 517bc

76 - SPINE SESSION (SAM)
O-712

Pediatric Spine

Schwartz, E.
Children's Hosp. Of Philadelphia
Philadelphia, PA

Abstract/Presentation Summary
The phrase "children are not just small adults" is commonly used in pediatric neuroimaging, and
is equally applicable in the spine as in the brain. There are numerous spinal pathologies that are seen nearly exclusively in the pediatric population or have different imaging appearances and presentations when affecting children. These include congenital spinal anomalies (spinal dysraphism), certain neoplastic processes, and conditions such as Langerhan cell histiocytosis. Prenatal magnetic resonance imaging (MRI) is increasingly being used to evaluate spinal anomalies in utero. Conditions such as the myelomeningocele and lipomyelomeningocele have imaging features that usually allow for their differentiation, as well as differentiating between these and other forms of spinal dysraphism. Patterns of traumatic injury in the spines of children are frequently different than those seen in adults, particularly cervical spine injuries. Understanding these patterns and their typical imaging features should result in an increase in physician comfort when interpreting these neuroimaging studies, and an increase in accuracy of diagnoses.

O-713

Adult Spine

Malhotra, A.
Yale University School of Medicine
New Haven, CT

Abstract/Presentation Summary
Cauda equina syndrome (CES) refers to a typical set of neuromuscular and urogenital symptoms that result from the simultaneous involvement of multiple lumbosacral nerve roots below the level of the conus medullaris. These symptoms include low back pain, sciatica (unilateral or, usually, bilateral), saddle sensory disturbances, bladder and bowel dysfunction, and variable lower extremity motor and sensory loss. Imaging often plays a critical role in evaluation and management of these patients. CES mainly affects middle aged individuals, particularly men in their forties and fifties. Although disc herniation and canal stenosis are the most frequent causes, the conus and the cauda equina nerve roots can be involved by a range of pathologies, including vascular, neoplastic, infective and inflammatory. Presentation can be acute or chronic. Although the cauda equina lesions involve nerve roots and represent a "peripheral" nerve injury, damage may be irreversible and cauda equina syndrome may be a surgical emergency. Optimization of imaging is important for diagnosis of lesions affecting the conus and cauda equina nerve roots. Delayed or incorrect diagnosis can have significant medicolegal implications.

Questions and Answers

Thursday
8:30AM - 10:00AM
Palais des congrès de Montreal, 517bc

78 - ASSR PROGRAMMING

O-724

8:30AM - 8:50AM

Understanding Spine Care: Clinical Visit to Imaging to Surgery to Controversy, and Health Care Policy

Cho, C.
Brigham & Women's Hospital
Boston, MA

Abstract/Presentation Summary
As medicine moves from treatment of patient illness to management of health, it becomes imperative for physicians to understand the driving forces that ultimately dictate the way we practice. Radiologists must recognize the changes happening in many parts of the country, such as CMS lead Accountable care organizations through share savings, and innovative global payment strategies pushed by private payers. This transformation points to a direction of understanding the entire care spectrum through collaboration, and in this case, spine care. Using one common disease, degenerative disc disease, this presentation reviews the limitations of medical treatment, restrictions on imaging, surgical approaches, and controversy in the surgical arena. The hope of this presentation is to stimulate the radiology audience to recognize the wave of care redesign, and the need to understand the entire treatment spectrum. Learning Points: 1. ACO concept 2. Global payment of 2014 3. Initiatives from hospital networks on healthcare change 4. Non-surgical treatment process for degenerative disc disease 5. Imaging limitations by regulations 6. Surgical treatment options and approach 7. Controversy in surgical arena

O-725

8:50AM - 9:10AM

Leading Edge for Bone Augmentation

Muto, M.
AORN Cardarelli Hosp.
Naples

Abstract/Presentation Summary
Vertebral augmentation is a percutaneous treatment in which a synthetic material (poly-methylmethacrylate- PMMA) is injected in a vertebral body that has wide the applications in the last 10 years having been used not only for the typical vertebral porotic fracture but also for the treatment of primary and secondary spine tumors and vertebral trauma. Vertebral porotic compression fracture still represent the major indications to vertebral augmentation and usually it is perform in case of porotic fracture refractory to medical therapy 6-8 weeks after the onset of acute spine pain. MR is the method of choice to diagnose bone marrow edema that is the most important imaging finding to decide to treat or not to treat the patient. Usually 2/3 of patients show a clinical improvement and recover within 6-8 weeks after the onset of clinical symptomatology, so statistically 1/3 of the patients with porotic vertebral fractures can be
potentially treated with vertebral augmentation. The standard medical therapy includes analgesic, orthosis devices, CA and Vit D plus bisphosphonates and for this reason it is always very important to cooperate with a bone metabolic center to prescribe the best medical therapy is possible to patients. Many papers are published in the literature showing not many differences in terms of clinical results between vertebral cementoplasty performed with only cement injection (vertebroplasty –VP) or if the treatment is preceded by the creation of a cavity with a balloon or any type of metallic implant (assisted techniques- AT). The biomechanic target to reduce kyphotic deformity is certainly obtained more frequently with AT compared to simple VP but this does not mean a gain in terms of clinical results that is usually good in 85-90% of the treated patients with both systems. The common question performing VP or AT is if there is an increased risk of new fractures to adjacent or distant metamer related to the stiffness of the injected material compared to normal bone. Theoretically this stiffness could represent a problem but in practice statistically there are no major changes in terms of new fractures to new metamer in patients with porotic fracture treated or not treated with a previous vertebral cementoplasty. We know in fact by the natural history of patients with vertebral porotic fracture, the risk of new fractures in the year following a previous one in 20% higher than patients without porotic fracture and this risk does not increase after VP or AT. In the last years it has been show it is useful to perform a preventive VP to the superior and inferior vertebral body to reduce the incidence of new fracture in case of osteoporotic fractures. In case of multiple fractures in patients with long history of steroid assumption for collagenopathies, or Chron's disease or patients in chronic treatment for epilepsy it is possible to perform one session vertebroplasty up to 10 levels in neuroleptoanalgesia. It is always important to perform those treatment with the best technologies available such as angio suite or CT-Fluoro guidance. Vertebral hemangioma is a common finding performing MR examination but only the aggressive type with vascular epidural component and the symptomatic hemangioma needs to be treated with VP that also reach a stabilization of the metamer with antalgic effects. In those cases VP is the treatment of choice obtaining a venous embolization with arterial vascular deafferentation and reducing the vascular epidural compression. There is no indication for AT in spine hemangioma. Aneurysmal bone cyst (ABC) is a rare benign spine tumors causing pain and less stability that has been treated in the past in many ways causing potential spinal cord damage with acute clinical onset. Surgical, endovascular and percutaneous treatment with glue can be performed. Now it is also available a new treatment with osteconductive material that has the properties to rebuilt normal bone with normal stiffness and embolizing properties. Another common application of vertebral augmentation are spine metastasis. We cannot apply the same concept of traumatic spine instability to oncological spine instability. Oncological Spinal Instability is poorly defined in the literature and presently there is a lack of guidelines available to aid in defining the degree of spinal instability in the setting of neoplastic spinal disease. The concept of oncological spinal instability remains important in the clinical decision-making process for patients with spine tumors. The Spine Oncologic Study Group (SOSG) has defined it as the loss of spinal integrity associated with pain related to movement, symptomatic deformity, and progressive neurological deficit under physiological load. Malignant primary tumors or metastases can disrupt the normal biomechanics of the spine via bone destruction or deformity resulting in a decrease in its load-bearing capacity. The loadbearing capacity is determined by a number of factors, including tumor size as well as cross-sectional area of the intact body and its bone mineral density. Krishaney has divided the vertebral body in 27 Similar cubes. When the destruction of all the cubes within 1/3 of the axial soma occurs, it creates an instability due to a deficit of the anterior
and middle column. In case of sagittal destruction only, the spinal stability is maintained and not altered. The location of the tumor (and hence bone destruction) within the vertebral body may also play a role in the patient's risk of fracture and instability. There is a distinct discrepancy between the thoracic and thoracolumbar or lumbar spine and spinal oncological instability. In fact, according to Taneichi, the most important risk factor of fracture of thoracic spine instability is the disruption of costo-vertebral joint and, only after, the vertebral body. The costo-vertebral joint and all thoracic muscular structure increase the stiffness and the resistance of the thoracic spine maintaining the spinal biomechanical. In fact, in thoracic level, it is demonstrated that it is necessary to have about 50-60% vertebral disruption to have pathologic vertebral fracture and instability versus 35-40% of Thoraco-Lumbar and Lumbar level. A comprehensive classification system based on patient symptoms and radiographic criteria of the spine was developed to aid in predicting spine stability of neoplastic lesions. The classification system includes: -global spinal location of the tumor, -type and presence of pain, -bone lesion quality, spinal alignment, -extent of vertebral body collapse, -posterolateral spinal element involvement. By the combinations of all these elements a score – The Spine Instability Neoplastic Score - comes out that can guide clinicians in identifying when patients with neoplastic disease of the spine may benefit from surgical treatment. A score between 0 and 6 results in spinal stability, between 7 and 12 possible instability, and between 13 and 18 results in oncological instability. The management of patients affected by neoplastic lesions involving the spine have to respond to two major concepts: • Pain treatment • Stability treatment especially for the spinal metastasis. Certain type of vertebral spine fracture such as Magerl A1.1 type represent another good indication for vertebral augmentation avoiding orthosis devices and kyphotic deformities.

O-726

Intra-Operative Imaging Correlates: Surgical Anatomy of Spine

Groff, M.
Brigham and Women's Hospital
Boston, MA

O-777

Interventional Pain Management in Failed Back Surgery Syndrome

Georgy, B.
North County Radiology
- -

Abstract/Presentation Summary
In this presentation, common interventional procedures performed on patients with failed back surgery syndrome (FBSS) will be discussed in details regarding the indications, techniques and potential complications. Procedures presented will include epidural steroid injections, selective trans-foraminal epidural injections, median branch blocks and sacroiliac joint injections. The evolving role of spinal cord stimulation will be discussed in more details.
Carotid Stenosis and Plaque Imaging

Wasserman, B.
Johns Hopkins University
Baltimore, MD

Plaque Component Thickness Measurements in Carotid Artery Stenosis: A Potential CTA Marker of Symptomatic Plaque

A Gupta¹, H Baradaran¹, H Kamel¹, A Pandya¹, A Mangla¹, A Dunning¹, R Marshall², P Sanelli¹
¹Weill Cornell Medical College, New York, NY, ²Columbia University Medical Center, New York, NY

Purpose
In light of improvements in the effectiveness of nonsurgical therapy for carotid atherosclerotic disease in the past two decades, there has been renewed interest in evaluating imaging techniques for risk stratification beyond luminal stenosis severity, including direct carotid plaque imaging to evaluate for vulnerable plaque. Most of the recent carotid plaque imaging literature has been MR imaging (MRI)-based. There are several challenges, however, in the wide implementation of multisequence carotid MRI as a risk stratification tool in the clinical setting, including the need for specialized MRI coils, lengthy acquisitions times, and the complexity of image interpretation. We correlated recently proposed CT markers, soft and hard plaque thickness measurements on axial CT angiography (CTA) source images, with symptomatic disease status (ipsilateral stroke or TIA) in high-grade carotid disease.
Materials and Methods
Soft plaque and hard plaque thickness were measured by a board certified neuroradiologist with a recently validated technique using CTA source images in subjects with ≥70% extracranial carotid artery stenosis. Figure demonstrates technique on a magnified axial CTA image (left panel) of the proximal right ICA. Asterisk represents the residual patent ICA lumen. Measurements are shown with the calipers, with the white calipers representing maximum soft plaque thickness and black calipers representing maximum hard plaque thickness measurement. The right panel demonstrates a coronal view from a curved multiplanar reconstruction in the same subject showing the patent vessel lumen (asterisk) significantly narrowed by predominantly soft plaque, as measured on axial image. We used multiple logistic regression analysis to measure the strength of association between each 1 mm increase of soft plaque thickness and symptomatic disease status while controlling for the percent degree of NASCET stenosis and any additional covariate risk factors found to be statistically significant in univariate analyses at a threshold of p < 0.05. In addition, receiver operating characteristic (ROC) curve analysis was performed to determine which imaging feature (maximum total plaque thickness, maximum soft plaque thickness, or maximum hard plaque thickness) had the best discrimination for symptomatic carotid disease status. Finally, to test for reliability of measurements, a second board-certified neuroradiologist blinded to the initial measurements repeated linear axial dimension measurements on a subset of 20 subjects.

Results
A total of 42 of 76 subjects meeting inclusion criteria had symptomatic carotid disease. Compared to asymptomatic subjects, those with symptomatic carotid disease had significantly larger soft plaque and total plaque thickness measurements and smaller hard plaque thickness measurements. For every 1 mm increase in maximum soft plaque thickness, there was approximately a 2.7 times greater likelihood (OR = 2.7) of prior ipsilateral stroke or TIA (p<0.0001). Conversely, for each 1 mm increase in hard plaque thickness, there was 45% (OR = 0.55) decreased likelihood of prior ipsilateral stroke or TIA (p = 0.007). Soft plaque thickness measurements provided excellent discrimination between symptomatic and asymptomatic disease with ROC analysis showing an area under the curve of 0.90. A cutoff of 3.5 mm maximum soft plaque thickness provided a sensitivity of 81%, specificity of 83%, positive predictive value of 85%, and a negative predictive value of 78%. Inter-reader correlation coefficients for measurements of maximum total wall thickness, maximum soft plaque thickness, and maximum hard plaque thickness were 0.93, 0.91, and 0.88, respectively, indicating excellent inter-observer reliability.

Conclusions
Increasing maximum soft plaque thickness measurements are strongly associated with symptomatic disease status in carotid artery stenosis. Prospective validation of these results may translate into a widely accessible stroke risk stratification tool in high grade carotid artery atherosclerotic disease.

KEYWORDS: Carotid Artery, Carotid Artery Stenosis, CTA
High-resolution 3T MR protocols for detection and quantification of the vulnerable hemorrhagic plaque

M Vargas¹, M Scheffler¹, I Barnaure-Nachbar¹, R Sztajzel¹, B Delattre¹, V Cuvinciuc¹, V Mendes-Pereira¹, K Lovblad¹
¹Geneva University Hospitals, Geneva, Switzerland

Purpose
We aimed to detect carotid hemorrhagic plaque using a black blood fat sat T1 sequence and quantify the degree of stenosis at 3 T.

Materials and Methods
The inclusion criteria was the diagnosis of symptomatic carotid plaque; 29 patients (10 women and 19 men, ages 37 - 89 years, average of 72 years) were studied on a 3 T MR Philips Ingenuity TF PET/MR Unit. The technical protocol performed comprised axial diffusion, axial EG T2 and coronal FLAIR of the brain and 3DTOF and a 3DT1 black blood sequence at the level of the carotid bifurcation. Both carotids were analyzed in each patient and the NASCET scale was used for quantification of degree of stenosis.
Results
We analyzed 58 carotid arteries at the level of the bifurcation; all of our 29 patients had plaques (right=10, left=14, both= 5). Hemorrhagic plaque appears as a localized hyperintensity on the black blood 3D T1 sequence. We detected 13 hemorrhagic plaques, and 18 patients without hemorrhagic plaque; three carotid arteries in two patients (2 right and one left) were not interpretable due to kinetic movement. The NASCET scale measurement showed: 9=40-50% stenosis, 7=between 60-65% stenosis, 3=70%, 3=80% 4=90% stenosis, 4=nonsignificant stenosis. Five patients of 13 patients with hemorrhagic plaques had brain ischemia. No statistical difference was found between the two groups (with hemorrhagic plaque and without) and the degree of stenosis (p=0.116).

Conclusions
MR imaging with black blood technique fat sat T1 is a safe, confident and noninvasive tool useful for detection and quantification of hemorrhagic vulnerable plaque. The capacity to detect hemorrhage will help in defining patients that need treatment.

KEYWORDS: Fat Suppression, MR Imaging/MR Angiography, MR Plaque Imaging
MRI-detected Intraplaque Hemorrhage, Stenosis and Current Smoking are Essential Markers of Stroke Risk

J McNally¹, D Parker¹, M McLaughlin¹, G Treiman¹

¹University of Utah, Salt Lake City, UT
Purpose
Carotid atherosclerosis accounts for 20-30% of the >690,000 strokes occurring annually in the United States, according to the American Heart Association 2013 update. Stroke risk stratification based on carotid stenosis results in many unnecessary surgeries on asymptomatic patients each year. Lumen evaluation does not detect plaque components, and recent studies suggest that plaque components such as intraplaque hemorrhage (IPH) may account for the majority of carotid source strokes. The purpose of this study was to determine essential markers of acute ischemic stroke in a multivariate logistic regression model including IPH and standard imaging and clinical markers.

Materials and Methods
Over four years, 450 patients with suspected acute stroke were imaged with MR imaging (MRI)/MR angiography (MRA). Carotid MRA was used to measure lumen markers of plaque vulnerability (stenosis, plaque thickness, ulceration and intraluminal thrombus). Intraplaque hemorrhage was detected with the magnetization prepared rapid acquisition gradient-recalled echo (MPRAGE) sequence. Ipsilateral embolic ischemic events were detected with brain diffusion tensor imaging (DTI). Of the 450 patients, 141 were excluded due to noncarotid stroke sources (e.g., atrial fibrillation). This provided 309 patients with 618 carotid artery and ipsilateral brain image pairs. After excluding eight vessels due to occlusion, 610 carotid arteries were used in the final analysis.

Results
Carotid IPH was associated with acute territorial ischemic events [odds ratio (OR)=55.1, 95% confidence interval (CI)=17.3-176.5]. After adjusting for covariates including the above lumen markers of plaque vulnerability and clinical markers (current smoking, prior smoking, diabetes, hypertension, dyslipidemia, age and male sex), IPH remained significantly associated with acute territorial ischemic events (OR=12.1, 95% CI=4.1-35.4). In addition, two of the covariates remained significantly associated with ischemic events, including stenosis (OR=8.2, 95% CI=1.9-36.1) and current smoking (OR=2.8, 95% CI=1.1-7.1).

Conclusions
In this cross-sectional study, carotid IPH was an independent risk factor for ischemic stroke. After adjusting for the confounders in our logistic regression model, only IPH, stenosis and current smoking remained significantly associated with carotid source embolic events. These results strongly argue against using carotid stenosis as the sole imaging determinate of stroke risk and argue for the additional use of carotid IPH imaging techniques. Interestingly, current smoking was the lone clinical covariate resulting in stroke risk unexplained by current plaque imaging techniques. Advances in positron emission tomography (PET) imaging of plaque inflammation and dynamic contrast-enhanced (DCE) MRI measures of plaque permeability may shed further light on this association.

KEYWORDS: Carotid, Intraplaque Hemorrhage, Stroke
O-783

Transient Ischemic Attack

Zaharchuk, G.
Stanford University
Stanford, CA

O-784

Tissue Negative-Transient Ischemic Attack: Is There a Role for MR Perfusion?

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1University of Arizona, Tucson, AZ

Purpose

Conventional imaging is inconclusive in the majority of clinically diagnosed transient ischemic attack (TIA) patients. The purpose of this study is to evaluate the added diagnostic value of dynamic susceptibility contrast (DSC) perfusion in detection of perfusion deficits as a footprint of ischemia in diffusion-weighted imaging (DWI)-negative patients with TIA.
Materials and Methods
Electronic charts of TIA patients who presented to the emergency department between October 2012-October 2013 were reviewed by stroke neurologists. The inclusion criteria were: 1) clinical presentation of TIA at the time of admission and discharge confirmed by stroke neurologist, 2) Negative conventional imaging including DWI, and 3) acquisition of DSC perfusion imaging. The MR imaging was performed within first 24 hours after the clinical presentation. Dynamic susceptibility contrast perfusion was performed using a gradient-EPI sequence (TR/TE: 1450/22 msec, FA 90º, FOV: 22×22-cm, matrix 128 mm, voxel size 1.7 x 1.7 x 4 mm³, GRAPPA x3) after intravenous injection of 0.1 mmol/kg of Multihance-gadolinium contrast. Using a FDA-approved software (Olea Medical, La Ciotat, France), all DSC scans were processed with block-circulant singular value deconvolution. The perfusion parametric maps of cerebral blood flow (CBF) and time to maximum (Tmax) were scored using a 1-3 scoring scale for the presence and location of perfusion disturbance by two independent observers (stroke neurologist and neuroradiologist) blinded to patients history. Statistical analysis was performed by Kappa and Wilcoxon tests.

Results
Thirty patients (16 M, 14 F), age (range 20-95 years old, median 74) who met our inclusion criteria were evaluated. The ABCD2 score ranged 2-7 with median of 5. In 7/30 (23%) TIA patients, a perfusion abnormality was identified by both observers. There was a high agreement (k= 0.82) between both readers. In 6/7 (86%) TIA patients with a positive perfusion scan, the brain regions where perfusion abnormalities were identified matched with the neurologic deficits at TIA presentation. The mean of ABCD2 scores in patients with positive perfusion abnormalities was higher (p=0.05) than in patients without perfusion deficit.

Conclusions
MR perfusion has an added diagnostic value in approximately a quarter of DWI-negative TIA patients. There is high correlation between presence of location of perfusion deficit with patient clinical presentation and ABCD2 score, suggesting the perfusion deficit is a footprint of hemodynamic disturbance in this population.

KEYWORDS: DSC MR Imaging, MR Imaging Perfusion, TIA

O-785

Comparison of Susceptibility-Weighted Imaging and CT Angiography for Evaluation of Clot Burden in Acute Ischemic Stroke

A Agarwal¹, K Thamburaj², S Kanekar³

¹Penn State University, Hummelstown, PA, ²Penn State University, Hershey, PA, ³Penn State Milton Hershey Medical Center, Hershey, PA

Purpose
1. To evaluate the diagnostic accuracy of the magnetic resonance imaging (MRI) susceptibility-weighted images (SWI) for the detection of clot in acute ischemic stroke. 2. To compare the diagnostic accuracy of susceptibility-weighted imaging against computed tomography (CT) angiography for estimation of clot length and burden in acute ischemic stroke.
Materials and Methods
The University Institutional Review Board approved the study. A series of 79 patients with acute MCA stroke was selected using 'MCA infarct' in our search engine software (Primordial Design, Inc., San Mateo, CA); under the time frame of January 2009 to May 2012. Inclusion criteria included: (1) Diffusion positive cases of acute onset MCA infarct, (2) CT angiogram of the brain and MRI performed within 24 hours of clinical onset, (3) SWI included in the MRI protocol. All patients with SWI, included in our study, had minimum intensity projection (mIP) images which were used for detection of thrombus. Computed tomography angiogram was performed on a Siemens 128 slice dual tube (Definition Flash) scanner. MR imaging was done on Siemens Magnetom Aera 1.5 T, Siemens Magnetom Skyra 1.5 T, or Philips Intera 1.5 T. The interval between CT and MR imaging ranged from four hours to 21 hours (mean, 13 hours 36 minutes). We finally had 35 patients who satisfied all the criteria. All of these patients were evaluated with the new 3D-GRE SWI MR technique in addition to other conventional MRI techniques, including DWI with apparent diffusion coefficient (ADC) maps. All the cases, which finally were included in our study, were reviewed by two fellowship trained neuroradiologists. We first reviewed the SWI-mIP images only, being completely blinded to the clinical history and other imaging sequences. Observations were made for the presence of MCA thrombus, extent of thrombus, and segments of MCA involved. Following these observations, other MR sequences including DWI and the CT angiogram of the brain were reviewed.

Results
The clinical and imaging standard for our study was the presence of DWI positive MCA infarct. Intra-arterial MCA thrombus was seen on SWI in 30 cases (86%) of the 35 reviewed. Of the 30, SWI showed thrombus in more than one MCA segments in seven patients. M1 segment was most commonly involved, with thrombus seen in this segment in 19 of 30 cases. Thrombus was seen in the M2 segment in 12 cases. One patient had involvement of the opercular M3 MCA segment. Six patients had involvement of the cortical M4 branch of MCA. We excluded any case with frank hemorrhagic transformation from our study; however, few scattered foci of petechial hemorrhages were seen in 13 cases (37%). More than 50% of cases positive for branch occlusion on CTA had poor distal reconstitution. Estimation of thrombus burden or the number of MCA segments involved was therefore difficult for most cases on CTA (Figure 1). The mean length of the clot on SWI was 14.9±6.4 mm (range: 5-39) and on CTA was 11.1 ±4.1 mm (range: 5-27). Thrombus was noted in two patients on SWI only, with no corresponding abnormality seen on CTA. Both of these patients had branch occlusion of distal M4 segment of MCA. Two patients with acute MCA infarct showed no vascular occlusion or thrombus on either CTA or SWI.

Conclusions
Recanalization is a powerful predictor of stroke outcome in patients with arterial occlusion treated with either intravenous (iv) recombinant tissue plasminogen activator (rt-PA) or an endovascular approach. Many factors impact the success of recanalization therapy, including clot composition, clot burden and site of clot impaction. Our study demonstrates that SWI is a very sensitive tool for detection of intra-arterial thrombus in acute MCA stroke, compared with other techniques including CT angiography. Moreover, SWI can provide an accurate estimation of thrombus burden.

KEYWORDS: Clot, Stroke, Susceptibility-Weighted Imaging
Abstract/Presentation Summary
Secondary prevention of ischemic stroke relies on determination of stroke etiology. Yet conventional clinical, laboratory, and imaging investigations often fail to identify the cause of a stroke. High-resolution contrast-enhanced vessel wall MRI (VW-MRI) is emerging as a useful tool in this context. In this session, I will briefly discuss the technical requirements for intracranial VW-MRI, and then discuss the use of VW-MRI for differentiating among causes of intracranial arterial narrowing, diagnosing arterial disease in the absence of luminal narrowing, and evaluating disease activity.
Towards a better assessment of vascular clots in acute ischemic stroke

V Macaigne¹, P Roux¹, M Obadia¹, A Gueguen², K Malkani³, E Tollard⁴, A Halimi-Cohen², J Savatovsky¹
¹Fondation Ophtalmologique Adolphe de Rothschild, Paris, France, ²Fondation Rothschild, Paris, France, ³University of Angers, Saint Sylvain d'Anjou, Pays de la Loire, France, ⁴CHU Charles Nicolle, Rouen, France

Purpose
Acute ischemic stroke is a major cause of morbidity and mortality worldwide. Brain imaging, which plays an important role in the initial evaluation of the disorder including the assessment of vascular clot location and length, is being used increasingly as a decision-making tool in selecting patients for recanalization treatments, such as intravenous thrombolysis and intra-arterial therapy. Here we compare the efficacy of 3D contrast-enhanced magnetic resonance angiography (CEMRA) with those of time of flight (TOF) angiography, T2* sequences, and TOF angiography combined with T2* sequences, in the evaluation of middle cerebral arterial clots in patients with acute ischemic stroke.

Materials and Methods
The records of 70 consecutive eligible patients were selected from those of 253 patients having undergone brain MRI within 12 hours of an acute neurological deficit during the period from November 2011 to August 2013. All patients had been scanned on the same 3 T MRI system with a 16-channel neurovascular coil. Two independent observers retrospectively analyzed the results of the various MRI sequences performed to determine the location and length of cerebral arterial clots using CEMRA, TOF angiography, T2* sequences, and TOF angiography combined with T2* sequences. Interobserver reproducibility in the determination of vascular clot location and length with each of these techniques then was assessed.

Results
Interobserver reproducibility for appreciating vascular clot location and length was better with CEMRA than with the other techniques. Contrast-enhanced MRA gave results similar to those of TOF angiography combined with T2* sequences for the detection and location of the clots. In contrast, clot length was poorly assessed when using TOF angiography alone, and compared to the results of CEMRA, the combination of TOF angiography and T2* sequences appeared to overestimate the length of the arterial occlusion.

Conclusions
Our retrospective study suggests that satisfactory intracranial assessment of the presence, and of vascular clots in patients with acute ischemic stroke can be obtained either with TOF angiography combined with T2* sequences or with CEMRA. However, CEMRA appears to offer better interobserver reproducibility and more reliable results for thrombus length without compromising examination time. These preliminary results would need to be tested by a prospective controlled study based on digital subtraction angiography as the reference technique. If confirmed, they would allow the use of CEMRA as a unique tool in cases of acute ischemic stroke for the selection of patients likely to benefit from revascularization strategies.

KEYWORDS: Clot, MR Imaging/MR Angiography, Stroke
O-788

Vessel Wall MRI in Acute Ischemic Stroke: Effects of Embolus and Mechanical Thrombectomy on the Arterial Wall

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¹University Health Network: Toronto Western Hospital, Toronto, Ontario, Canada, ²Toronto Western Hospital, Toronto, Ontario, Canada

Purpose
Secondary prevention of ischemic stroke requires determination of stroke etiology. High resolution contrast-enhanced vessel wall MR imaging (MRI) (VW-MRI) is a potential method of differentiating among intracranial etiologies such as atherosclerosis, vasculitis, and vasoconstriction syndromes (1-3). However, it is not known whether an embolus from a proximal source may itself injure the arterial wall and mimic the VW-MRI appearance of primary intracranial arteriopathy. Similarly, it is not known whether mechanical thrombectomy alters the VW-MRI appearance of the arterial wall. The purpose of this study was to determine
the VW-MRI appearance of the arterial wall in the days after acute occlusion of large intracranial arteries.

Materials and Methods
This was a cross-sectional study of consecutive patients with acute intracranial arterial occlusion who underwent contrast-enhanced VW-MRI using a 3 T MR system as part of a secondary prevention clinical imaging protocol. Studies were performed over an 18-month period. The VW-MRI technique has been described in detail elsewhere (2, 3). We performed a detailed chart review for each case and categorized stroke etiology as cardioembolic, carotid embolic, or other/unknown. A neuroradiologist, blinded to clinical data including management, reviewed the imaging. Using the contralateral arteries as a reference standard, the neuroradiologist evaluated the site of occlusion and categorized the lumen (occluded, partially recanalized, fully recanalized), arterial wall thickening (none/minimal, mild, moderate, severe), and arterial wall enhancement (same four categories). We used the Fisher exact test to compare presence versus absence of arterial wall thickening and presence versus absence of wall enhancement in patients treated with medical therapy alone versus mechanical thrombectomy.

Results
Sixteen patients satisfied the inclusion criteria. There were eight women and men; median age was 58.5 years (interquartile range 18.5 years.) The accompanying table provides the results for each patient. The majority of patients (69%) had occlusion of a middle cerebral artery M1 or M2 segment (n=11), and most of the remainder (25%) had a carotid terminus occlusion. There were 10 patients managed without endovascular therapy and six patients who underwent mechanical thrombectomy using a stent-retriever device, either Solitaire FR (Covidien, EV3 Neurovascular, Irvine, California) or Trevo (Stryker Neurovascular, Mountain View, California). Unless contraindicated, intravenous tissue plasminogen activator (tPA) was administered, with 12 of 16 patients (75%) receiving iv tPA. Median time from symptom onset to vessel wall MRI was three days (interquartile range 2 days). The arterial occlusion had completely recanalized at the time of vessel wall MRI in 14 cases and there was mild residual narrowing in two cases. Vessel wall MRI demonstrated two main patterns: the underlying arterial wall appeared essentially normal with no/minimal wall thickening or enhancement in eight cases (50%) and there was mild/moderate wall thickening and enhancement in eight cases (50%). In one case (subject 1), the arterial wall abnormality was focal and had the appearance (1, 3) of an intracranial atherosclerotic plaque. This was the only patient with moderate arterial wall abnormality who had not undergone mechanical thrombectomy. Arterial wall thickening and enhancement were more frequent in patients who had undergone mechanical thrombectomy than nonendovascular therapy alone (p=0.03 for thickening; p=0.05 for enhancement).

Conclusions
Preliminary investigation suggests that acute embolic occlusion of intracranial arteries may itself result in concentric arterial wall thickening and enhancement but this is usually very mild. In contrast, mechanical thrombectomy commonly results in pronounced concentric segmental arterial wall thickening and enhancement. Knowledge of these appearances may be important for accurate interpretation of VW-MRI in patients with recent intracranial arterial occlusion.

KEYWORDS: Mechanical Thrombectomy, Stroke, Vessel Wall
Table: Study Results. Left (Lt), Right (Rt). Carotid terminus (carotid T). Mechanical thrombectomy (MT). Intravenous tissue plasminogen activator (IV tPA). Imaging interval is time in days from symptom onset to VW-MRI. M1 and M2 segments of the middle cerebral artery (M1, M2). P2 and P3 segments of the posterior cerebral artery (P2/3).

<table>
<thead>
<tr>
<th>Subject no.</th>
<th>Age yrs</th>
<th>Sex</th>
<th>Location of Occlusion</th>
<th>Arterial Wall Thickening</th>
<th>Arterial Wall Enhancement</th>
<th>MT</th>
<th>IV tPA</th>
<th>Imaging Interval (days)</th>
<th>Stroke Mechanism</th>
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<tr>
<td>1</td>
<td>38</td>
<td>M</td>
<td>Lt M1</td>
<td>Moderate</td>
<td>Moderate</td>
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<td>N</td>
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<td>2</td>
<td>88</td>
<td>M</td>
<td>Lt M1</td>
<td>None/minimal</td>
<td>None/minimal</td>
<td>N</td>
<td>Y</td>
<td>11</td>
<td>Unknown</td>
</tr>
<tr>
<td>3</td>
<td>84</td>
<td>F</td>
<td>Lt M2</td>
<td>None/minimal</td>
<td>None/minimal</td>
<td>N</td>
<td>Y</td>
<td>2</td>
<td>Cardioembolic</td>
</tr>
<tr>
<td>4</td>
<td>49</td>
<td>M</td>
<td>Rt P2/3</td>
<td>None/minimal</td>
<td>Mild</td>
<td>N</td>
<td>Y</td>
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<td>N</td>
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<tr>
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<td>N</td>
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<td>3</td>
<td>Carotidembolic</td>
</tr>
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Thursday  
8:30AM - 10:00AM  
Palais des congres de Montreal, 517a

80 - SNIS PROGRAMMING: UPDATE ON CEREBRAL ANEURYSMS (SAM)  
O-790  
8:30AM - 8:50AM

Endovascular Aneurysm Therapy: Current State of the Art and What the Future Holds

Turk, A.  
Med. Univ. Of So. Carolina  
Charleston, SC

Abstract/Presentation Summary
Cerebral aneurysms are the most frequent cause of non traumatic hemorrhagic stroke. Approximately 1 in 50 people harbor an unruptured brain aneurysm. The annual rate of rupture is approximately 8-10 of 100,000. When aneurysms rupture, as many as 65% of patients do not survive and approximately half of those that survive are disabled. The endovascular treatment of cerebral aneurysms continues to expand, with many now viewing this approach as the preferred method over open surgical clipping. Endovascular therapy has traditionally focused on coiling of aneurysms. Utilizing adjunctive devices such as balloons and stents have allowed operators to treat more difficult wide-necked aneurysms and often to achieve better angiographic outcomes. However, recurrence of treated aneurysms requiring retreatment occurs as frequently as 15% of the time. There have been significant advances in aneurysm endovascular device technology to
address this potential limitation. In efforts to overcome this potential limitation, coils have been coated with bioactive substances to accelerate healing. Coils have been developed with substances that swell to increase the volume filling or complex into compact mass to increase packing density. Stents have been developed to provide better covering of the aneurysm neck and easier to interact with coil catheters. This has naturally progressed to high density stents that function as flow diverters that can treat aneurysms without having to enter into the aneurysm. However, this type of device is limited to sidewall aneurysms. More recently, intrasaccular flow diverters have been developed and are in initial human use in Europe. Other next generation experimental devices are seeing limited initial human use or are being evaluated in the pre-clinical arena. This talk will focus on the evolution of cerebral aneurysm treatment and focus on next generation technology coming to the US.

O-791

Endovascular Management of Dissecting Intracranial Aneurysms

Tampieri, D.
Montreal Neurological Hospital and Institute
Montreal, Quebec

Abstract/Presentation Summary
Arterial dissections originate from the disruption of the lamina intima of an artery which allows blood to accumulate in the arterial wall. A cerebral arterial dissection may give rise to the formation of a dissecting aneurysm. This pathological process results in an increased risk of rupture of the arterial wall and can therefore lead to SAH. When unruptured, dissecting aneurysms likely present with mass effect related symptoms such as headache, seizure, focal neurological deficit and they are often associated with pain. In the past various treatments, surgical and endovascular, have been applied in the management of these lesions, often leading to the sacrifice of the parent artery. Surgical and endovascular approaches include wrapping, clipping and trapping, and neurointerventional treatments consist of proximal occlusion, coiling. More recently the use of stent-assisted techniques have permitted to perform reconstructive interventions with successful preservation of the parent artery. The use of endovascular techniques and in particular the stent assisted coiling or flow diverters techniques enables preservation of the parent artery, with relative low risks procedure and stable long terms follow up. The management of anticoagulation represents certainly one of the major challenges in these treatments mainly if the patients presents acutely with a SAH.

O-792

Flow Diversion: Is it the Solution to the Aneurysm Problem or Another Tool in the Kit?

Fiorella, D.
Stonybrook Univ. Medical Center
Stonybrook, NY
Abstract/Presentation Summary
Flow diversion represents a conceptually new approach to the endovascular treatment of brain aneurysms. These new devices have provided us with the ability to achieve a durable and complete reconstruction of even the most complex cerebral aneurysms, many of which were not previously amenable to surgical or endovascular repair1. The devices work to redirect flow away from the aneurysm, causing the aneurysm to proceed to thrombosis. Eventually tissue grows over the device and definitively excludes the aneurysm from circulation. Finally, the thrombus mass within the aneurysm is resorbed and the mass effect dissipates2. As this technology is increasingly applied, we are continuously learning more about its capabilities and limitations. We will review the theoretical basis for the mechanism of action of flow diveters, the existing clinical data and the existing indications and contraindications for treatment3.

80-4
9:30AM - 10:00AM
Questions and Answers

Thursday
8:30AM - 10:00AM
Palais des congres de Montreal, 520

81 - ASFNR PROGRAMMING: DEMENTIA
O-793
8:30AM - 8:50AM
Pathophysiology of Alzheimer’s Disease Revealed by Neuroimaging
Black, S.
Sunnybrook Health Sciences Center
Toronto, ON

Abstract/Presentation Summary
The pathophysiology of Alzheimer's Disease (AD) is becoming clearer, but is much more complex than first imagined. Oligomers of amyloid beta 40-42 are thought to be a key instigator in the pathological cascade. Overproduction appears to drive neurodegeneration in autosomal dominant cases, but impaired clearance is likely an important mechanism in sporadic AD, exacerbated by aging, genetic (e.g. apolipoprotein E e4), and other factors such as oxidative stress and innate immune activation. Alzheimer pathology combined with vascular lesions is the common substrate of dementia postmortem, and co-morbid synucleinopathy is also frequent. Advances in MRI and computational analysis can reveal a typical pattern of cortical thinning in AD along with hallmark hippocampal atrophy. Functional and structural connectivity using diffusion tensor, resting state and activation fMRI, have added new optics to neurodegenerative patterns, exemplified by decreased functional connectivity in the Default Mode Network in AD.
Small vessel disease (SVD) is evident in 95% of elders on FLAIR or T2-weighted MRI, and is increasingly important to understand relationships between SVD and AD, including amyloid angiopathy, which is a potent cause of hemorrhagic stroke, as well as microbleeds. 18F-glucose PET has been available for 30 years with hypometabolic signatures discernable using statistical parametric mapping and surface projections. However, the most exciting development over the last decade is C-11 and now 18F amyloid PET ligands. Now we can visualize the culprit pathologies in the living brain. We can credential patients for participation in clinical trials of anti-amyloid therapies. In the A4 study, for example, normal individuals aged 65 to 85 considered at risk of AD are now being recruited to undergo a florbetapir scan. If appropriate uptake is seen, they are offered randomization to solanezumab vs placebo, infused monthly over 3 years, with the goal of preventing cognitive decline. Similar interventions are being considered in patients with autosomal dominant AD. Tau ligands are also in development to make tau pathology visualizable in AD and Fronto-Temporal tauopathies. Synuclein ligands are also actively being pursued. It is now possible to identify pathologies in vivo to guide therapeutics, monitor target engagement and clinical outcomes. Whether or not this will translate into clinically meaningful slowing and prevention remains to be seen and How to affordably integrate this into the clinic will be challenging. Cost-benefit analyses will be needed to determine clinical utility even before proven effective disease-modifying therapies become available. Irrefutably, however, our ability to document amyloid beta and tau pathology in vivo as it is unfolding (or perhaps folding!) is a game changer for neuroimaging in vascular and neurodegenerative cognitive impairment.

O-794
8:50AM - 9:10AM

The Value of PET Tracers in the Assessment of Dementia

Rabinovici, G.
University of California, San Francisco
San Francisco, CA

O-795
9:10AM - 9:30AM

The Utility of Diffusion Imaging in the Assessment of Dementia

Helpern, J.
The Medical University of South Carolina
Charleston, SC

Abstract/Presentation Summary

Water molecules diffusing in the brain can be used to probe tissue microstructure non-invasively with diffusion MRI (dMRI). The microstructural distances to which dMRI is most sensitive is set by the typical distance a water molecule diffuses during the approximately 100 ms needed to acquire an individual dMRI signal. This distance of about 10 μm makes dMRI ideal for investigating cell-sized microstructural features (i.e. dendritic, axonal, myelin). In this sense, dMRI overcomes the resolution limits of other MRI techniques and bestows upon dMRI a unique
ability to non-invasively assess the microstructure of human brain tissue in vivo. This makes dMRI particularly useful for investigating brain tissue microstructural changes that occur during the evolution of AD pathology.

O-796

9:30AM - 9:50AM

Resting State BOLD MRI Methods in the Assessment of Dementia

Ances, B.
Washington University
Saint Louis, MO

Abstract/Presentation Summary
Recent advances in neuroimaging may allow for earlier diagnosis of preclinical late onset Alzheimer's disease (sAD). One marker that has gained increasingly application is resting state functional connectivity (rs-fc). Correlations in oscillations in the blood oxygen level dependent (BOLD) signal are used to map out resting state networks (RSNs) in an individual while they lie quietly in the scanner. These networks nicely recapitulate those seen when performing a functional task. Using rs-fc MRI significant differences between cognitively normal and sAD individuals for multiple RSNs, including the default mode network (a group of brain areas that is most active at rest when not performing a task). A decrease in rs-fc in the DMN sAD nicely overlaps changes seen in amyloid imaging. In addition, to the DMN additional networks including the dorsal attention network (DAN) and control (CON) are affected with increasing disease progression. When comparing known risk factors for AD, the presence of at least one APOE e4 allele causes decreases in rs-fc in the DMN, even in cognitively normal individuals. Using rs-fc we have begun to distinguish healthy aging from early preclinical changes in sAD. Changes in rs-fc may not be the earliest biomarker for preclinical sAD but instead may be a theranostic measure that could evaluate the efficacy of potential therapeutics. Finally, genetic mutations in presenilin and amyloid precursor protein can lead to autosomal dominant AD (ADAD). Recent comparisons between sAD and ADAD have shown similar changes using rs-fc.

81-5

9:50AM - 10:00AM

Discussion
Introduction to SILAN.ORG and SILAN Foundation

Figueroa, R.
Medical College of Georgia
Augusta, GA

O-798

Current Impact of Imaging in Selecting ICH patient’s Treatment

Romero, J.
Massachusetts General Hospital, Harvard Medical School
Boston, MA

O-799

MR Imaging of the Brachial Plexus

Torres, C.
The Ottawa Hospital
Ottawa, Ontario

Abstract/Presentation Summary
Magnetic Resonance Imaging (MRI) is the imaging modality of choice for the evaluation of the brachial plexus due to its superior soft tissue resolution and multiplanar capabilities. The evaluation of the brachial plexus however represents a diagnostic challenge for the clinician and the radiologist. The imaging assessment of the brachial plexus, in particular, has been traditionally challenging due to the complexity of its anatomy, its distribution in space and due to technical factors. During the presentation, we will describe a modified technique used in our institution for the evaluation of the brachial plexus which led to a substantial decrease in scanning time and to better visualization of all the segments of the brachial plexus from the roots to the branches, in only one or two images, facilitating therefore the understanding of the anatomy and the interpretation of the study. We illustrate the benefit of this modified technique with an example of a patient with a lesion in the proximal branches of the left brachial plexus that was clinically suspected but missed on conventional brachial plexus imaging for 6 consecutive years. In addition, we will review the common and infrequent benign and malignant pathology that can affect the brachial plexus.

O-800

Eight Years of Experience - Update and Current Status in Flow Diveters
Abstract/Presentation Summary
INTRODUCTION The introduction of the flow diversion concept in the treatment of intracranial aneurysms emerged as a paradigm shift in the endovascular field. It also represents the evolution of the endovascular treatment: starting with balloon aneurysm filling, coiling, balloon assisted coiling, stent assisted coiling and finally flow diversion for vessel repair. Since the first flow diverter device, four different generations were introduced in the practice, including monolayers, multilayers, retrievable devices, and we experienced all these generations. MATERIALS AND METHODS Since March 2006, intracranial aneurysms were treated with different flow diverter devices. The first device used was Pipeline Endovascular Device (PED), with more than 599 aneurysms, 497 patients and 739 devices. SNEG was used in 66 aneurysms, 57 patients and 73 devices. CMFM in 67 aneurysms, 61 patients, 83 devices. P64FMD in 41 aneurysms, 29 patients, 33 devices. WEB single or dual layer in 26 aneurysms, 24 patients, 26 devices. All patients were followed up with MRI and DSA images every 3 months during the first year, and annually after. Clinical and angiographic data were reported. RESULTS A total of 804 aneurysms were treated with flow diverter devices, 673 patients and 959 devices. 85% of the aneurysms were located in anterior circulation, 51% were large or giant aneurysms. The range of clinical and angiographic follow up was at 3 months and up to 8 years. Occlusion rate at 6 months and 12 months was 80% and 90%, and 100% after the third year. Technical success up to 90%. The combined morbidity and mortality rate was 4.6% for all flow diverter devices.
CONCLUSION Flow diversion technique proved to be a feasible, safe and effective technique, with acceptable number of complications and morbidity/mortality rate. We learned about the clinical management over the years and its limitations. Better devices with specific characteristics as greater sizes, retrievability, surface coating are needed to continue improving this technique.

Dyna CT for Planning the Endovascular Treatment of Spinal Epidural Arteriovenous Fistula

Diaz, O.
The Methodist Hospital
Bellaire, TX

Abstract/Presentation Summary
Spinal extradural (epidural) arteriovenous fistulas (AVFs) are uncommon vascular lesions of the spine with arteriovenous shunting located primarily in the spinal epidural venous plexus. Understanding the complex anatomical variations of these uncommon lesions is important for management. We will present the most common neuroaxial location of the spinal extradural AVFs as well a practical and treatment oriented classification according to the hemodynamic status and the venous drainage. According to that the spinal extradural AVFs we have divided into 3 types. In Type A spinal extradural AVFs, arteriovenous shunting occurs in the epidural
space and these types have an intradural draining vein causing venous hypertension and spinal cord edema with associated myelopathy or cauda equina syndrome. Type B1 malformations are confined to the epidural space with no intradural draining vein, causing compression of the spinal cord and/or nerve roots with myelopathy and/or radiculopathy. Type B2 malformations are also confined to the epidural space with no intradural draining vein and no mass effect, and are asymptomatic. The current description of the different types of spinal extradural AVFs can help in understanding their pathophysiology and guide management. DynaCT was found to be useful in understanding the complex anatomy of these lesions. Endovascular treatment with Onyx is a good alternative for spinal extradural AVF management.

Thursday
10:30AM - 12:00PM
Palais des congres de Montreal, 517bc

83 - PARALLEL PAPERS: Spine: New Techniques and Neurography
O-802

Spinal Cord DTI in Motor Neuron Disease

A Meoded¹, C Blackstone², M Floeter¹, C Pierpaoli³, R Roda², J Sarlìs⁴, O Schanz¹

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Purpose
The hereditary spastic paraplegias (HSPs) comprise a large group of inherited neurologic disorders. Hereditary spastic paraplegia type 4 (SPG4), is the most common form in a heterogeneous group of autosomal dominant HSP's. Pathologically, there is a bilateral fiber loss: corticospinal tract (CST) and posterior columns (PCs) of opposite gradients of progression. In uncomplicated HSP there is insidiously progressive spastic paraplegia often accompanied by decreased vibratory sensation in the toes. Primary lateral sclerosis (PLS) is a sporadic disorder characterized by slowly progressive CST dysfunction. Primary lateral sclerosis is recognized clinically by its nearly exclusive involvement of upper motor neurons, initially affecting the legs and later involving upper extremities and bulbar muscles. The description of MR imaging (MRI) findings in the literature of the spinal cord in these patients is scarce and mainly qualitative. Diffusion tensor imaging (DTI) permits the investigation of white matter organization and microstructure. The aims of our study were: (a) calculate the DTI metrics, and fiber volume and perform 3D-tractography of the lateral CSTs and the PC in the cervical spine in healthy subjects, and (b) compare these metrics between healthy controls (HCs) and HSP and PLS patients.

Materials and Methods
Primary lateral sclerosis and HSP patients, and age-matched healthy-controls (HC) were enrolled. Clinical ratings for motor/sensory functions were assessed with finger/foot tapping and vibration sense of the index finger/great toe, respectively. Reduced field-of-view DTI at 2mm isotropic resolution with 60 diffusion directions was acquired of the cervical spinal cord. We
performed region of interest (ROI)/deterministic-tractography analysis for the lateral CSTs and PC. Statistical analysis was performed using ANCOVA with age as covariate in order to evaluate the mean differences of DTI metrics: fractional anisotropy (FA), Trace, axial and radial diffusivity (AD, RD) and cord volume, measured as number of fibers per voxel normalized for slice number, between groups. This study was approved by the local IRB.

Results

Six healthy control, seven PLS and four HSP patients (mean age: 51.8, 58.2, 51.75 years), were studied. Sensory and motor ratings in PLS patients were lower compared to HSP (foot>finger). The following DTI-metrics in the regions studied were statistically different between groups: Left CST-FA: (F(2,13)=6.48, p=0.01) HV>PLS p=0.021, HV>HSP p=0.056; Trace: (F(2,13) =8.94, p=0.003), PLS>HV p= 0.01, PLS>HSP p=0.006; RD: (F(2,13)=9.32,p=0.003), PLS>HV p=0.004, PLS>HSP p=0.012. Fiber volume (spinal-cord C0-C4): F(2,13)= 2.752, p=0.104; HSP<HC (p=0.046, LSD corrected for multiple comparison).

Conclusions

Precise localization of focal pathologies in the spinal cord requires accurate depiction of its intrinsic anatomical structures, in particular differentiation of gray and white matter structures. In our study both patient groups demonstrated more motor/vibration sense deficit (foot>hands) compared to controls. Primary lateral sclerosis>HSP patients more abnormalities of DTI metrics, and HSP demonstrated more volume loss compared to controls. The combination of reduced FA, increased Trace and RD, and volume loss in the spinal cord may reflect tissue loss, due to axonal degeneration, gliosis, or expanded extracellular space. The relative preservation of upper extremity sensory/motor function may explain the lesser degree of change in diffusion metrics at this upper cervical level. Additional patients will be studied in order to assess the relationship with clinical measures.

KEYWORDS: Diffusion Tensor Image, Neurodegenerative, Spinal Cord

O-803

10:37AM - 10:44AM

Cervical Spine 3D Double Inversion Recovery (DIR) Sequence in Multiple Sclerosis

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Purpose

The double inversion recovery (DIR) sequence suppresses simultaneously the signal from both the cerebrospinal fluid (CSF) and the white matter. It became apparent that this sequence is widely accepted and crucial in MR imaging (MRI) diagnostic of multiple sclerosis (MS) in the brain, especially for the detection of intracortical lesions. Spinal cord imaging in MS is still challenging, though very important for diagnosis and prognosis. The application of the DIR sequence on the spine, however, has not been established yet. Therefore, we developed and evaluated a cervical spine 3D DIR sequence in this study.

Materials and Methods

We examined 30 patients with suspected multiple sclerosis (16 female, mean age 39 years) and 10 healthy controls (4 female, mean age 33 years) in a 3 T Philips Ingenia MR scanner. The 3D
DIR sequence (TR: 5500 ms, scan time: 7:36 min, acq. voxel size: 1,2 x 1,2 x 1,3 mm) was compared with the conventional T2 TSE sequence (sag/ax, TR: 3000 ms, scan time: 3:47/1:48 min, acq. voxel size: 0,94 x 1,18 x 2/0,65 x 0,82 x 4 mm). Axial and coronal multiplanar reconstructions (MPR) were done postprocessing. Lesions were counted independently by two neuroradiologists. Furthermore, the standardized contrast to noise ratio (sCNR) was calculated. No abnormalities were found in the control group.

Results
Many more lesions could be detected with the 3D DIR sequence than with the conventional T2 TSE sequence (121 versus 92; = 32%). The sCNR was significantly higher (p<0.001) in the 3D DIR sequence compared to the T2 TSE sequence (left image). Therefore, it was easier for the raters to interpret the images using the DIR sequence. The lesion load ranged from multiple focal lesions to confluent lesions. The coronal reconstructions have proven helpful especially in the localization of lesions and delineation of elongated lesions (right image). Particularly, lesions in the border of the spinal cord were very conspicuous.

Conclusions
The 3D DIR sequence has proven essential in the detection of cervical spine lesions in MS. The number of detected lesions was higher and the sCNR was significantly stronger than with the conventional T2 TSE sequence. The 3D DIR sequence might be a helpful supplement for the conventional MRI protocol for the examination of spinal cord lesions, especially in MS.

KEYWORDS: MRI Spine, Multiple Sclerosis
Evaluation of Monochromatic Imaging to Reduce Metallic Artifacts in Computed Tomography of the Spine with Fusion Hardware

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Purpose
Monochromatic imaging with dual energy computed tomography (CT) has been proposed to reduce metallic artifacts as compared to conventional polychromatic CT. The purpose of this study is to systematically evaluate and define the optimal dual-energy CT imaging parameters for specific spinal implant alloy compositions.

Materials and Methods
Spinal fixation rods of chromium-cobalt (Cr-Co) or titanium (Ti) alloys inserted in the cervical spine section of Alderson Rando anthropomorphic phantom were imaged ex vivo with fast-kV
switching CT at 80 and 140 kVp. The collimation width and field of view were varied between 20-40 mm and medium-large, respectively. Extrapolated monochromatic images were generated at 70, 90, 110 and 130 keV. The standard deviation of voxel intensities along a circular line profile around the spine was used as an index of the magnitude of metallic artifact.

Results
The metallic artifact was more conspicuous around the fixation rods made of Cr-Co than those of Ti alloys. The magnitude of metallic artifact seen with Cr-Co fixation rods was minimized at 130 keV using a collimation width of 40 mm and medium field of view settings.

Conclusions
Optimization of acquisition settings used with monoenergetic CT studies yields reduced metallic artifacts. As compared to Cr-Co, spinal fixation rods manufactured from Ti cause less metallic artifacts on cervical spinal CT images.

KEYWORDS: CT, Dual-Energy CT, Metal Artifact
Diffusion tensor imaging detects the spatial variation in fiber angle and lamellar number in intact human discs

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Purpose
The biological and physiological modifications of the disk tissue's structure underlie the loss of its functional integrity and ultimately, loss of its performance as a mechanical joint. This study investigated the use of tensor diffusion imaging to directly interrogate the spatial orientation of collagen fibers in intact human disks.

Materials and Methods
Four human lumbar cadaver spinal disk units (L2-L3), from donors age 48 and 52 years, were scanned using a 9.4 T scanner (Bruker Biospin MRI GmbH, Ettlingen, Germany) equipped with an actively shielded 400 mT/m gradient coil (Bruker, BGA12S). The disks were imaged in 72 mm inner-diameter quadrature birdcage coil with the disk's caudal-cranial axis aligned with the main static magnetic field direction (laboratory z-axis). Diffusion tensor imaging (DTI): 3D spin-echo echo-planar imaging (SE-EPI) diffusion tensor image data were acquired using 30 noncollinear directions and two averaged b0 images with: \(b = 670\ \text{s/mm}^2\), TE/TR = 29/700ms, NEX = 8, FOV = (56 x 50 x 16)mm, acquisition matrix = 290 x 176 x 16, reconstructed resolution = (193 x 195 x 500)\(\mu\text{m}\). Imaging time = 10 hours. Diffusion tensor imaging data were reconstructed in Slicer 3D (v.4.1, www.slicer.org) and a weighted least-squares algorithm used to estimate the 3D diffusion tensor from the diffusion-weighted images. Diffusion tensor imaging data set was analyzed directly from the 3x3 diffusion tensor (V.14, Matlab, Mathworks) and the orientation angle relative to the axial plane of the disk computed at each voxel.

Results
The DTI analysis showed clear demarcation of the AF and NP regions [Figure 1(A)] with fine details of the annuls structure demonstrated by the number of laminae. In agreement with histological studies (1), analysis of fiber angles at the anterior, lateral and posterior regions (B) shows the increase in fiber angle as a function of region within the AF. Of note is the increase in the fibers angle dispersion at the posterior region.

Conclusions
In close agreement with histological studies (1), fiber angle within the AF increased from the anterior to the posterior aspect of the disk with respect to its transverse plane. We are able to count the number of lamellae as a function of location around the circumference of the disk. Since disk degeneration produces, among other things, a loss in the number of laminae, this permits a more detailed assessment of the structural effects of disk degradation. This approach also permits evaluating the range of fiber orientations as a function of degeneration. This protocol will enable us to provide novel data on the effects of degenerative changes in the disk, on the relationships between structure and composition and, in turn, their effect on the
mechanical behavior of the disk. This study, for the first time, showed the ability to directly visualize fiber angle and the number of lamina in the AF within the intact disk.

KEYWORDS: Diffusion Tensor Image, Disk, Spinal Imaging
Fig. 1. Fiber angle based segmentation of the DTI data set shows discrete, alternating, lamella structure in the AF and a near uniform structure in the NP [A].
MR Diffusion is Sensitive to Mechanical Loading in Human Intervertebral Discs

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Purpose
Though quantitative measurements MR have targeted the assessment of disk composition, water and proteoglycan content, as markers of the severity of degeneration, it is the loss of the disk's mechanical function and its tissue structural integrity that underlie the degradation of its primary role as a mechanical joint. This study investigated the use of MR diffusion imaging to directly interrogate the loss of dynamic and viscoelastic properties of intact human disks.

Materials and Methods
Five complete human L2-L3 disk units were isolated from donors age 39, 65, 69, 72 and 81 years. The disks were rehydrated (37°C saline, 4 hours, 200N compression), conditioned (10 compressive load cycles (100 - 300N, 0.5Hz) and mechanically characterized by a) Dynamic test: Fifty cycles of compressive strain (0-9.1%, 1Hz), simulating endplate deformation under daily loads, b) Stress-relaxation: A constant displacement, computed to impose 9.1% strain, applied for a period of 4500 seconds. For each disk, dynamic stiffness (Sy), elastic (E1) and viscous (E2) stiffness and viscosity (h1), were computed from the curves. The disks were scanned in a 72 mm inner-diameter quadrature birdcage coil using a 4.7 T scanner (Bruker Biospin MRI GmbH, Ettlingen, Germany) with the disk's caudal-cranial axis aligned with the main static magnetic field direction (laboratory z-axis). Two MR experiments were performed: a) T2 relaxation: MSME sequence (TR/TE=5000/7..186 ms, 11.6ms spacing), matrix=256^2, Slice=1mm. b) Diffusion: Diffusion sensitization gradients [(1,0,0), (0, 1, 0), (0,0,1)] with four equally spaced b-values (100-1000)mm^2/s, large delta=14ms, small delta=8ms, Matrix=128^2, Slice=1mm. These experiments were performed with the disk loaded at 200N and at 800N, simulating a sitting and standing load conditions (2). Repeated measure MANOVA (JMP 8.0, SAS, NC) tested for the effects of loading, tissue (nucleus versus annulus) on the change in either the mean or COV as main effects. Tukey's HSD was used for post-hoc analysis. Linear models were used to test for correlation between MR and mechanical parameters.

Results
Loading caused a significantly lower mean diffusivity ((11.3 versus 10.1)10^-4.mm/sec, p<0.001) and higher variance (COV: 22.0% versus 30.1%, p<0.001) of diffusivity. No such effect was seen for the T2 values. The nucleus (NP) showed higher T2 (45%) and MD (25%) compared to the annulus(AF) (p<0.001 for both). Under load tissue-based differences were observed only for diffusion values with the AF showing lower MD (21%) but higher COV (31.9)% compared to the NP (p<0.001). Loading had no significant effect on diffusion anisotropy (p>0.05).

Degenerative grade was significantly associated with the reduction in MD and T2 (p<0.01 for both). Diffusivity and T2 were correlated with the disk's dynamic (p<0.01 and p<0.05) and long term viscoelastic (p<0.05 and p<0.05) stiffness. Diffusivity but not T2, was correlated with its viscoelastic dampening (p<0.01) and instantaneous stiffness (p<0.05). MR estimated hydration...
was significantly correlated with the reduction in the disk's dynamic ($r^2=0.66$, $p<0.05$) and instantaneous ($E_1: r^2=0.89$, $p<0.01$) stiffness.

Conclusions
In contrast to the T2, diffusion measures detected the effect of loading on the disk. Strong tissue-based differences for both MR metrics appear to reflect the difference between the highly structured AF versus the less structured but highly hydrated NP, Figure 1. Increased degenerative state of the disk was associated with loss of tissue definition, decreased variability in the NP and conversely, increased variability in the AF, suggesting a loss of tissue demarcation. In effect, the disks appeared more "cartilaginous" - one of the hallmarks of disk degeneration. The strong correlations between diffusivity and the rheological assessments of disk mechanics, suggests that MR might permit quantitative assessment of disk functional status and structural integrity.

KEYWORDS: Diffusion MR Imaging, Disk Degeneration, Mean Diffusivity

![Diagram](TCT_O-806_Fig1.jpg)

Fig. 1. Comparison of the cyclic and time dependent response [A] and corresponding change in MR diffusivity for a grade II-III disc (Filename: TCT_O-806_Fig1.jpg)

O-807

11:05AM - 11:12AM

MR-Neurography: Sensitivity of Nerve T2-Signal and Nerve Caliber in Hereditary Transthyretin Familial Amyloid Polyneuropathy

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Purpose
Transthyretin familial amyloid polyneuropathy (TTR-FAP) is a fatal autosomal dominantly transmitted hereditary disease leading to misfolding and extracellular deposition of transthyretin amyloid. TTR-FAP usually manifests with a rapidly progressive and incapacitating axonal,
distal-symmetric, sensory-motor polyneuropathy (1, 2). Recently, we were able to show that lower limb nerve injury in TTR-FAP is detectable in vivo by an increase of nerve T2-lesions using high resolution MR neurographic (MRN) sequences. The aim of the current study is to evaluate whether nerve caliber can be used as an additional MRN criterion to detect amyloid-related nerve injury in TTR-FAP. Furthermore, we compared the sensitivity of nerve T2-signal and nerve caliber to differentiate between symptomatic TTR-FAP, asymptomatic gene carriers and healthy volunteers.

Materials and Methods
We prospectively examined 20 patients with rare genetically confirmed TTR-FAP [13 with manifest polyneuropathy (PNP), seven asymptomatic gene carriers] and 60 healthy volunteers, age/gender matched. All participants received detailed neurological/electrophysiological examinations. High resolution imaging was done on a 3 T MR scanner Magnetom/Trio/Siemens: (1) axial T2-TSE-fs-sequences from proximal thigh to distal ankle (140 slices/leg; TE/TR 55/5970ms, voxel-size 0.4x0.3x3.5mm); 2) 3D-T2-IR-SPC-sequence with axial reformation (50 images) for the lumbar plexus/spinal nerves (TE/TR 202/3000, voxel-size 1.0x1.0x1.0). Manual segmentation of the lumbar plexus/sciatic/tibial nerve as nerve tissue voxels and voxel-based measurement of nerve caliber was performed on each axial imaging slice (320/subject).

Results
Proximal thigh to ankle level: Cumulative nerve lesion-voxel number was significantly higher in manifest TTR-FAP than in controls: 8282±1585 versus 0±328;p<0.00001. Lesion-voxel number in asymptomatic gene carriers (4079±1503) also was increased significantly compared to controls (p=0.008) but decreased compared to manifest TTR-FAP (p=0.033). In both TTR-FAP groups a clear proximal focus of nerve lesions (p<0.00001) was observed. Here, nerve caliber also was increased significantly and with proximal predominance in manifest TTR-FAP (p<0.00001) and gene carriers (p=0.0084) compared to controls. Lumbar plexus/spinal nerves: Evaluation at plexus level revealed also statistical differences of nerve T2-lesions between controls and both TTR-FAP groups (both:p=0.0002), but not between the two TTR-FAP groups (p=0.843), while differences in nerve caliber were highly significant between all three groups: manifest TTR-FAP versus controls, p<0.00001; asymptomatic gene carriers versus controls, p<0.00001; manifest TTR-FAP versus gene carriers, p=0.0157.

Conclusions
We could show for the first time, that TTR-FAP related nerve lesions are detectable in vivo not only by an increase of nerve T2-lesions, but also by an increase of nerve caliber with a proximal focus in both, manifest and asymptomatic TTR-FAP. Furthermore, our results especially at plexus level may indicate that nerve T2-signal has a particularly strong sensitivity to detect early nerve injury, while nerve caliber may help to differentiate between severe and even more severe cases of nerve impairment.

KEYWORDS: Amyloid, High-Resolution Imaging, MR Neurography
Purpose
Systemic light chain (AL) amyloidosis, a chronic hematological disorder caused by plasma cell dyscrasia or B-cell lymphoproliferative disorders, is the most common form of amyloidosis in
the western world. It leads to an extracellular deposition of amyloid fibrils, which are components of immunoglobulins, known as light chains (1). Clinically, it presents as a multisystem disorder with progressive dysfunction of several organs, including heart, liver and kidneys due to an accumulation of amyloid (2). Untreated, prognosis is very bad. A peripheral neuropathy is relatively rare and manifests as a symmetrical distal sensory-motor polyneuropathy (PNP) (3, 4). For the first time, we investigated, whether lower limb nerve injury in AL amyloidosis can be detected and localized in vivo by using high resolution T2-weighted imaging with large anatomical coverage.

Materials and Methods
Prospective investigation in a relatively large sample of 10 patients with rare PNP due to AL amyloidosis (no former therapy with neurotoxic agents such as Velcade or Vincristin) and 38 healthy volunteers, matched for gender and age. All participants received a neurological examination, including scoring for NIS-LL (Neuropathy-Impairment-Score-Lower-Limbs), NDS (Neuropathy-Deficit-Score), NSS (Neuropathy-Symptom-Score), and detailed electrophysiological studies of the tibial, peroneal and sural nerve as well as small-fiber testing (sympathetic skin response). Imaging was done feet-first and supine in a 3 T MR scanner (Magnetom/Trio/Siemens) with high resolution axial T2-weighted turbo-spin-echo, fat-suppressed sequences separately for each leg from proximal thigh to distal ankle (140 slices/leg): TE/TR 55/5970ms, voxel-size 0.4x0.3x3.5mm. Nerve T2-signal was evaluated as contrast-to-noise ratio (CNR) by manually delineating the nerve circumference as intraneural region-of-interest (ROI) on each axial imaging slice. Additional ROIs were read out in adjacent muscles for normalization of nerve T2-signal.

Results
Quantitative evaluation revealed a marked increase of nerve T2-signal in all AL patients (Signal Ratio 2.20±0.24) with strong statistical significance compared to the group of healthy volunteers (Signal Ratio 1.36±0.04, p=0.02; Figure). These nerve lesions appear completely symmetrically. Furthermore, we found a clear proximal focus of nerve lesions in all our patients with distally symmetric polyneuropathy due to AL amyloidosis (Figure).

Conclusions
Our study results present for the first time, that nerve lesions in AL amyloidosis are detectable in vivo by using high resolution MR neurography. While we could show that nerve lesions appear symmetrically inconsistent with the clinical appearance, we surprisingly found a clear proximal focus of nerve lesions at thigh level, although symptoms prevail distally. This suggests that MRN can serve as a novel and sensitive diagnostic marker of amyloid-related nerve injury and may help to better understand the underlying and yet not completely understood pathomechanism in polyneuropathy due to AL amyloidosis. Furthermore, MRI may hold potential to identify patients with early or subclinical polyneuropathic nerve lesions, and therefore an increased risk to develop neurotoxic side effects due to Velcade or Vincristin therapy.

KEYWORDS: Amyloid, MR Neurography
Representative MRN of sciatic nerve at proximal thigh

a. healthy volunteer, b. manifest polyneuropathy in AL-Amyloidosis
* = fibular nerve, ** = tibial nerve

![Graph showing T2-Signal Ratio comparison between AL-Amyloidosis and Control groups.]
Proximal Nerve Lesions in Distally Symmetric Hereditary and Non-Hereditary Amyloid Polyneuropathies

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Purpose
Among cardiac and autonomic manifestations patients with either hereditary transthyretin associated, or nonhereditary primary systemic light-chain amyloidosis can manifest with a severe polyneuropathy (PNP) due to an extracellular deposition of amyloid (1, 2). Peripheral nerve affection occurs in form of a nerve length-dependent impairment, first involving unmyelinated or small myelinated fibers causing spontaneous, often burning pain sensations, loss of temperature and numbness in the lower extremities. Later patients develop increasing sensory and motor deficits due to an alteration of larger motor and sensory fibers undergoing wallerian degeneration (3-5). Like in other metabolic PNP, clinically it presents distally symmetric. However, the exact pathomechanism of peripheral nerve injury is still a matter of research. Therefore, we investigated the spatial appearance and focus of nerve lesions in the lower extremities from proximal-to-distal in both hereditary and nonhereditary amyloid PNP by using MR neurography (MRN) with high spatial resolution.

Materials and Methods
We prospectively examined a large sample of 23 patients with manifest amyloid-related polyneuropathy [13 with genetically confirmed, manifest transthyretin familial amyloid polyneuropathy (TTR-FAP) and 10 with systemic light-chain amyloidosis (AL)], seven asymptomatic gene-carriers for TTR-FAP and 38 healthy volunteers. First, all participants received detailed neurological and electrophysiological examinations, including scoring for three established scores used in PNP. Then high resolution MRN of proximal thigh, distal thigh, proximal lower leg, ankle region was done in a 3 T MR scanner separately for both legs with axial T2-TSE-fs sequences (140 slices/leg; TE/TR 55/5970ms, voxel size 0.4x0.3x3.5mm). In the TTR-FAP group manual segmentation of the sciatic/tibial/peroneal nerve was performed as nerve-tissue-voxels on each axial imaging slice (320/subject) with subsequently fully automated and operator-independent classification of lesion voxels. In AL nerve T2-signal was evaluated quantitatively as contrast-to-noise ratio (CNR) by manually delineating the nerve circumference as intraneural region-of-interest (ROI) on each axial imaging slice, followed by normalization of nerve T2 signal with respect to adjacent intramuscular T2 signal.

Results
In the TTR-FAP group, two-way ANOVA revealed significantly more proximal than distal nerve lesions (f-value 76.06, p-value <0.00001) with a gradient between increased proximal and distal nerve lesions being most pronounced in symptomatic patients (f-value 67.65, p-value <0.00001). Post-hoc pairwise comparisons between proximal (0-60) and distal slice positions (80-139) and between manifest TTR-FAP and asymptomatic gene carriers revealed for nerve T2 lesion voxels per position a predominant proximal focus at thigh level in both groups (p<0.00001). In the AL
group we also found a strong and statistical significant gradient between proximal and distal nerve lesions by an increase of normalized nerve T2-signal intensity compared to our healthy volunteers (p=0.0023).

Conclusions
For the first time, MRN could accomplish to determine the precise localization of nerve lesions in hereditary and nonhereditary amyloid PNP in vivo. Our findings of a surprisingly clear proximal focus of nerve lesions in distal symmetric PNP may lead to a better understanding of the underlying and possibly same pathomechanism in all metabolic PNP, at least in all amyloid-related PNP. One possible explanation may be a metabolic-toxic mechanism leading to microvascular dysfunction and therefore ischemia in the watershed areas of peripheral nerves prior to distal axonal degeneration. That is supported by the proximal predominance of nerve lesions in complete asymptomatic gene carriers for TTR-FAP.

KEYWORDS: MR Neurography, Nerve Imaging, Peripheral Nerve
Denervation Changes are Detectible on MRI after Botulinum Toxin A Injection into the Rat Hind Limb.
Purpose
Patient response to chemodenervation with Botulinum Toxin A (BTX) injection for painful muscle syndromes is variable. One possible reason is a difference in degree of muscular denervation, but to date there has been no objective measure of chemodenervation effect. This study describes an MRI method to document muscular denervation, and seeks to characterize the time course, nature, and intensity of such changes following BTX-mediated chemodenervation of the rat hind limb.

Materials and Methods
MR imaging of the hind limbs were performed on 14 adult male Sprague Dawley rats. Animals were anesthetized with 5% isoflurane by facemask and MRI was performed at 3 T using a phased array rat coil. Imaging sequences included short-tau inversion recovery (STIR) and multi-echo T2-weighted images with quantitative T2 mapping. Twelve rats were injected with 2.5 U botulinum toxin A in 0.05 to 0.1 mL 0.9% preservative-free saline into the left hamstring muscles. Two additional rats underwent sham injection with 0.1 mL 0.9% preservative-free saline without BTX. The right hind limb served as an internal control for all animals. MR imaging was performed at baseline and at weekly intervals postinjection for six weeks, then at two months and three months. Gait track analysis was performed at baseline and at each MRI session to assess functional effects of chemodenervation. MR images were analyzed using OsiriX v5.8 64-bit software. STIR signal changes were evaluated visually. The area of maximal STIR abnormality was selected on the four-week scan, and regions-of-interest (ROIs) were placed on the injected left hind limb. Similar ROIs were placed over the homotopic area of the uninjected right hind limb. Mean values and standard deviations were recorded for each ROI at each time point. For each animal at each time point, STIR and quantitative T2 values were recorded from each limb. STIR and T2 values were normalized to the contralateral side (Left/Right *100). Values were compared at each time point using a two-tailed paired Student's t-test. Animals were donated to the animal-use training program at the conclusion of the study.

Results
All BTX-injected animals demonstrated increased STIR signal in the affected hind limb (Figure 1). Mean normalized STIR values increased significantly in the BTX-injected limb by one week postinjection (p<0.001), remained significantly elevated compared to the baseline scan through the two-month study (p<0.01), but were not significantly different compared to baseline scan at the three-month time point (p=0.2, Figure 2). Normalized quantitative T2 values were significantly elevated beginning at week one scan (p<0.001), and remained significantly elevated through the two month scan (p≤0.02). The control animals showed no increase in STIR signal or T2 values in the sham-injected limb. Quantitative T2 values in the uninjected right leg also did not significantly differ from baseline at any time-point in BTX rats or controls.

Conclusions
MR imaging signal changes are evident on STIR and quantitative T2 images after chemodenervation with botulinum toxin A but not after sham injection. Signal changes are evident at one week and gradually normalize over a three-month period. Therefore, MRI may provide an objective measure to evaluate extent of chemodenervation after BTX injection.
KEYWORDS: MR Imaging, Muscle Denervation, Pain
Fig. 1. Axial STIR through the rat hind limb 4 weeks post chemodenervation with arrowheads showing increased signal in the injected left leg compared to the right.

Fig. 2. Normalized STIR signal in experimental versus control animals.
Imaging Genital Nerves with a Molecular Imaging Agent: Preliminary Animal Studies

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Purpose
Erectile dysfunction (ED) is a common complication of all forms of prostate cancer treatment, with incidence varying from 13-97% depending on the series quoted. Damage to the neurovascular bundles is a root cause, with strong indications from many studies that preservation of the neurovascular bundles avoids post-treatment ED. The goal of this study is to use a novel neural imaging agent based on the nontoxic Tetanus Toxin C-fragment (TTc) to allow the visualization of the anatomy of genital nerves in prostate cancer. This will reduce the clinical impact of prostate cancer by reducing the nerve complications associated with the treatment of prostate disease, predominantly erectile dysfunction (ED).

Materials and Methods
Male rats were anesthetized (1-2% isofluorane/oxygen) and stereotactically injected with 50 µg of fluorescently labeled TTc546 in a total volume of 20 µl in the tunica albuginea of the left corpus cavernosum. Animals were imaged live one hour postinjection with a Xenogen IVIS 200 small animal imager. Animals then were killed, and the cavernosal nerves, prostates, nerve plexi were dissected, followed by ex vivo imaging as well as confocal imaging of cleared prostate tissues.

Results
En bloc excision of the prostate with the penis allowed imaging of the genital nerves. We note fluorescent TTc-related signal uptake along the expected course of the nerve tract ipsilateral to the injection site (Figure 1 A-C). Postdissection we visualized TTc signal along the corpus cavernosum, urethra and within the prostate lobes and seminal vesicles. Detailed histological assessment of the prostate after clearing with BABB clearing agent allowed visualization of the pelvic nerve ganglion (Figure 1 D), a key structure in nerve preserving surgery of the prostate.

Conclusions
We demonstrate preliminary data suggesting that TTc could be used as a nerve imaging agent to demonstrate the cavernosal nerves by imaging. This suggests that with further work, image guidance could be provided to physicians and surgeons to spare these nerves during treatment for prostate carcinoma, allowing the preservation of genital nerve function and quality of life in prostate cancer survivors.

KEYWORDS: Nerve Imaging, Neuronavigation
Diabetic Neuropathy Can be Demonstrated by Molecular Neurographic Imaging and Parallels Neurologic/Behavioral Findings

D Schellingerhout, L Flores, D Gomez, L Le Roux

Purpose
The purpose of our study was to utilize neurography, a molecular imaging technology evaluating retrograde transport, to demonstrate the development of diabetic neuropathy and correlate it with neurological function in an animal model of diabetes.

Materials and Methods
Male CD1 28-30 gm nonfasting mice received multiple doses of Streptozotocin (STZ) at 55 mg/kg body weight for five consecutive days injected intraperitoneally. Control animals received citrate buffer (n=6). Blood glucose was determined with tail vein puncture and a blood glucometer (ReliOn, Arkray, Shiga, Japan) and body weights were taken every three days. Mice were considered to be diabetic when their nonfasted blood glucose levels were ≥200mg/dl and those experimental animals that did not develop diabetes were excluded from further assessment (final n=9). We assessed the development of diabetic neuropathy by means of both imaging and Von Frey testing for mechanical sensitivity. For each imaging session, animals received
fluorescently labeled TTc-Alexa790 (15 ug/20 uL) via intramuscular injection into the calf muscle. Fluorescent imaging using a small animal optical imager (Xenogen IVIS 200) was used to image the distribution of TTc over 60 minutes, with region of interest (ROI) measurements taken over the thoracic spine to quantitate fluorescent uptake. Region of interest measurements had background activity subtracted, and were normalized to the signal intensity at time=0. Mechanical sensitivity was assessed through the use of von Frey nylon filaments by applying calibrated force to the palmar surface of the hind paw, and the 50% withdrawal threshold was calculated. At the end of the study tissue was harvested for immunohistochemical analysis.

Results
Blood glucose values (mg/dl) were at baseline 148.00±17.09 and 167.89±51.05, 145.00±24.62 and 312.00±80.97 1st week, 135.00±14.31 and 350.44±42.23 2nd week, 107.33±34.77 and 377.78±61.78 3rd week, 156.33±54.54 and 414.13±59.82 5th week, 133.67±12.24 and 394.38±42.58 7th week, 126.83±25.47 and 384.00±59.00 9th week, 102.67±11.96 and 467.13±61 11th week, 126.60±18.51 and 492.38±60.44 14 week, 132.40±21.73 and 478.71±48.98 16th week and 149.20±32.54 and 517.38±57.07 18th week for the control and diabetic animals. These values were statistically different from the 1st week onward (two-tailed T-test p<0.0001). The mean Radiance of TTc imaging (photons/s/cm²/steradian) were 2.67E+08±1.77E+07 and 2.69E+08±3.68E+07 before treatment, 3.75E+08±6.04E+07 and 3.11E+08±6.08E+07 5th week, 2.89E+08±2.94E+07 and 1.97E+08±5.31E+07 at 7th week, 1.84E+08±2.97E+07 and 1.86E+08±7.62E+07 at 9th week, 1.73E+08±3.88E+07 and 1.36E+08±3.31E+07 at 11th week, 1.94E+08±1.00E+07 and 1.50E+08±2.86E+07 at 14th week, 1.15E+08±1.59E+07 and 7.12E+07±1.68E+07 at 16th week and 1.04E+08±2.44E+07 and 6.72E+07±2.01E+07 at 18th week for control and diabetic animals. Statistical significant difference were noted at 7th week (p=0.0179) and from 14 weeks onward (p=0.0240, 0.0029 and 0.0248). Log transformed Von Frey values were 2.92±0.48 and 3.31±0.41 5th week, 2.90±0.34 and 3.35±0.49 at 7th week, 2.95±0.13 and 3.99±0.33 at 9th week, 3.03±0.09 and 3.87±0.31 at 11th week, 3.14±0.19 and 4.01±0.18 at 14th week, 3.38±0.37 and 4.05±0.07 at 16th week and 3.98±0.00 and 4.29±0.16 at 18th week for control and diabetic animals. These showed statistically significant differences from 9th week onward (p=0.0003, 0.0002, <0.001, 0.0025, 0.0134).

Conclusions
The development of diabetic neuropathy could be detected via molecular imaging targeting the retrograde axonal transport mechanism (neurography). This suggests that defective retrograde axonal transport is important in the development of diabetic neuropathy, and that imaging can play a role in diagnosing and monitoring the disease. Behavioral and imaging data were well correlated.

KEYWORDS: Diabetes, Nerve Imaging, Neurography
Semi-Automated 3D Segmentation of Peripheral Nerves Using a Novel MR Neurography Postprocessing Software Tool
Purpose
MR neurography is limited in its ability to optimally display peripheral nerves due to their small size, low contrast and complex course that does not conform well to traditional orthogonal imaging planes. This study seeks to evaluate and test a novel MR neurography program that provides 3D nerve segmentation for improved nerve display.

Materials and Methods
We retrospectively segmented and evaluated images from a series of patients who previously underwent MR neurography (MRN) of the ulnar, sciatic and femoral nerves to determine clinical utility. Images were obtained using a 3 T scanner and standard MRN imaging techniques, including high resolution STIR and fat suppressed T2 sequences to highlight nerve structures and suppress background tissues. Using the newly developed 3D MR neurography program (3D NerveVision, Milwaukee, WI), we were able to segment the peripheral nerves and display them in 3D. They then could be manipulated for optimal evaluation, including rotating the nerve in any plane, applying variable degrees of background tissue suppression, and highlighting various nerve features.

Results
The process requires initial nerve location/selection by the user at several points along its course with subsequent automatic tracking and contour formation. The user then confirms the programmatic selection and modifies the nerve boundary at any level for optimal segmentation. The resulting postprocessing provided excellent nerve visualization in the upper and lower extremities. Since the program utilizes semi-automated techniques for segmentation of the nerve tissue from adjacent structures, processing time was reasonable for an initial learner, taking approximately 5-10 minutes per nerve on average. Importantly, the nerve was well segmented while accurately maintaining the contour of the nerve and preserving signal intensity variation across the length of the nerve. Nerve intensity and size at each slice is measured easily for comparison using standard measurement tools. Next steps will be to improve the speed and accuracy of segmentation and test its clinical utility in a series of patients with blinded reader evaluations with and without nerve segmentation display.

Conclusions
This new 3D neurography postprocessing tool appears to provide excellent quality 3D peripheral nerve image display that can be used to display nerve structures in various projections for clinical interpretation and for treatment planning.

KEYWORDS: Nerve Imaging, Peripheral Nerve, Postprocessing
Utility of MR neurography in identifying extraspinal disease in patients with lumbosacral neuropathy

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Purpose
Low back pain/radiculopathy is the most common cause of disability in the United States and is
experienced by 80% of the population at some point in their lives. MR imaging (MRI) has emerged as the imaging modality of choice for diagnosing the cause of low back pain. A newer technique, MR neurography of the lumbosacral plexus, is being used increasingly as an adjunct technique when standard lumbar spine MRI sequences fail to provide a diagnosis. MR neurography can be used to follow peripheral nerves as they course outside spine and is more sensitive than standard MRI sequences for detecting peripheral nerve disease that can present as low back pain and radiculopathy. We aim to demonstrate the added utility of neurography over standard lumbar spine MRI.

Materials and Methods
We conducted a retrospective chart review of 145 consecutive patients undergoing MR neurography of the lumbosacral plexus at our institution from 12/9/2012 to 11/6/2013. A GE MR imaging (MRI) scanner was used to produce axial and coronal STIR images through the lumbosacral plexus. All of the patients had prior lumbar spine MRI scans that failed to diagnose an etiology for their symptoms. The patient demographic information was obtained, and we categorized the indication for the studies as sensory symptoms, motor symptoms (i.e., weakness) or peripheral nerve tumors. Results of the MR lumbosacral neurograms were characterized as normal, nerve compression, nonspecific inflammation in a single nerve, peripheral nerve tumor, iatrogenic radiation or surgical nerve damage, musculoskeletal abnormality, diffuse lumbosacral plexopathy and miscellaneous. The results also were correlated with the referring clinician’s follow-up notes and clinical diagnosis.

Results
Of the 145 patients undergoing lumbosacral MR neurograms, 54% (n=79) of the patients were female and 45% (n=66) of the patients were male. Patient ages ranged from 16 to 89 years old. The indications for the studies were: sensory symptoms such as pain, numbness and tingling mostly in a sciatic nerve distribution (74%, n=107); weakness (13%, n=19), mixed motor and sensory symptoms (6%, n=8) and peripheral nerve tumors (8%, n=11). The results of the lumbosacral plexus MR neurograms for our 145 patients were abnormal in 56% (n=81), and only four of these studies had abnormal findings that the referring clinicians felt did not correlate with the symptoms, yielding a very low false positive rate of 6%. The most common abnormality identified was nerve compression (31%, n=25) caused by piriformis syndrome, ischiofemoral impingement, spinal hardware, neuroforaminal narrowing, or discosteophytes. Additional abnormalities that were identified include nonspecific inflammation in a single nerve (17%, n=14), peripheral nerve tumor (14%, n=11), iatrogenic radiation or surgical nerve damage (12%, n=10), musculoskeletal abnormality (11%, n=9), diffuse lumbosacral plexopathy (4%, n=3) and miscellaneous (6%, n=5).

Conclusions
In patients with unexplained low back pain or lower extremity neuropathic symptoms, lumbosacral MR neurography can be a useful imaging modality for demonstrating etiologies not identifiable on routine lumbar spine MRIs.

KEYWORDS: Neurography
Ulnar Nerve Entrapment: MR Neurography Evaluation with Clinical and Surgical Correlation

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Purpose
Ulnar nerve entrapment at the elbow is the second most common entrapment neuropathy. High resolution magnetic resonance neurography (MRN) is used increasingly in the evaluation of entrapment neuropathy due to its ability to assess fine morphological features of the nerves as well as their relation to surrounding structures. We correlated MRN features of ulnar nerve entrapment at the elbow with clinical, electrophysiological and surgical findings, with the hypothesis that MRN would provide information complementary to electrophysiology.

Materials and Methods
We retrospectively reviewed MRN studies of 10 patients with suspected ulnar nerve entrapment at the elbow. All studies were performed using a 3 T MR scanner equipped with a dedicated extremity coil. Inclusion criteria were the following: suspected ulnar neuropathy; clinical evaluation at our institution; preoperative MRN; surgical treatment. All cases were reviewed by two radiologists in consensus and a score of 0 to 7 was calculated based on the imaging features including nerve T2 signal intensity (0:Normal; 1:Increased), nerve caliber (0:Normal; 1:Mild increase; 2:Moderate increase; 3:Severe increase), nerve fascicular pattern (0:Normal; 1:Abnormal), perineural fat stranding (0:Absent; 1:Present), and signs of muscle denervation (0:Absent; 1:Present). Patients were classified into three groups based on presurgical electrophysiological and clinical findings as follows: sensory neuropathy only (grade I); sensory and motor neuropathy (grade II); sensory neuropathy, motor neuropathy and muscle atrophy (grade III). Magnetic resonance neuropathy assessment of longitudinal extent of T2 signal hyperintensity of the nerve and likely site of entrapment (proximal to, within, or distal to the
cubital tunnel) also were noted and correlated with surgical findings. Mann-Whitney test was used for statistical comparisons. P-value less than 0.05 was considered significant.

Results
Seven of 10 patients had grade III and three had grade II ulnar neuropathy. Magnetic resonance neuropathy scores varied between the grade II (1 to 4 MRN score) and grade III (5 to 7 MRN score) neuropathy groups and the difference was statistically significant (p<0.017). Electrophysiological testing conclusively demonstrated focal ulnar neuropathy in seven of 10 patients with grade II and grade III neuropathy; it showed nonfocal nerve abnormality in two cases (clinically grade III) and was normal in one patient (clinically grade II). Imaging findings included T2 hyperintensity of the nerve (10/10), abnormal fascicular pattern (9/10), nerve thickening (9/10), perineural fat stranding (8/10) and muscle denervation changes (2/10). T2 hyperintensity, abnormal fascicular pattern, and perineural fat stranding were observed in both groups of patients. In patients with grade II neuropathy there was none to mild nerve thickening, while mild to severe nerve thickening was present with grade III. Magnetic resonance neuropathy identified the site of entrapment with 90% accuracy. In one patient MRN and surgical findings were discordant: MRN showed T2 hyperintensity and increased caliber of the ulnar nerve within the cubital tunnel; however, at surgery a fibrous band compressing the nerve was found proximal to the tunnel.

Conclusions
Magnetic resonance neuropathy is a promising modality for detection and localization of nerve abnormality in patients with ulnar nerve entrapment at the elbow. Integration of high resolution MRN into diagnostic algorithm of patients with ulnar entrapment can improve presurgical planning and influence patient management.

KEYWORDS: MR Neurography, Neurography

Thursday
10:30AM - 12:00PM
Palais des congres de Montreal, 517d

84 - MINI SYMPOSIUM STROKE - PART III: BEYOND ROUTINE IMAGING
O-816

Cerebrovascular Reserve and Oxygen Extraction Fraction

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Abstract/Presentation Summary
The search for means to identify patients who may benefit from tPA treatment beyond the approved therapeutic window has been actively pursued, particularly in light of recent success on the ECASS III (European Cooperative Acute Stroke Study III) trial, which demonstrated efficacy of tPA treatment could be extended from the original 3hrs to 4.5hrs from onset. In addition, with an accumulating arsenal of mechanical clot retrieval devices promising to achieve more effective reperfusion than IV-tPA, it is likely that the therapeutic windows for these retrieval devices will
differ from that of IV-tPA. Toward this end, imaging approaches have been actively sought to potentially provide a signature for tissue viability. The diffusion/perfusion mismatch (DPM) concept represents the most widely adopted imaging approach to depict the "ischemic penumbra" to potentially select patients who may benefit from treatment beyond approved therapeutic windows. However, recent negative results from MR-RESCUE have called for additional refinements to the DPM approach and/or new imaging methods that exploit underlying metabolic alterations during hyper-acute stroke. Positron emission tomography (PET)-measured cerebral metabolic rate of oxygen utilization (CMRO2) is capable of discerning brain tissue viability in both transient and permanent middle cerebral artery occlusion in primate models. However, the need for an onsite cyclotron as well as invasive arterial lines for quantitative measures have largely limited the clinical utility of PET, particularly for imaging acute stroke patients. Alternative MR approaches have recently been developed that are capable of providing information similar to PET derived CMRO2. Here, we will discuss the current status of MR imaging approaches aimed at measuring oxygen metabolism/oxygen extraction fraction with special emphasis on their potential clinical applications. In addition, new approaches on the horizon will also be discussed.

O-818

Long-term survival probability following conservative therapy according to simple time-intensity curve’s types of perfusion-weighted images in severe stroke patients due to the ipsilateral carotid-middle cerebral artery occlusion

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Purpose
It is difficult to anticipate long-term survival probability (SP) in acute stroke setting. The aim of our study was to investigate whether or not simple time-intensity curve (TIC) types of perfusion-weighted images (PWI) was useful for anticipating long-term SP in severe acute stroke patients due to the ipsilateral carotid-middle cerebral artery occlusion.

Materials and Methods
Included were patients 1) who were transferred to our institution within 24 hours of onset between January 2005 and August 2013, 2) who underwent MR angiography (MRA) displaying the affected internal carotid and middle cerebral artery (IC-MCA) occlusion and 3) who were treated without any reperfusion therapy. We evaluated TIC types, any death within 90 days and clinical outcome at 90 days. Time-intensity curves were generated on regions of interest set at symmetrical positions of the bilateral MCA territories. According to the time to peak (TP) and the peak signal (PS) comparing the affected side (a) with the contralateral side (c), we classified TIC pattern into four types and defined type 1 as \( [T_{Pa} - T_{Pc} \geq 1 \text{ s}] \) or more and \( P_{Sa} < 0.25 \times P_{Sc} \) or less than 0.25xPSc or TPa-TPc of 18 s or more, type 2 as TPa-TPc of 1 s or more and less than 18 s and PSa of 0.25xPSc or more and less than 0.75xPSc, type 3 as TPa-TPc of 1 s or more and less than 18 s and PSa of 0.75xPSc or more, and type 4 as TPa-TPc less than 1 s.

Results
Fifty-four patients were analyzed. There were 20, 20, 14 and 0 patients in type 1, 2, 3 and 4 of TICs. Twenty-seven patients (50%) died within 90 days, mostly within 10 days. In type 1, 2 and
3 of TIC, 17, eight and two patients died within 90 days, and SP of the Kaplan-Meier method at 90 days was 15%, 56.9% and 85.7% (p<0.0001), respectively. Among 12 survivors of type 2 at 90 days, there were two of mRS of 3, two of mRS of 4 and eight of mRS of 5. Among 12 survivors of type 3 at 90 days, there were two of mRS of 2, two of mRS of 3, five of mRS of 4 and three of mRS of 5.

Conclusions
Time-intensity curve types of PWI were useful for anticipating long-term survival probability in acute stroke setting. We must rescue patients with type 1 and improve clinical outcome of patients with type 2 or 3.

KEYWORDS: MR Perfusion-Weighted Imaging, Outcome, Stroke
Assessing Collateral Circulation

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Analysis of Reperfusion, Clinical, and Safety Results of Intra-arterial Ultrasound vs. Standard Microcatheter in The IMS Trials

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Purpose
The purpose of this study was to further investigate the efficacy and safety of intra-arterial (IA) microcatheter versus IA-ultrasound (US) microcatheter-assisted thrombolysis in acute ischemic stroke in the Interventional Management of Stroke (IMS) Trials.

Materials and Methods
Interventional Management of Stroke I, II, and III subjects with ICA (ICAO) and M1 occlusions following reduced-dose rtPA were compared based upon whether IA thrombolytic therapy was administered via microcatheter or in conjunction with high frequency (1.7 MHz)/low energy US via EKOS Micro-Infusion US microcatheter. Comparisons of the primary clinical (mRS 0-2), reperfusion (mTICI 2-3), and safety endpoints, including symptomatic intracranial hemorrhage (SICH), and death, were recorded and compared for each study individually and cumulatively according to treatment method.

Results
Table 1 outlines individual study and cumulative total results for reperfusion, clinical, and safety end points for IMS I, II, III according to treatment method. Symptomatic intracranial hemorrhage was more common with US-catheter-assisted thrombolysis than with standard microcatheter in the IMS Trials (p=0.013).

Conclusions
The IMS III Trials yielded experienced higher percent SICH with use of US-assisted thrombolysis, with no differences in reperfusion or good outcome, compared to standard microcatheter treatment. While the data are not adjusted as yet for relevant clinical variables, data suggest risks of ICH should be monitored closely in future studies of ultrasound-assisted thrombolysis following administration of IV rtPA.

KEYWORDS: Stroke, Thrombolysis, Ultrasonography

| Table | Standard Thrombolysis | Ultrasound-Assisted |
**Time and Infarct Size Dynamics in Major Anterior Circulation Ischemic Strokes**

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**Purpose**

Major anterior circulation ischemic strokes caused by occlusion of the distal internal carotid artery (ICA) or proximal middle cerebral artery (MCA) or both are an important subset of strokes, which account for about a third of all ischemic strokes and produce the most poor outcomes in this disease. These strokes are treatable by iv tPA and by endovascular methods with management governed primarily by time since stroke onset. However, the dynamics of infarct growth in these strokes are not well documented. The purpose of this study was to gain insight into infarct growth dynamics by measuring acute infarct size by diffusion-weighted (DWI) MR imaging (MRI) at known times after stroke onset in patients with documented ICA/MCA occlusions.

**Materials and Methods**

A total of 188 patients were included in the study. Forty-seven consecutive patients with terminal ICA or proximal MCA occlusions or both who underwent diffusion MRI within 30 hours of stroke onset were included in the retrospective part of this investigation. Prospectively, 141 patients were identified with the same inclusion criteria. Diffusion-weighted imaging lesion volumes were measured and compared to time since stroke onset.

**Results**

Acute infarct volumes ranged from 0.4 ml to 319 ml. There was no correlation between infarct size and time (r\(^2\) < 0.0006, p > 0.5). The mean infarct volume was 61 ml and was similar when grouped into temporal cohorts. Using 70 ml as a threshold, the majority of patients fell under this threshold regardless of whether they were imaged less than or more than eight hours after stroke onset. In a subset of patients imaged over multiple time points, the majority had diffusion lesion growth that was less than 2 ml per hour.
Conclusions
The lack of correlation between infarct volume and time after stroke onset suggests that there are factors more powerful than time that determine infarct size within the first 24 hours. The observations may be explained if infarct dynamics are determined primarily by the collateral circulation; that there is wide variation in the vigor of this circulation; and that the pattern of infarct growth may be logarithmic, similar to animal models where a rapid early growth of infarcts is followed by a slower infarct growth phase. If verified, the clinical implications include the possibility of treating many patients outside traditional time windows.

KEYWORDS: Infarct Prediction, Stroke, Treatment Assessment

O-822

Early Neurological Deterioration After Thrombolysis: Extra-penumbra Infarct Growth?

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Purpose
Early neurological deterioration (END) without obvious cause (intracerebral hemorrhage, malignant edema…) is observed in about 7% of thrombolysed patients. This could be explained by infarction of extra-penumbral tissue. To test this hypothesis, we compared infarct growth after treatment in patients with and without unexplained END (END+ and END-, respectively).

Materials and Methods
A case-control design was used for this study. From a population of 308 consecutive patients (2003-13) treated by iv rtPA ≤4.5 hours for anterior circulation stroke, we selected patients with unexplained END (END+ defined as ΔNIHSS 0-24 hours ≥ 4 points without obvious cause) with MR imaging (MRI) before [diffusion-weighted imaging (DWI)+perfusion-weighted imaging (PWI)] and ~24 hours after treatment. Control patients (END-) were selected (3 controls per case) by individual matching for initial DWI volume, initial NIHSS, occlusion and 24 hour-recanalization. Automated coregistration of MRI images before and after treatment and semi-automated segmentation of DWI and PWI lesions were performed blind to clinical status and visually checked. We studied the volume of Progressing Acute DWI lesions (PAD, defined as hyperintense voxels on 24 hour DWI without any abnormality on initial DWI) within or beyond the penumbra (Tmax>6s).

Results
There were 10 eligible cases (END+). They did not differ from controls (END-) for age (mean ±SD 73±14 versus 63±17; p=0.08), initial NIHSS [median (IQR) 10 (8-12) versus 11 (7-15); p=0.52], onset-to-treatment time [168 (122-210) versus 142 (110-185) min; p=0.27], proximal occlusion i.e., internal carotid artery or proximal MCA [n=10 (100%) versus n=25 (83%); p=0.31], initial DWI volume [13 (4-21) versus 14 (6-24) cc; p=0.98] or mismatch volume [86 (49-142) versus 56 (32-104) cc; p=0.27]. The volume of symptomatic tissue before treatment (core+penumbra) was also similar [END+ 97 (56-188) versus END- 87 (47-130) cc; p=0.44]. PAD volume was larger in END+ than END- patients [median (IQR) 38 (24-81) versus 10 (3-31)
cc, p=0.014]. Furthermore, END+ had larger extra-penumbral PAD than END- patients [16 (10-350) versus 5 (1-16) cc, p=0.047].

Conclusions
Unexplained early neurological deterioration after intravenous thrombolysis is associated significantly with, and probably caused by, infarct growth beyond penumbra.

KEYWORDS: MR Imaging/Diffusion, Stroke, Thrombolysis

O-823
11:30AM - 11:45AM

Chronic Neurovascular Uncoupling Syndrome

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Toronto, ON

O-824
11:45AM - 11:51AM

White matter Ischemic Changes in Patients with Hyperacute Ischemic Stroke: A Voxel-based Analysis Using Fractional Anisotropy and DSC Perfusion

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Purpose
Using diffusion tensor imaging (DTI)-fractional anisotropy (FA), the ischemic microstructural changes can be heterogeneous and variable between the infarction core and ischemic regions (1). The purpose of this study was to evaluate the DTI-FA changes of white matter infarction and hypoperfusion in patients with acute ischemic stroke (AIS) using a quantitative voxel-based analysis.

Materials and Methods
The inclusion criteria for this prospective study were: patients with AIS who presented within six hours from symptom onset with acquisition of both DTI and DSC perfusion on a 3 T MR scanner (Skyra, Siemens). Dynamic susceptibility contrast perfusion was performed using a gradient-EPI sequence (TR/TE: 1450/22 msec, FA 90º, FOV: 22×22-cm, matrix 128 mm, voxel size 1.7 x 1.7 x 4 mm³, GRAPPA x3) after intravenous injection of 0.1 mmol/kg of Multihance-gadolinium contrast. Diffusion tensor imaging were acquired by using single-shot echo-planar imaging (TR/TE, 5500/82 ms; FOV: 22×22-cm; matrix 128 mm; voxel size 1.5 x 1.5 x 2 mm). Diffusion-sensitized gradients were applied along 20 noncolinear directions with a b-value of 1000 s/mm² resulting in four minutes acquisition time. The measured FA, apparent diffusion coefficient (ADC), and Tmax images were coregistered for voxel-based quantification using a region-of-interest (ROI) approach in the ipsilateral affected side and in the homologous contralateral white matter (WM). The infarction core and hypoperfusion were determined by threshold method defined as an ADC value less than 600 x 10−6 mm2/s 2 and DSC-Tmax > 2 sec 3. A mask of the gray matter (FA threshold > 0.15) was generated for each patient to ensure
extraction of voxel values is limited only to WM. The image analysis was performed by combination of FDA approved software (Olea Medical, La Ciotat, France) and Matlab. Data were analyzed by unpaired t-test.

Results
Fifteen patients (9M, age 48-83 years old) met our inclusion criteria. The average time from onset to MR imaging was 4.3 hours and the NIH stroke scale range was 4-12. Total number of voxels included were 1100 for WM infarction, 5100 for WM hypoperfusion and 3300 for normal contralateral WM. The mean of FA values were significantly higher in the regions of WM hypoperfusion (p<0.0001, t: 7.90) and significantly lower in the regions of WM infarction (p<0.0001, t: 6.52), compared to FA values in the contralateral normal WM. In subanalysis of hypoperfused regions with different Tmax, the FA values were significantly higher (p<0.0001, t: 32.0) in the hypoperfused WM with Tmax ≥ 6 sec in comparison to regions with Tmax< 6 sec with a mean difference of 0.14 (see Figure 1). The mean of Tmax values was significantly higher in both WM hypoperfusion (p<0.0001, t: 58.31) and WM infarction (p<0.0001, t: 42.70), compared to Tmax values in the contralateral normal WM. The mean ADC values were significantly lower in the WM infarction (p<0.0001, t: 58.3) in comparison to hypoperfused WM and normal WM. There was no statistically significant difference between the mean ADC values in the WM hypoperfusion and normal WM (p =0.07, t: 2.1).

Conclusions
Diffusion tensor imaging-FA is decreased in regions of WM infarction and increased in hypoperfused WM in patients with AIS. The FA values are significantly higher in the hypoperfused WM with Tmax ≥ 6 sec suggestive of early microstructural changes related to ischemia.

KEYWORDS: Actue Stroke, Diffusion Tensor Image, Dynamic Susceptibility Contrast-Enhanced
Wake-up Stroke: Multimodal CT based Measurement of % Water-Increase in Ischemic Lesions as possible Surrogate Marker for Time of Onset

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Purpose
In wake-up strokes, obtaining the time of symptom onset (T0) has been a major focus of acute stroke imaging. In the early infarct core there is unidirectional increase of percent water content (edema) with time. The CT value calibrated at 100% water content (HU=0) correlates linearly with tissue density. The purpose of this study was to apply CT-based quantification percent water increase within early infarct core and test this physiological marker for determining T0.

Materials and Methods
In CT, the product of volume and its density remains constant regardless of any amount of water added. When water of volume VE is added to a volume V0 with density D0 resulting in a new volume V1 and density D1, then V0xD0=V1xD1=(V0+VE)xD1 (Eq. 1). The proportion of added water within V1 is VE/V1 which can be expressed as 1/(D1/(D0-D1)+1) (Eq. 2).
edematous infarct at time T1 with volume V1 and lowered density D1 has a percent water increase of VE/V1 which can be calculated from Eq. 2, where D1 is the density within the ischemic lesion at T1 (identified by CTP) and D0 is the density at T0 (measured in the healthy contralateral hemisphere). Precision of Eq. 1 and Eq. 2 was tested in a set of increasingly diluted iodine solutions. In 50 acute proximal MCA occlusive strokes, measurements of percent water content were correlated with time between symptom onset (T0) to imaging (T1). Receiver operating characteristic (ROC) curve analysis was performed to predict (T1-T0)<4.5 hours.

Results
The optimal cut-off value of percent water increase within the ischemic lesion to predict symptom onset <4.5 hours was 7.0% (94.4% sensitivity, 88.2% specificity, AUC 0.93, p<0.0001).

Conclusions
This novel approach of CT-based measurement of percent water increase within early ischemic brain is a reliable method to identify patients with time of symptom onset <4.5 hours.

KEYWORDS: CT And Stroke, CT Perfusion, Stroke

![Measurement of %-increase of water content in ischemic lesion](TCT_O-825_FIG.jpg)

Thursday
10:30AM - 12:00PM
Palais des congres de Montreal, 517a

85 - PARALLEL PAPERS: Brain: Functional Imaging III
O-826

10:30AM - 10:37AM
Increased Between-Network Causal Connectivity in Substance Dependence

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Purpose
Drug addiction may be associated with changes in the functional organization of the brain. The default mode network (DMN) and networks that underlie habit and executive control have been implicated in drug-seeking behavior (1, 2). While seed-based resting state analyses have demonstrated altered connectivity in brains of drug users (3, 4), the strength and direction of connectivity between larger functional networks has not been explored. The goal of this study was to investigate between-network connectivity and the direction of such connections using Granger causality analysis. We hypothesized that compared to controls, substance dependent individuals (SDI) would have stronger connectivity between the DMN (internal mental processing) and basal ganglia (habit formation) networks and weaker connectivity between executive control and DMN.

Materials and Methods
Fifty SDI (28M/22F, 34±8 years) were compared to 50 controls (25M/25F, 32±9 years). Substance dependent individuals met DSM-IV criteria for dependence on amphetamine and/or cocaine. Gradient recalled echo (GRE) functional MR imaging (fMRI) scans were acquired over five minutes during quiet rest with eyes closed. Data analysis using group independent component analysis was conducted on SDI and controls separately (GIFT toolbox). Fourteen independent components were selected automatically using template matching to a standardized set of resting state networks (http://findlab.stanford.edu/functional_ROIs.html) (5). Each network time series was concatenated across subjects. Signals were adjusted for motion, cerebrospinal fluid (CSF), and white matter signal fluctuations. Between-network connectivity was calculated using Granger causality. Group comparisons were conducted using nonparametric permutation statistical testing (200 iterations). Significance levels were set at p<0.05, FDR-corrected for multiple comparisons.

Results
Substance dependent individuals showed more bidirectional connectivity whereas controls showed more unidirectional connectivity among the 14 network components (Figure 1). Furthermore, among 182 possible between-network pairs, only three pairs differed significantly in patients compared to controls. Compared to controls, SDI showed stronger connectivity from the DMN to the basal ganglia network and from the right executive control network to the DMN.

Conclusions
Greater connectivity from DMN to basal ganglia resting state networks in SDI compared to controls is consistent with the hypothesis that internal mental processes (DMN) influence habit formation (basal ganglia) to a greater extent in SDI than controls. Pathological habit has been implicated in the persistence of drug-seeking behavior in SDI. Contrary to prediction, there was greater connectivity from the executive control network to DMN in SDI. Increased bidirectional connectivity may suggest overall less efficient functional organization in brains of drug users.

KEYWORDS: Functional Connectivity MR, Functional Networks, Resting-State FMRI
Iron Particles as an MRI Contrast Agent May Differentiate Dural-Based Masses Better than Gadolinium Contrast

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Purpose
Enhancing dural-based intracranial masses often are diagnosed as meningiomas, however this may lead to inappropriate management when other pathology is encountered. Unlike gadolinium-based contrast agents (GBCA), ferumoxytol enhancement characteristics may better differentiate among causes of dural-based disease and may contribute to a better understanding of pathophysiology.

Materials and Methods
We searched the clinical records in our research database comprising two separate ferumoxytol neuroimaging protocols to retrieve all studies in patients imaged with dural-based intracranial masses. Cases from these protocols with the same histopathology elsewhere in the central nervous system (CNS) and extracranial head and neck also were included. We retrospectively evaluated immediate and 24-hour delayed postferumoxytol scans using T1- and T2-weighted sequences and compared enhancement patterns to GBCA-enhanced MR imaging (MRI).

Results
Fifteen cases were identified in eight females and seven males (aged 34-76 years). Five meningiomas, one case each of hemangiopericytoma and schwannoma showed no intratumoral enhancement with ferumoxytol at any time. One extracranial hemangiopericytoma and transcranial paragangioma showed only delayed enhancement. One meningioma showed delayed postferumoxytol enhancement. Three dural metastases showed delayed enhancement that was more prominent compared to GBCA-enhanced MR imaging (MRI). One dural and one
intramedullary cavernous malformation showed immediate enhancement that increased at delayed imaging.

Conclusions

Ferumoxytol-enhanced MRI may better differentiate among causes of dural-based masses than GBCA-enhanced MRI. Nonenhancement likely reflects intact capillary tight junctions in benign disease. Blood-brain barrier compromise in malignant dural disease presumably leads to vascular exit and intracellular uptake. Immediate postferumoxytol enhancement is typical of vascular lesions and allows differentiation from benign and malignant dural neoplasms.

KEYWORDS: Brain Perfusion, Cancer, MR Imaging Perfusion

O-828

Subject-Level Characterization of Functional Connectivity in Schizophrenia Utilizing Region-Specific Graph Theoretic Analysis

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Purpose

Given the heterogeneity across individual patients, to apply resting state functional MR imaging (rs-fMRI) assessed functional connectivity for clinical use, methods are needed that can assess individual subject whole-brain functional connectivity while retaining region-specific resolution. Here we develop methodology for quantification of inter-network connectivity patterns in individual subjects, for assessing the contribution of individual brain regions to these results, and for comparison of individual subject connectivity to a control distribution. We apply this methodology to characterizing functional connectivity perturbations in a cohort of schizophrenic patients.

Materials and Methods

A publicly available dataset from the COBRE (1) research group was utilized. Briefly, the data included 72 schizophrenic patients spanning a variety of DSM 295 codes, with 75 group age-matched controls (ages 18-65 in each group). Available phenotypic information included DSM category, handedness, age, and gender. Each subject underwent T1 MPRAGE and five min BOLD fMRI (TR=2 sec) sequences. Data were preprocessed using FSL (FMRIB, Oxford, UK), SPM8 (Wellcome Trust, UK) and custom MATLAB (Mathworks, MA) scripts to complete slice-timing correction, rigid-body motion correction, segmentation and normalization to a standard template (MNI, 2mm), COMPCOR nuisance regression, bandpass temporal filtering (0.01-1Hz), and spatial smoothing (6mm Gaussian kernel). The whole brain gray matter (cortical, deep, and cerebellar) was parcellated automatically into 875 anatomically and functionally compact (2) regions of interest (ROIs). Each timecourse was extracted as the first eigenvariate of the set of voxel timecourses across the ROI. Pearson correlation coefficients between each pair of ROI timecourses were calculated. The set of average control correlation coefficients were fed as a weighted adjacency matrix (thresholded at the false discovery rate, FDR, for alpha=0.05) into the infomap modularity algorithm (3) to generate a map of functional networks spanning gray matter. For each network and for each subject, the intra-network efficiency of the FDR thresholded adjacency submatrix was calculated using the Brain Connectivity Toolbox (4), with
a similar measure applied to the internetwork efficiency. Individual subject network efficiency maps were calculated as z-scores relative to the distribution of control subjects.

Results
As shown, 17 networks spanning all of brain gray matter were detected (Figure, each node is plotted at the left hemisphere network centroid; networks were symmetric across midline) (5). Without any a priori information of expected network structure, the methods produced spatially compact, left-right symmetric, functionally related modules corresponding to known resting state networks (6). The differences in network efficiency between schizophrenics and control for each pair of networks (Figure, top left; red indicates increased efficiency in schizophrenics) show that this population has reduced internetwork efficiency in regions considered part of the salience network (anterior insula, dorsal anterior cingulate) but increased internetwork efficiency in limbic regions such as the amygdala, hippocampus and orbitofrontal cortex, overall consistent with prior studies (7, 8). In individual subjects, differing patterns of connectivity are seen seemingly dependent on the particular DSM category of the schizophrenia (Figure, top right and bottom left and right).

Conclusions
We have developed a methodology for rs-fMRI analysis that allows for interrogation of whole-brain functional connectivity that can be traced back to individual brain regions of particular networks in individual subjects. We find patterns of group differences between schizophrenics and controls that are commensurate with those described in the literature (7, 8). We further identify particular patterns of connectivity in individual patients that show interesting variations depending on the individual subtype of schizophrenia.

KEYWORDS: Graph Theory, Psychiatry, Resting-State FMRI
Brain Tumor Identification Using Gaussian Mixture Model Features and Decision Trees Classifier
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Purpose
Image processing enhances the accuracy of imaging information for medical diagnosis; this is particularly the case with magnetic resonance imaging (MRI). The feature extraction process is the main step to obtain the information from raw medical images, and each feature can be described within image; most features are based on statistical computation. We propose a novel image processing method for glioblastoma (GBM) detection based on the Gaussian mixture model (GMM) features which represent the weighted sum of Gaussian component densities. Gaussian mixture model provides some features, namely, mean, standard deviation and weight. These features are extracted from MR (T1, T2 and FLAIR) images in order to enhance GBM identification.

Materials and Methods
Multithresholding segmentation technique was applied on the morphological MR images (T1WI, T2WI, and FLAIR) to detect the abnormal area (GBM tumor); redundant features were discarded, thereby improving the performance of the feature-based scheme to detected GBM. The Decision Trees classifier was applied on the GMM features and reduced using three principal components to evaluate the classifier accuracy of cancer and normal area discrimination. The discrimination between GBM and normal tissue in the images, was compared using three performance indicators, namely, accuracy, false alarm and missed detection, and three modes of MRI images T1, T2 and FLAIR were employed.

Results
Seventeen images from each sequence T1-, T2-weighted and FLAIR were analyzed. We successfully applied new imaging features using the raw data images from 17 patients. Using the Decision Trees classifier, the GMM features demonstrated the best performance overall. For the T10- and T20-weighted images, the accuracy performance was 100% with 0% missed detection and 0% false alarm respectively. In the FLAIR mode, the accuracy decreased to 94.11% with 2.95% missed detection and 2.95% false alarm. The following figures show the simulation results of the present proposal.

Conclusions
Gaussian mixture model features successfully discriminate between GBM and normal tissue. The high accuracy of this technique demonstrates the efficiency of this work, and promises to enhance the GBM diagnosis. This is important as robust feature extraction is needed in order to develop imaging biomarkers that accurately reflect the genomic and pathologic composition of the tumor.

KEYWORDS: Classification, Glioblastoma

| Simulation result of performance indicators based on the reduced GMM features |
|-----------------------------|---------------|----------------|------------------|
| MR mode | Accuracy | False alarm | Missed detection |
| T1 | 100 | 0 | 0 |
| T2 | 100 | 0 | 0 |
| FLAIR | 94.11 | 2.95 | 2.95 |
High Resolution DTI of the Optic Pathway in NF1 Patients with Readout-segmented, Multi-shot Echo Planar Imaging at 3T

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Purpose
Children with neurofibromatosis type 1 (NF1) have up to a 40% incidence in developing optic nerve glioma associated with visual loss. Diffusion tensor imaging (DTI) may be helpful in assessing optic pathway integrity as a marker for treatment in these patients. However, susceptibility artifacts that are common in conventional DTI using single-shot echo planar imaging (EPI) can severely distort areas of interest such as the optic tracts and optic chiasm. As such, a readout-segmented multi-shot EPI technique (rsEPI) (Siemens RESOLVE, Erlangen Germany) was utilized to minimize susceptibility distortions of the skull base which may preclude accurate diffusion tensor evaluation of the optic apparatus.

Materials and Methods
IRB approval was obtained for this prospective pilot study. Healthy adult volunteers, children with NF1 with and without optic gliomas as previously diagnosed with MR imaging were recruited. A final axial protocol, consisting of seven shots, 12 diffusion directions, b-values of 0, 250, 500, and 800, 1.2 x 1.2 x 2.2 mm3 voxel resolution, and 16 slices was chosen on 3 T scanners (Siemens Verio and Trio, Erlangen, Germany). Positioning of the slices was done to cover the optic tracts, optic chiasm, and as much of the optic radiations as possible. Healthy adult volunteers were scanned with both the conventional product DTI and rsEPI technique, matching FOV, resolution, b-values, and diffusion direction scheme. Fractional anisotropy (FA) maps of the optic nerves and tracts for both product and rsEPI were evaluated for significant differences.
Fractional anisotropy data sets consisting of subjects with NF1 with and without optic gliomas were evaluated by two fellowship-trained neuroradiologists separately for region of interest (ROI) placement along the bilateral intraorbital, intracanalicular, and prechiasmal optic nerves, chiasm, bilateral optic tracts and Meyer's loops. The resulting FA and mean diffusivity (MD) values were analyzed for appreciable changes in patients with NF1 with and without optic gliomas.

Results

Five healthy adult volunteers, three children (ages 7-15 years) with NF1 without optic glioma, and four children (ages 4-18 years) with NF1 with optic glioma were imaged. T-test of the means of the FA on the optic nerves and tracts on healthy volunteers were significantly higher in the rsEPI (0.49 ± 0.14) compared to product DTI (0.29 ± 0.12) (t=2.94, p=0.011). The mean of the FA values from both neuroradiologists were significantly higher (t=3.07, p=0.0025) in NF1 patients without tumor (0.59 ± 0.12) versus NF1 patients with optic gliomas (0.52 ± 0.14). Conversely, mean MD values from both neuroradiologists were significantly higher (t=3.26, p=0.0014) in NF1 patients with tumor (0.00098 ± 0.0003 mm²/s) versus NF1 patients without optic gliomas (0.00082 ± 0.0003 mm²/s). Comparison of FA values between healthy volunteers (0.49 ± 0.14) and NF1 patients without optic gliomas (0.59 ± 0.12) were not significant (t=1.93, p=0.09). Figure A shows axial FA map from rsEPI technique with visualization of the chiasm (arrow) in a healthy adult volunteer. In contrast, Figure B of the same volunteer shows product DTI FA map at the same level with significant distortion of the chiasm (arrow).

Conclusions

High resolution DTI with readout-segmented multi-shot EPI technique can better visualize the optic pathway and allow more confident measurements of anisotropy. This is shown by a significant increase in FA with rsEPI versus product DTI. Also, in patients with NF1, FA decreases and MD increases with the development of optic gliomas. Further study with a larger patient population would be necessary to establish treatment thresholds.

KEYWORDS: DTI, Neurofibromatosis, Optic Nerve
Intracranial Atherosclerotic Disease: Impact of Regional Stenotic Lesions on Systemic Intracranial Hemodynamics

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Purpose
Digital subtraction angiography (DSA) is the gold standard for the diagnosis and evaluation of intracranial atherosclerotic disease (ICAD). Cerebral hemodynamic factors were considered to be critical in the development and risk stratification of ICAD. The purpose of this study was to evaluate the feasibility of 4D flow MR imaging for the comprehensive evaluation of the impact of regional stenotic lesions on intracranial hemodynamics in all major vascular territories of the brain including quantitative analysis of peak velocity and mean blood flow in the large intracranial vessels.

Materials and Methods
Twenty-one symptomatic ICAD patients (11 male + 10 female, age=65±16 years) with mild to
severe intracranial vascular stenosis and three normal volunteers were included in this study. The stenosed vessels in these patients were internal carotid artery (ICA, n=8), middle cerebral artery (MCA, n=7), vertebral artery (VA, n=2), basilar artery (BA, n=5), and posterior cerebral artery (PCA, n=3). Four-dimensional flow data acquisition with ECG synchronization (TR/TE=5.2/2.8ms, flip angle=15º, VENC=80-100cm/s, spatial resolution=1.1mm×1.1mm×1.5mm, temporal resolution=42ms, acquisition time=15-20min) was performed for all subjects on a 1.5 T MRI scanner (Siemens, Germany). Intracranial hemodynamics was visualized by time-integrated 3D pathlines demonstrating the cumulative flow path over one cardiac cycle in all major intracranial arteries and veins (example for left ICA and right MCA stenosis in the figure). Peak velocity (m/s) and mean blood flow (ml/s) in manually positioned planes were quantified at different vascular regions (EnSight, CEI, USA). Due to limited spatial resolution of 4D flow MRI, locations proximal to the stenosis were used for flow quantification. Blood flow and peak velocity ratios of the nonaffected versus affected side (N/A) or the right versus left side (R/L) for BA stenosis and volunteers were calculated in four vascular territories (ICA, MCA, PCA, and ACA) for all subjects.

Results
For the healthy subjects, blood flow velocities were distributed coherently across the brain vessels [R/L blood flow and peak velocity ratios: ICA (1.03±0.03, 0.92±0.10), MCA (1.01±0.07, 1.04±0.16), PCA (0.98±0.05, 1.06±0.09), ACA (1.12±0.15, 1.00±0.20)]. For the patients with ICA stenosis, highly asymmetric blood flow and peak velocity were observed in the other three vascular territories in MCA (2.27±2.31, 1.34±0.52), PCA (0.70±0.19, 0.86±0.25), and ACA (5.16±6.25, 1.13±0.60). Similarly for those patients with MCA stenosis, highly asymmetric flow and peak velocity were observed in the vascular territories in ICA (2.46±2.14, 1.60±1.16), PCA (0.76±0.24, 0.95±0.53) and ACA (0.77±0.39, 0.80±0.23). We also noted that the blood flow ratios in PCA were opposite to the ratios in ICA and MCA, which indicated intracranial blood flow redistribution due to regional stenotic lesions. However, the impact of regional PCA and BA stenosis on the hemodynamics in other vascular territories (e.g., ICA, MCA) were not significant. In addition, we found that the blood flow proximal to the stenosis (ICA: 3.16±1.45ml/s; MCA: 1.20±0.52ml/s) were significantly lower compared with the normal contralateral vessels (ICA: 7.17±2.38ml/s; MCA: 3.65±0.82ml/s) in two subgroups with ICA (p=0.002) and MCA (p<0.001) stenosis.

Conclusions
Our findings demonstrated significant impact of regional stenotic lesions on the hemodynamics in other vascular territories. Quantitative hemodynamic markers in the major intracranial vessels may provide additional insight into the pathophysiology and risk stratification for ICAD patients. In addition, 4D flow imaging may be useful for the monitoring of intracranial hemodynamic alterations for ICAD patients during interventions.

KEYWORDS: Hemodynamics, Intracranial Atherosclerosis, Phase Contrast Imaging
Diffusion Tensor Imaging Measures in Posterior Limb of the Internal Capsule Correlate with Motor Function Outcome in Stroke Patients

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Purpose
Motor outcome prediction is important in determining the effective rehabilitation strategy provided for stroke patients. Recent advances in neuroimaging techniques have contributed to
motor outcome prediction after stroke. Studies using magnetic resonance imaging (MRI) suggest that stroke location rather than the volume of an infarct is more important for predicting functional outcomes (1, 2) and that lesions of the internal capsule were associated with a significantly lower probability of return of isolated hand motor function than lesions of the cortical, subcortical regions and corona radiata (3). In this study, we examined the relationship between structural integrity of the posterior limb of internal capsule (PLIC) measured using diffusion tensor imaging (DTI) and upper limb motor outcome in stroke patients.

Materials and Methods
Diffusion tensor imaging (DTI) data were obtained from nine stroke patients (6 male, chronicity of stroke range 2-23 months) with persistent upper-extremity motor deficits who completed maximum 15 sessions' interventional rehabilitation facilitated by Brain-Computer Interface (BCI) and Functional Electrical muscle Stimulation (FES). Neuroimaging scans and clinical motor outcome assessment including the hand function domain of Stroke Impact Scale (SIS) and the Action Research Arm Test (ARAT), were conducted at four time points for all patients: pre-, mid-, post- and one-month-after intervention. Values of fractional anisotropy (FA), axial diffusivity (AD), radial diffusivity (RD) and mean diffusivity (MD) were computed for the white matter tracts of PLIC. Asymmetry index of each DTI-derived metric comparing ipsilesional and contralesional PLIC--(Value_contralesional - Value_ipsilesional)/(Value_contralesional + Value_ipsilesional), was further calculated. The asymmetry scores range from -1 to 1, with positive and negative values indicating reduced or increased DTI measures respectively in ipsilesional PLIC relative to the contralesional PLIC, a value of 0 indicating an equivalent measurement between the two hemispheres. Values of DTI-derived metrics and asymmetry index of each metric were assessed in relation to the motor outcome measurements, respectively.

Results
Ipsilesional PLIC showed significantly reduced FA and increased diffusivity (AD, RD and MD) compared with contralesional side. Regression analyses on the PLIC DTI and motor function measurements revealed that better performance in motor outcome measures was related to higher FA values and lower diffusivity in ipsilesional PLIC. Asymmetry indices of DTI-derived metrics also showed significant correlation with motor function outcomes (all p-values < 0.00001 for regression coefficients), with lower FA asymmetry scores and higher diffusivity asymmetry scores associated with better motor function performance (Figure 1; Table 1).

Conclusions
The results of this study suggest that motor functional recovery of upper-limb extremity in stroke patients receiving BCI-facilitated intervention relates to microstructural status of the PLIC. Thus DTI-derived measures may be applicable for upper-limb motor outcome prediction and in monitoring the effect of therapy. Asymmetry indices of DTI-derived measures were shown to be stronger predictors compared to pure DTI measures, which may reflect a potential remodeling of both the ipsilesional and contralesional PLIC in stroke recovery.

KEYWORDS: Biomarkers, Diffusion Tensor Image, Stroke

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**Figure 1:** Shown are asymmetry indices of FA and RD correlating with upper limb function assessed by ARAT.

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**O-833**

White Matter Diffusion Abnormalities in Carotid Artery Disease: A Systematic Review and Meta-analysis

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**Purpose**

Abnormalities in apparent diffusion coefficient (ADC), fractional anisotropy (FA), and mean diffusivity (MD) values can be used to assess microstructural damage to white matter tracts and
could represent a quantitative marker of chronic ischemia and thereby potentially serve as a stroke risk factor. We performed a systematic review and meta-analysis to evaluate the association between unilateral carotid stenosis/occlusion and ipsilateral ADC, FA, or MD abnormality.

Materials and Methods
With the aid of an experienced medical librarian, we performed a comprehensive literature search evaluating the association of carotid stenosis/occlusion and quantitative white matter diffusion imaging, including ADC, FA, and MD values. The included studies were retrospective or prospective studies examining patients for ADC, FA, and MD values ipsilateral and contralateral to the site of carotid artery disease. A meta-analysis using standardized mean differences with assessment of study heterogeneity and publication bias was performed.

Results
Of the 2920 manuscripts screened, seven met eligibility for systematic review including a total of 257 patients. Of the manuscripts included for meta-analysis, three studied ADC values, six studied FA values, and three studied MD values. The standardized mean difference for ADC, FA, and MD values between cerebral hemispheres ipsilateral and contralateral to carotid artery disease site were 1.13 (95% CI: 0.79-1.47, p <0.001), -0.42 (95% CI: -0.62 to -0.21, p<0.001), and 0.23 (95% CI: -0.32-0.77, p=0.41), respectively. Measures of heterogeneity showed mild heterogeneity and no statistically significant publication bias in any of the three meta-analyses.

Conclusions
Carotid artery steno-occlusive disease is associated with significant ADC and FA value changes, suggesting that carotid disease is associated with quantifiable white matter microstructural damage. Further work is warranted to assess the ability of white matter diffusion imaging abnormalities to predict clinically evident ischemic events.

KEYWORDS: Carotid Stenosis, Stroke, White Matter Tracts
Diffusion and Perfusion Weighted Imaging in Acute Stroke: How Well Do Diffusion Restricted, Perfusion-Diffusion Mismatch Ratios and Hypoperfused Volumes Correlate with Clinical Outcomes?

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Purpose
Treatment decisions in patients with acute stroke often are made based upon imaging findings at MR imaging (MRI) including diffusion (DWI) and perfusion (PWI) sequences. The role of "penumbra" imaging, however, is still not established in clinical practice. Our aim is to correlate stroke outcome with DWI restricted lesion volume and volume of hypoperfused brain tissue.
Materials and Methods
We obtained IRB approval for this retrospective study. We did a search for MRI performed with PWI for evaluation of acute stroke. Our search returned 197 patients. Thirteen patients were excluded from the final analysis (12 had no PWI performed and 1 PWI study was performed for evaluation of brain tumor, not stroke). On a Vitrea workstation, we utilized OLEA software for postprocessing of PWI and DWI studies. The arterial input function was selected automatically by the software. The following perfusion parameters were obtained: mean transit time (MTT), cerebral blood flow (CBF), cerebral blood volume (CBV) and Tmax. The DWI lesion volume was calculated by setting an ADC value threshold level to match the DWI abnormality. The volume of hypoperfused brain tissue was calculated using the Tmax, with threshold level typically set at six seconds. Finally, we performed a chart review to correlate the clinical outcomes with the DWI restricted volumes and volumes of hypoperfused brain tissue. In our initial evaluation, we assessed the first 35 patients. Treatment outcomes were defined as the change in NIH Stroke scale value (NIHSS) between admission and discharge. A poor clinical outcome was defined as a decrease in NIHSS less than four. We performed a statistical analysis utilizing the SPSS Statistics Data Editing software. We performed a Pearson correlation in order to identify how well hypoperfused volume, DWI restricted lesion volumes and PWI-DWI Mismatch Ratios correlated with NIHSS values at admission and discharge.

Results
There were 35 patients in our initial evaluation with average age 69 years (range 40-92 years). There were 15 males and 20 females. Eight patients were excluded from our final analysis due to the absence of either an admission or discharge NIHSS value. The range of diffusion restricted lesion volumes included in the initial evaluation was 2.3-153 mL. The range of hypoperfused volumes included in the initial evaluation was 0.46-243 mL. Fourteen patients had a poor clinical outcome as defined by our study. The mean of DWI restricted lesion volumes in this subset of patients was 48.6 mL [standard deviation (std. dev.) 43.6]. The mean of hypoperfused volumes in this subset of patients was 92.5 mL (std. dev. 53.5). Thirteen patients had a good clinical outcome as defined by our study. The mean of DWI restricted lesion volumes in this subset of patients was 35.2 mL (std. dev. 36.7). The mean of hypoperfused volumes in this subset was 61.9 mL (std. dev. 55.5). No significant difference in DWI restricted lesion volumes or hypoperfused volumes between our two subsets of patients was seen. A statistically significant correlation was detected between hypoperfused volumes and DWI restricted volumes (r=0.753, p<0.001), NIHSS at admission (r=0.700, p<0.001), and NIHSS at discharge (r=0.748, p<0.001). The DWI restricted lesion volumes also correlated significantly with the NIHSS values at admission (r=0.535, p=0.004) and discharge (r=0.507, p=0.01), although to a lesser degree. The PWI-DWI mismatch ratios showed no significant correlation to either NIHSS value at admission or discharge. A partial correlation of hypoperfused volumes and NIHSS values was performed, controlling for age, sex and DWI restricted volume. This showed that hypoperfused volume has a statistically significant correlation with NIHSS values at admission (r=0.592, p=0.004) and discharge (r=0.662, p=0.001), independently of the other variables.

Conclusions
In our initial assessment of 35 patients, those with poor outcomes tended to have higher DWI restricted volumes and hypoperfused volumes relative to those who had good clinical outcomes, although this did not reach statistical significance. We were able to show that there is a statistically significant correlation between hypoperfused volumes and NIHSS values at admission and discharge. A significant correlation also is seen between DWI restricted volumes
and NIHSS values, although to a lesser degree. The correlation of hypoperfused volumes with NIHSS values was independent of DWI restricted lesion volume, age and sex. No significant correlation is seen with PWI-DWI mismatch ratios and NIHSS values at admission or discharge, emphasizing that mismatch ratios must be interpreted in the context of DWI restricted lesion and hypoperfused volumes. We believe that a further analysis of the remaining patients in our study will allow us to better delineate the relative importance of DWI restricted lesion and hypoperfused volumes in stratifying patients for potential treatment.

KEYWORDS: Diffusion-Perfusion Mismatch, Diffusion-Weighted Imaging, Stroke

O-835

Variables of 123I-IMP SPECT by graph plot method relating to elevation of blood sampling global oxygen extraction fraction in patients with a high-grade carotid stenosis

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Purpose
Hyperperfusion syndrome is likely to occur in patients who undergo CEA or CAS for a high-grade carotid stenosis causing hemodynamic failure of stage 2 or 3 compared to stage 1. However, it is difficult to identify patients with stage 2 or 3 in general hospitals. In patients with stage 2 failure, oxygen extraction fraction (OEF) is elevated to maintain cerebral metabolic rate of oxygen (CMRO2). Not regional but global OEF can be calculated from blood sampling and SPECT also can be performed in general hospitals. The aim of our study was to investigate whether or not some variables of 123I-IMP SPECT by graph plot method is related to elevation of blood sampling oxygen extraction fraction (OEF).

Materials and Methods
Included in our study were patients 1) who underwent elective CAS for symptomatic or asymptomatic lesions between September 2010 and July 2013, 2) who underwent 123I-IMP SPECT before CAS and 3) in whom blood sampling OEF was calculated just before CAS. Oxygen extraction fraction was calculated from cerebral arteriovenous oxygen difference. Arterial blood was sampled from the common carotid artery and venous blood from the dominant-sided superior jugular bulb. Variables of 123I-IMP SPECT calculated with graph plot method were as follows; supra- and infra-tentorial cerebral blood flow (CBF) on regions of interest (ROIs) set in the affected (a) and contralateral (c) sided MCA territory before and after 1 gram acetazolamide challenge (D). Cerebral blood flow against ipsilateral cerebellar blood flow (MCA/CE) was calculated as CBF(a) divided by cerebellar BF(a) x 100, cerebral vasoreactivity (CVR) as (D_CBF(a) - CBF(a) ) divided by CBF(a) x100 and asymmetry index (AI) as CBF(a) divided by CBF(c) x 100. Evaluated were relationship between elevated OEF and SPECT variables.

Results
During the study period, 142 patients matched to our criteria. Average age, OEF, CBF(a), CBF(c), MCA/CE(a) and CVR(a) were 74.4±6.7 years, 0.42±0.075, 39.3±7.5 ml/min/100g, 39.9±7.9 ml/min/100g, 87.3±16% and 26.9±21, respectively. Median OEF and MCA/CE were 0.41 (0.37-0.47; IQR) and 88.9% (76-98). When cut-off value of significant elevation of OEF
was defined as 0.47 (the third quartile), there were significant differences in MCA/CE(a) (p<0.05), CBF(a)(p<0.05) and CBF(c)(p<0.05) between elevated and nonelevated OEF groups. Stepwise regression analysis showed that MCA/CE was only an independent significant variable (p<0.05) for OEF elevation of 0.47 or more. Receiver operating characteristic curve displayed that cut-off point of MCA/CE was 88.9%. Two by two table showed that there was a significant difference between MCA/CE of 88.9% or less and OEF of 0.47 or more (p<0.01, odds ratio of 3.1). AI, CVR and D_MCA/CE were not related to elevated OEF.

Conclusions
Middle carotid artery/CE in the affected side calculated from 123I-IMP SPECT values by graph plot method significantly related to elevation of blood sampling global OEF.

KEYWORDS: Carotid Artery Stenting, Hemodynamics, Oxygen

O-836

Highly Selective MRI-Guided Targeting of Chemotherapy to the Brainstem Across a Focally Disrupted Blood Brain Barrier in a Rabbit Model.

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Purpose
Inadequate penetration of chemotherapeutic agents across an intact blood-brain barrier (BBB) and lack of methodology for precise drug delivery represents a major therapeutic challenge in the treatment of pontine gliomas. The purpose of this study is to demonstrate that intra-arterial (IA) chemotherapy administration can be performed with high precision after focal blood-brain barrier disruption (BBBD) and that parenchymal penetration of drug-sized molecules can be validated with fluorescent microscopy.

Materials and Methods
Our IACUC approved this protocol. Using a hybrid MR imaging (MRI) angiography suite (Miyabi, Siemens), the left vertebral artery of 4-kg New Zealand white rabbits was catheterized with a 4-French catheter. A 1.7-French microcatheter then was advanced into the basilar artery. The rabbits were transported to a 3 T MRI (Magnetom Trio, Siemens) for anatomical reference images [horizontal and sagittal T2-weighted (TR/TE=1500/105)]. Real-time assessment of trans-catheter contrast-enhanced perfusion territory using GE-EPI sequence (TR/TE=3000/30; 60 measurements) was performed during infusion of iron oxide nanoparticle solution (Feraheme) (rates of 0.001-0.1ul/s). Intra-arterial mannitol (25% over 5 minutes at the predetermined optimized infusion rate) was administered for focal BBBD. Intravenous gadolinium (Magnevist, 0.5 mM, 0.125 mmol/kg) was administered followed by T1-weighted (TR/TE=300/9.1) images. Intra-arterial fluorescein isothiocyanate (FITC) (19 µmol), a surrogate marker for the chemotherapy drug melphalan, then was infused. The brains were immediately harvested and snap frozen on crushed dry ice. Cryo-sectioned tissue slices were counterstained with DAPI and imaged by fluorescence microscopy (Zeiss) for detection of extravasated fluorescein. The drug (melphalan) was conjugated to a fluorescent moiety (fluorescein) to obtain a melphalan-fluorescein conjugate, for subsequent studies of direct monitoring of this drug across the BBB.
The conjugate then was purified using silica-gel columns and characterized by HPLC, NMR, and MS.

Results
Feraheme-enhanced real-time MRI demonstrated an optimal injection rate of 0.01 ml/sec to selectively perfuse the pons. Using this rate, IA mannitol resulted in specific pontine BBBD as visualized by gadolinium enhanced T1-weighted images. Post-mortem evaluation of fluorescein distribution correlated well with T1 enhancement (Figure 1). Horizontal postgadolinium T1-weighted image (A) and histological preparation of a brain slice through the pons and medulla demonstrate pontine enhancement (asterisk) and pontine uptake of FITC (green) with nuclear DAPI counterstain (blue).

Conclusions
MRI-guided targeted IA mannitol-induced BBBD in rabbit brainstems can be performed allowing for highly selective delivery of chemotherapeutic agents to the pons. Assessment of therapeutic drug delivery after BBBD can be depicted with fluorescent microscopy.

KEYWORDS: Blood-Brain Barrier, Brainstem, Intraarterial Chemotherapy
Comparison of connectivity from simultaneous direct intracranial stimulation and fMRI, with subsequent diffusion and resting state connectivity

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Purpose
We recently developed the capability to perform simultaneous direct intracranial stimulation and fMRI, on patients undergoing invasive evaluation for intractable epilepsy. This technique can successful produce maps of BOLD activation, both local and distal to the stimulating electrodes,
whose patterns may reflect underlaying maps of connectivity. We now compare these maps with those obtained subsequently in the same patient using diffusion MRI and resting-state MRI measures.

Materials and Methods

To date, five patients with medically refractory epilepsy have been studied using the technique of DES-fMRI. All used a block paradigm for the temporal pattern of stimulation (typically 32 seconds at 8 mA/20Hz), with the recent addition of a successful event paradigm (2 second stimulation at 8 mA/20Hz). Connectivity measures from this method are simply the t-statistic of induced BOLD activation. After DES-fMRI, and prior to resective surgery, the patients underwent HARDI (61 direction) and resting state fMRI, with each providing its measure of connectivity. Thereafter, these two measures of connectivity were compared with DES-fMRI measures, using the location of the stimulating electrodes as the seed point. Measures were compared on a voxelwise basis, using all voxels in the brain, and two-dimensional scatter plots produced. Correlation values and significance were computed.

Results

DES-fMRI has been now extended to five patients, recently including an event paradigm that can show the temporal evolution of BOLD signal changes across the brain due to stimulation of a single electrode pair (see attached figure, where each row shows a BOLD map at one second intervals. The yellow arrow shows the location of the stimulating electrode pair, at 8 mA 20Hz for a duration of 2 seconds). Correlation of the fMRI t-statistic to a diffusion-weighted imaging (DWI) connectivity score shows a significant but weak correlation (R2=0.04, p<1e-6). Similarly, voxelwise correlation with resting state connectivity shows a significant but weak correlation (R2=0.0004, p=3e-5).

Conclusions

We compare voxelwise connectivity maps made from three methods: direct intracranial stimulation and fMRI, diffusion MRI, and resting state MRI. While the correlations are significant, they are modest such that there are many brain regions strongly connected by one measure, but weakly connected using another measure. These results raise questions about the meaning of connectivity, and any possibility of a "gold standard".

KEYWORDS: Deep Brain Stimulator, Epilepsy, Functional Brain Mapping
Perfusion in evaluating Pediatric tumor

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Purpose
Arterial spin labeling (ASL) has a special appeal for study of the brain function in the pediatric population for two important reasons; it eliminates the need for intravenous contrast injection and secondly removes the ionizing radiation. Tumor pediatric population does receive contrast on a routine basis for tumor evaluation. But, it is the differences in ASL measured blood flow that can assist in further evaluation of underlying tumor histology. The aim of this research was to measure blood flow of tumor population presented in our pediatric hospital.

Materials and Methods
Arterial spin labeling was institutionalized in our hospital about 24 months ago. We reviewed all tumor population magnetic resonance images (MRIs) for the last 24 months. There were 38 patients with new and known tumor population that had ASL. There were 20 additional patients that did not have ASL, either there was post-tumor removal or ASL was not technically viable. The latter 20 patients therefore were not in our study. Of the 38 patients in our study with ASL there were 19 male and 19 female patients. The youngest male patient reviewed was 14 months old; the oldest 12 years old. The youngest female patient was nine months old; the oldest 19 and a half years old. We measured and documented the tumor blood flow for all of the 38 cases. In case of heterogeneous tumor population we measured multiple sites. In addition, we used cerebral blood flow (CBF) of the right mesial temporal lobe as a baseline. We then used this baseline flow against the tumor flow. Arterial spin labeling measurements then were compared and grouped against the known histology the tumor.

Results
We measured perfusion of 10 to 11 subcategories of tumor. Chart A shows perfusion peak for each subcategory. Chart B shows peak ratios of tumor to normal brain perfusion. By reviewing the charts, it is clear that there is variation in perfusion of each tumor subcategory. We also noted that ependymoma tumors (the third peak) had the highest perfusion in both charts. Anaplastic astrocytomas (fifth peak in Chart A and fourth peak in Chart B) had the second highest values. While the medulloblastomas and PNET tumors, the first and second peaks, had actually lower perfusion than pilocystic astrocytomas or glioma.

Conclusions
Our data showed that high grade tumors may not have a higher perfusion than a low grade glioma. Also perfusion values are influenced by the heterogeneity of the tumor. There were even some variation in perfusion measurements of the same tumor, even the tumor appeared homogenous on T2 and postenhancement imaging.

KEYWORDS: Arterial Spin-Labeling
Endovascular Embolization of Vein of Galen Aneurysmal Malformations: Noninvasive Assessment of Intracranial Hemodynamic Alterations with 4D Flow MR Imaging

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Purpose
Intracranial hemodynamics in patients with rare vein of Galen aneurysmal malformations (VGAM) and the impact of treatment on cerebral blood flow are still poorly understood. The purpose of this study was to evaluate the feasibility of serial 4D flow MR imaging for the noninvasive characterization of changes in intracranial hemodynamic in three pediatric VGAM patients treated by endovascular embolization.

Materials and Methods
Three VGAM patients (2 male +1 female; age=10±8 months) treated by endovascular embolization were included in this study. Electrocardiogram (ECG)-gated 4D flow MRI (TR/TE=5.5/2.9ms, flip angle=15°, velocity sensitivity VENC=100-150cm/s, spatial resolution=1.2mm×1.2mm×1.4mm, temporal resolution=44ms, acquisition time=8.9±1.8min)
was performed for all patients (patient 1: pre- and post-1st embolization; patient 2: post-1st and 2nd embolization; patient 3: post-2nd and 3rd embolization) on a 1.5 T MRI scanner. Intracranial 3D hemodynamics were visualized by time-integrated 3D pathlines depicting the cumulative flow path over the cardiac cycle in all MR visible vessels. Color coding was used to visualize the distribution of regional blood flow velocities. Peak velocity (m/s) and mean blood flow (ml/s) were quantified in manually positioned planes perpendicular to the major vessels.

**Results**
The figure illustrates 3D blood flow characteristics in patient 1 at pre- and post-1st embolization, demonstrating marked reduction of VGAM size and significant hemodynamic alterations after endovascular occlusion of the feeding right posterior choroidal artery (RPChA, open white arrow in the figure). Considerable VGAM shrinkage and hemodynamic changes also were observed in patient 2. The VGAM was not visible in patient 3 at post-2nd and 3rd embolization, but hemodynamic alterations in the surrounding cerebral vasculature clearly were evident. Blood flow through the VGAMs decreased for all patients after intervention (patient 1: from 27.92ml/s to 11.86ml/s; patient 2: from 11.69ml/s to 8.57ml/s; patient 3: from 3.84ml/s to 2.12ml/s). We also observed that the peak velocity in the straight sinus was decreased in patient 1 (from 0.68m/s to 0.46m/s) and patient 2 (from 0.44m/s to 0.37m/s) but increased in patient 3 (from 0.40m/s to 0.75m/s). In addition to regional hemodynamic alterations in the VGAMs, we also observed a systemic impact of focal embolization of the feeding artery on the hemodynamics in other intracranial vessels territories.

**Conclusions**
The results demonstrated the feasibility and potential of 4D flow MR imaging for the comprehensive noninvasive assessment of hemodynamic alterations in VGAMs before and during staged embolization. We were able to identified shunt reduction and blood flow redistribution after endovascular embolization. The full volumetric coverage by 4D flow MRI allows for the analysis of VGAM blood flow in combination with hemodynamics in other intracranial vessels. Future studies are needed to evaluate the potential of 4D flow MRI to complement existing diagnostic tool to better determine optimal timing for treatment, to evaluate the efficacy of therapeutic interventions, to monitor treatment effects, and to predict outcome.

**KEYWORDS:** Endovascular Embolization, Hemodynamics, Vein Of Galen
Vein of Galen Malformations: radiological and clinical features, and long-term outcome following endovascular treatment

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Purpose
Vein of Galen malformations (VOGMs) are rare and complex congenital arteriovenous fistulas. Clinical and radiological features of VOGMs and their relation to long-term clinical outcomes are not fully characterized. Thus, we examined these features and the predictors of outcome in patients with VOGM.
Materials and Methods
We retrospectively reviewed records of all patients with VOGM treated at our hospital (1986-2013), and measured outcomes via a survey performed in 2012. Thirty-nine cases were confirmed as VOGM. We applied the modified Rankin Scale to determine functional outcome by chart review.

Results
Most patients (89%) were diagnosed with VOGM in the first year of life. Age at treatment was distributed bimodally, with predominantly urgent embolization at <10 days of age and elective embolization after one year of age. Patients commonly presented with hydrocephalus (78%) and congestive heart failure (68%). The mixed-type (31%) VOGM was more common in our cohort than purely mural (25.5%) or choroidal (25.5%) types. The most common feeding arteries were choroidal and thalamoperforating. Transarterial embolization with coils was the most common technique used to treat VOGMs at our institution. Functional outcome (N=28) was normal or only mildly disabled in 50% of the cases at last follow up (median=1.1 years, range=0 to 23 years). Younger age at first diagnosis (p=0.006) and seizures (p=0.014) were predictive of adverse clinical outcome. Validated questionnaires (N=6) showed that children treated for VOGMs are affected variably in multiple functional domains.

Conclusions
VOGMs continue to be challenging to treat and manage. However, the long-term neurodevelopmental outcomes of affected children may be good in many cases.

KEYWORDS: Outcomes, Vein Of Galen
Effect of Venous Angioarchitecture on Hemorrhagic Presentation of Arteriovenous Malformations of the Brain

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Purpose

Intracranial hemorrhage accounts for the majority of morbidity and mortality caused by arteriovenous malformations (AVMs). Several angiographic features of the venous components of these malformations have been identified as affecting hemorrhage risk. The current study...
examines the association between the angiographic appearance of the venous components of AVMs with initial presentation of hemorrhage in a large prospectively maintained cohort using standardized digital subtraction angiographic (DSA) characterization.

Materials and Methods
Under an IRB-approved protocol, patients with an AVM were identified from a prospectively maintained cerebrovascular database between 2000 and 2011. Patients with VOGM, DAVF, or NGAVF were excluded. Demographics, clinical presentation, and angioarchitectural features of the lesions were noted. Univariate and multivariate regression models were constructed.

Results
Seven hundred fifty-three patients were evaluated during the study period. Three hundred thirty-nine (45.0%) patients had initial presentation of hemorrhage. Univariate analysis identified exclusively deep venous drainage (p<0.001) and single draining vein (p<0.001) as associated with initial presentation of hemorrhage. Lesions with venous ectasia (p<0.001) were less likely to present initially with hemorrhage. No statistical significance was noted for gender (p=0.711), venous stenosis (p=0.205), venous reflux (p=0.093), or sinus thrombosis (p=0.614). A multivariate Cox regression model was created to evaluate venous angiographic characteristics that were statistically significant in the univariate analysis. Exclusively deep venous drainage remained the most strongly predictive characteristic for initial presentation of hemorrhage (OR: 4.0, 95% CI: 2.1 to 7.5, p<0.001). Lesions with two or more draining veins (OR: 0.76, 95% CI: 0.63 to 0.92, p=0.004) and venous ectasia (OR: 0.48, 95% CI: 0.31 to 0.74, p=0.001) also retained statistical significance, with these findings found less commonly in patients presenting with hemorrhage.

Conclusions
Risk stratification for predicting future rupture of brain AVMs is of tremendous clinical interest, particularly following publication of the ARUBA study. In agreement with previously published literature, brain AVMs with deep venous drainage in our cohort were more likely to present with hemorrhage, as were patients with a single draining vein. Interestingly, patients with venous ectasia were less likely to present with hemorrhage. No statistically significant association was noted for previously implicated venous features including venous stenosis, venous reflux, or sinus thrombosis.

KEYWORDS: Arteriovenous Malformation, Hemorrhage, Venous Drainage

O-842

Cerebral venous thrombosis after embolization of pediatric AVM with jugular bulb stenosis or occlusion: management and prevention.

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Purpose
Thrombosis of cerebral arteriovenous malformation (AVM) after embolization is rare, but can involve the normal venous network with extensive venous thrombosis. We report
angioarchitecture findings, our management and prevention strategy for this complication in pediatric AVMs.

Materials and Methods
Between January 2008 and Jun 2013, 181 patients under the age of 15 years (vein of Galen aneurysmal malformation: n=101; pial AVM and pial fistulas: n=68; dural sinus malformation: n=12) were treated by NBCA or ONYX embolization in a total of 359 sessions. We retrospectively reviewed the chart of all 13 patients under 15 years who were anticoagulated after embolization. In our initial experience four children who didn't receive any prophylactic anticoagulation presented with extensive venous thrombosis after embolization (group 1). Following this, nine children with similar angioarchitecture and embolization modalities were treated with prophylactic anticoagulation immediately after embolization (group 2). We analyzed the type of AVM, angioarchitecture, dose of prophylactic anticoagulant, efficacy/complications of treatment and late outcome.

Results
All patients in group 1 had severe jugular bulb stenosis/occlusion associated with cerebral venous dilatation. In group 2 with similar angioarchitecture, only three patients (33%) developed extensive thrombosis. In both groups, thrombosis occurred within two days of treatment in six children and two weeks in one child. The diagnosis was suspected on ICH in five patients and occulomotor disorder in one. One was asymptomatic. All children were treated with therapeutic doses of LMWH (anti-Xa: 0.5-1). No hemorrhagic complications occurred. Good venous remodeling was observed in all but one patient.

Conclusions
Anticoagulation in extensive venous thrombosis after AVM embolization in children appears to be safe and effective. In cases with angioarchitectural features of dilatation of the cerebral venous network and occlusion/severe stenosis of the jugular bulbs, full dose anticoagulation may be required to prevent thrombosis.

KEYWORDS: AVM, Pediatric Cerebrovascular Disease, Venous Sinus Thrombosis

O-843
10:58AM - 11:05AM

Management of Tongue Venous and Lymphatic Malformations

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1

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Purpose
To determine the efficacy of ethanol embolization in management of tongue venous and lymphatic malformations.

Materials and Methods
Thirty-nine patients (22 females, 17 males; mean age: 38 years) presented with tongue low-flow malformations. Forty-seven patients had undergone 61 failed previous procedures (embo, laser, surgery, steroid injection, alpha-interpheron, radiation). All patients had baseline arteriograms and MRs. All patients underwent direct puncture ethanol endovascular therapy.

Results
Of 39 patients with venous and lymphatic malformations, 32 patients had dramatic reduction and
seven patients’ therapy is on-going with concurrent reductions (mean f/up: 60 months). One patient with AVM required additional surgery and one patient with mixed veno-lymphatic malformation required surgical debulking of excess tissues. Minor complications such as tongue blisters (9 instances) healed spontaneously; three tongue focal necrosis injuries healed spontaneously; three infections responded to antibiotic treatment; one focal tongue hemi numbness resolved.

Conclusions
Ethanol embolotherapy is a primary and consistent form of therapy to eradicate low-flow vascular malformations of the tongue permanently at long term follow up. Rarely is concurrent surgery required. Ethanol sclerotherapy is a curative treatment in which recurrences do not occur and permanent ablations are the rule. Complications that occur are minor and rare.

KEYWORDS: Embolization, Tongue, Venous Malformations

O-844

High resolution endovascular imaging during intracranial interventions - a paradigm shift in neurointerventional therapeutics?

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Purpose
Direct endoluminal visualization during endovascular therapy is an attractive concept which previously has received little attention due to the poor imaging quality and delicate nature of existing angioscopes. The potential benefits include enhancing existing techniques as well as extensive research opportunity. We report on the first application of a novel ultrathin high resolution scanning fiber endoscope (SFE) to directly visualize endovascular interventions in real time.

Materials and Methods
The physics and design of the SFE have been previously described (1). Under general anesthesia three Yorkshire pigs (35-40kg) underwent transfemoral cannulation and catheterization of common carotid and cervical arteries (3-5mm) using fluoroscopic angiography. Standard 6F guide catheters and distal access catheters were used to navigate the SFE. Our initial experiments concentrated on achieving reliable endovascular visibility which was achieved via a combination of saline irrigation through the guide catheter, the occlusive nature of the catheter in distal vessels and proximal balloon inflation via a 9F balloon guide catheter as needed. Subsequent experiments focused on recording standard endovascular techniques in real time: through microcatheters introduced via a second ‘working’ guide catheter we recorded high quality endoluminal views of microwire vessel cannulation, aneurysm coil deployment, stent retrieval of experimentally introduced thrombus using the Trevo and Solitaire stent retrievers and deployment of the Pipeline embolization device across a blind pouch created by sidebranch coiling.
Results
Endoscopy allowed visualization of neck coverage during coil embolization, the completeness and extent of clot retrieval during stent-retriever deployment and we were able to visualize the true and false lumens of an iatrogenic dissection flap. Accurate positioning and deployment of the flow diverter were achieved under direct vision. We were able to visualize flow stagnation within a blind vessel pouch area covered by flow diversion. Stent tine position and wall apposition could be assessed accurately.

Conclusions
Endovascular angioscopy is feasible and has tremendous potential as a tool to diagnostic and therapeutic enhancement during standard endovascular procedures. The SFE is a potential powerful research tool to understand endovascular therapeutics.

KEYWORDS: Endovascular Management, Endovascular Therapy

O-845 11:12AM - 11:19AM

Reduction of Radiation Exposure during Pediatric Cerebral Angiography

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Purpose
To identify imaging parameters under operator control during pediatric angiography most easily adjusted to reduce patient exposure and dose without compromise of patient care and safety.

Materials and Methods
In-vitro DSA and fluoroscopy exposures using a Rando phantom and an ArtisZee biplane unit (Siemens) were performed under standardized conditions for exposure settings, magnification, and source-image distance (SID). Recordings of dose-area product (DAP) and estimated skin dose (ESD) were recorded and standardized for controlled conditions in which kV, dose per frame, copper filtration, field of view, frames per second, and insertion or removal of the grid were independently varied. Image quality was evaluated using a line-pair resolution card and adjustment of post-processing edge-enhancement features.

Results
For DSA the most substantial reductions in exposure and dose were obtained through curtailing the length and fps setting of the DSA protocol with savings directly proportional to the degree of adjustment. For example, adjusting a single phase DSA run of 8 seconds at 3 fps to a multiphase run of 2 fps for 4 s and 1 fps for 4 s results in a 50% reduction of dose. Reductions in proportion to the adjustment in dose-per-frame were also evident, e.g. reduction of dose/fr from 0.54 mcGy/f to 0.17mcGy/f resulted in a 56% reduction of DAP and ESD. Grid removal resulted in a reduction of DAP of between 33-51% and of ESD of between 31-50% in the AP plane.

Introduction of copper filtration of above 0.3mm resulted in lower recordings of DAP and ESD but with undesirable upward adjustments of kV. Adjustments of the edge-enhancement settings above the default setting of 30% compensated favorably for the impact on image quality of removal of the grid.

Conclusions
1. Substantial radiation savings during pediatric cerebral angiography are possible through self-evident procedures such as reduction of the number of DSA runs, reduction of the frame rate during DSA, and reduction of the pulse-rate during fluoroscopy and roadmap. Depending on the operator's starting baseline, these reductions can reduce exposure by greater than 50%. 2. Less evident points of adjustment, but equally substantial in their impact on exposure, include settings such as dose-per-frame for DSA and dose-per-pulse for fluoroscopy, resulting in similar magnitudes of dose reduction. Furthermore, a single pediatric setting of dose-per-frame for DSA is probably not optimized for all children and smaller children likely will benefit from even lower dose/fr settings depending on body size, without compromise of image quality. 3. Grid removal results in substantial radiation savings of up to 50% just by itself independently of all other factors, with minimal impact on image quality some of which can be attenuated by edge-enhancement postprocessing. 4. Copper filtration in excess of 0.3mm is likely an adjustment of diminishing and unfavorable returns due to its impact on kV. In conclusion, thorough familiarity with the available adjustments relating to radiation exposure under operator control and inclusion of these factors in the preprocedure "Time-Out" can redound to the patient's advantage considerably with reductions of dose and exposure to a small fraction of those generated by default pediatric settings.

KEYWORDS: Radiation Dosage, Radiation Dose Reduction, Radiation Exposure
Transbrachial approach as a first access route for neurointervention

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Purpose
Transfemoral approach for neuroendovascular treatment is widely used but sometimes limited by aortic or peripheral arterial conditions. Purpose: The purpose of our study was to investigate the feasibility and safety of transbrachial procedures using the sheath-guide specifically designed for transbrachial cannulation into the carotid artery.

Materials and Methods
Included in our retrospective analysis were patients who underwent transbrachial neurointervention from January 2012 to December 2012. We used the particular sheath-guides, MSK-guide sheath (Medikit Co.Ltd., Tokyo, Japan), with two types of distal length; 1: (1) MSK-guide 7.5x90; 6Fr (2.24 mm, 0.088 inch) (ID: internal diameter) guiding sheath with 7.5cm-distal part and 90 cm in length; This sheath guide was developed for direct cannulation into the common carotid artery (CCA) without an inner catheter and used mainly for CAS. (2) MSK-guide 7.5x70; 6Fr (ID) guiding sheath with 7.5cm-distal part and 70 cm in length; This sheath guide was used for inserting the 2nd guiding catheter with up to 6Fr (outer diameter: OD) coaxially and positioning it in the internal carotid artery. 2: MSK-guide 15x90(3D); It is designated for transbrachial direct cannulation into the internal carotid artery (ICA) and for fitting to the anatomical feature of the ICA. This catheter was used for intracranial neurointervention, mainly intracranial angioplasty or stenting, or embolization of aneurysms with two or three microcatheters required.

Results
During the study period, 188 procedures were done. Among them, 135 were elective and 53 emergent. MSK-guide were used in 101 (75%) of 135 elective cases and in 29 (55%) of 53 emergent cases. Among 135 elective transbrachial procedures, 56 CAS, 17 intracranial angioplasty or stenting, 16 coiling and others were included. Among 29 emergent transbrachial procedures, 28 cases were reperfusion therapy for ischemic stroke. All transbrachial cannulation into the target CCA or ICA were successful in all cases. All transbrachial neurointervention were completed, too. The MSK-guide provided good support-force. Transbrachial procedures didn't depend on anatomical features of the abdominal aorta and/or peripheral arteries. Transbrachial procedures didn't depend on vascular diseases of the abdominal aorta and/or peripheral arteries.

Conclusions
Transbrachial neurointervention was feasible and safe by using the MSK-guide sheath specifically designated for transbrachial cannulation into the carotid arteries. Routine transbrachial approach can open the door for patients and neuroendovascular physicians.

KEYWORDS: Brachial Artery, Carotid Artery Stenting, Endovascular Therapy

O-847 11:26AM - 11:33AM

Significant Acquisition Dose Reduction Maintains Diagnostic Quality of Biplane Cerebral Digital Subtraction Angiography
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Purpose
Digital subtraction angiography (DSA) remains the gold standard modality for evaluation, diagnosis, and treatment planning of several intracranial vascular abnormalities. However, patient radiation dose can be considerable with both diagnostic and especially complex neurointerventional procedures. Modern biplane flat-detector angiography units provide several possibilities for automatic dose reduction by modifying X-ray tube potential, current, pulse width, and filtration thickness. We aimed to investigate the feasibility of reducing the radiation exposure dose in diagnostic DSA examinations while preserving the overall image quality for diagnostic purposes.

Materials and Methods
Following IRB approval and informed consent, a prospective study was performed on patients undergoing diagnostic cerebral DSA using biplane flat detector rotational fluoroscopy and angiography unit (Artis zee/zeego, Siemens). DSA images were acquired using a predefined manufacturer standard DSA program by selecting detector dose of 3.6 μGy/ frame (mean typical tube voltage (TTV): 80.6 kVP, mean tube current (TC): 230.6 mA, using focal spot size (FS) of 0.6 and inherent filtration) and reduced DSA detector dose of 1.2 μGy/frame (mean TTV: 73.6 kVP, mean TC: 153.5 mA, using FS of 0.3 with additional 0.1/0.2 copper filter) dose protocols for each patient. Using identical contrast agent, contrast injection rate, and fluoroscopy time, randomly selected internal carotid arteries or vertebral arteries and their contralateral equivalent arteries were injected to obtain standard radiation dose and low radiation dose AP and lateral DSA images, respectively. Images were not included for image quality assessment if any significant technical issue and/or flow limiting vascular stenosis/occlusion, or steal phenomenon from AV shunts were present. Image quality assessment was performed independently by two neurointerventionalists on a de-identified PACS workstation. A 5 point scale (5: Very good: excellent large and small vessel visualization; 4: Good: excellent large vessel and minimal compromise of small vessel visualization; 3: Average: diagnostic value for large vessel, but compromised small vessel visualization 2: Poor: compromised large and small vessel visualization; 1: Nondiagnostic) was used for qualitative evaluation of arterial, capillary, and venous phases of DSA images respectively. The total score was defined as the overall diagnostic value. Paired sample t-test and Wilcoxon’s signed rank test compared the kerma-area product (KAP) and scores assigned to image quality parameters, respectively. P value <0.05 was considered statistically significant.

Results
Twenty-three DSA image series were obtained from nine patients (8M/1F, mean age: 65.9 ±9.16) undergoing diagnostic DSA. Mean KAP was significantly reduced by 60% or 2.5 fold (1408.90 ± 419.18 μGy/m² versus 557.08 ± 214.56 μGy/m², P <0.0001). No significant difference was observed between image quality scores assigned by the observers while assessing arterial (observer 1: P=1.0; observer 2: P=0.24), capillary (observer 1: P=0.54; observer 2: P=0.3), venous (observer 1: P=0.14; observer 2: P=0.7) phases, and overall diagnostic value (observer 1: P=0.34; observer 2: P=0.8).
Conclusions
Radiation exposure dose can be reduced significantly without compromising image quality for diagnostic purposes in cerebral DSA studies.

KEYWORDS: Image Quality, Radiation Dose Reduction

O-848

A Prospective Trial of Venous Sinus Stenting for Idiopathic Intracranial Hypertension Refractory to Medical Therapy

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Purpose
Stenosis of the transverse-sigmoid sinus junction has been observed in a majority of patients with idiopathic intracranial hypertension (IIH), but whether it is a result of intracranial hypertension (IH), a contributor to IH or both remains controversial. Since Higgins demonstrated clinical improvement in a patient with IIH, multiple studies have demonstrated clinical improvement in select patients treated with venous sinus stenting. However, most of these studies have been retrospective, only some have included careful analysis of visual field data, and most have not demonstrated repeat opening pressure measurements following the procedure. We set out to perform a clinical trial (ClinicalTrials.gov Identifier: NCT01407809) of the effect of venous stenting on clinical symptoms, visual acuity and field data, papilledema and opening pressure on lumbar puncture (LP) in patients with medically refractive IIH. We hypothesized that there would be improvement in these parameters in a majority of patients.

Materials and Methods
We selected eight patients who were either medically refractory to or intolerant of acetazolamide and/or topiramate or presented with fulminant vision loss requiring a procedure for inclusion in the trial. Alternative options were discussed including optic nerve sheath fenestration and ventriculoperitoneal shunt placement, and for those who opted for stenting, informed consent was obtained. All patients satisfied the Dandy criteria for IIH including MR imaging (MRI) showing no mass lesion and LP showing elevated opening pressure with normal contents. Preprocedure fields, OCT and fundus photography were performed in all patients. Only patients whose MR venography (MRV) either demonstrated venous sinus stenosis bilaterally, or in a dominant transverse sinus, were included. Catheter venography was performed and trans-stenotic gradients were measured. Venous stents were placed only in patients with a gradient of 10 mm Hg of more. Venous stenting was performed under general anesthesia. Stent placement required aspirin and Plavix for one month and aspirin for six months.

Results
Out of the eight patients, clinical presentation included headache in 100%, pulsatile tinnitus in 87.5%, and diplopia in 63%. Out of 16 eyes, 16 (100%) demonstrated a visual field defect, 15 (94%) showed papilledema, and nine (56%) showed loss of visual acuity. MR venography showed bilateral stenosis in 50% and unilateral stenosis where the fellow sinus was hypoplastic in 50%. Stenting was feasible in all patients. Prestenting trans-stenotic gradients ranged from 14 to 28 mmHg (mean 19) and improved in all patients postprocedure (range 0-5 mmHg, mean 3).
At follow-up visits ranging from 2-9 months after stent placement, 63% reported an improvement in headache, 86% in pulsatile tinnitus and 100% in diplopia. Out of 16 eyes with visual field defects, eight (50%) showed an improvement, three (19%) worsened at the first follow up but subsequently improved past their baseline (2 to normal), and the remaining five (31%) were stable. Out of nine eyes with loss of visual acuity at presentation, five (44%) showed an improvement and the remaining four were stable. Visual acuity never worsened. Out of 15 eyes with papilledema, seven (47%) showed an improvement in Frisén grade and the remaining eight were stable. Of eight eyes that presented with Frisén grade 2 or more, six (75%) showed improvement. In those eyes that showed no improvement in papilledema grade on funduscopy, a decrease in the retinal nerve fiber layer (RNFL) thickness towards the normal range was demonstrated in 100% (8/8). Opening pressure improved in 100%. Complications included one small retroperitoneal hematoma without need for transfusion or surgery.

Conclusions
We present interim data in one of the first prospective FDA-approved studies of venous sinus stenting for IIH. Following stenting procedure, all patients demonstrated an improvement in trans-stenotic gradient on venography and intracranial pressure as demonstrated by LP. The majority of patients showed an improvement in headache, diplopia and pulsatile tinnitus, but the response was less vigorous in headache, possibly owing to the multifactorial nature of this symptom in IIH patients. While clinical funduscopy showed an improvement in only 47% of eyes, this appears to be the result of the inclusion of some eyes that were Frisén grade I at presentation, where clinical improvement would not be obvious. Looking only at Frisén grade II eyes, all demonstrated either a clinical improvement, or a reduction in RNFL thickness towards the normal range. Most importantly, the vast majority of patients showed improvement in visual field defects with stability demonstrated in the remainder. These preliminary results suggest that venous stenting for IIH is efficacious, as demonstrated in prior retrospective studies, but larger numbers of patients will be required to confirm the long term efficacy and safety of this procedure.

KEYWORDS: Cerebral Venous System, Increased Intracranial Pressure, Venous Sinus Stenting

O-849

Analysis of 24 False Negative Spinal Angiograms Performed in 16 Patients with Vascular Malformations Subsequently Documented by Angiography: What Went Wrong and How to Avoid It.

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Purpose
The diagnosis of spinal vascular malformations often is delayed by the lack of specific clinical signs and symptoms, and the nonspecific appearance on MR imaging (MRI). Spinal angiography is the gold standard imaging technique for the investigation of spinal vascular anomalies. But it is a technically demanding method, which must be conducted using a methodical approach to offer a high diagnostic yield. The possibility of falsely negative angiographic studies is
particularly distressing when one addresses progressive conditions with a limited therapeutic window. This review analyzes 26 false positive spinal angiograms obtained in 16 patients later diagnosed with and treated for a spinal vascular malformation.

Materials and Methods
Twenty-six false-negative spinal angiograms obtained in 16 patients with spinal vascular malformations subsequently documented by angiography were reviewed. Thirteen patients were referred to our services for further evaluation and/or second medical opinions after prior negative investigations, while three patients had their initial negative spinal study performed by two of the study's authors. In all cases, further investigations were warranted by the lack of clinical improvement or by symptoms progression.

Results
Sixteen patients with 17 spinal arteriovenous fistulas (AVFs) underwent a total of 26 negative spinal angiograms (average 1.6, range 1 to 6). At the time of report, 16 out of the 17 lesions had been treated successfully, either endovascularly (14) or surgically (2). The distribution of the lesions was as follows: 10 spinal epidural AVFs (SEAVFs) (59%), 5 spinal dural AVFs (SDAVFs) (29%), and 2 perimedullary AVFs (PmAVF) (12%). The SEAVFs/SDAVFs were found at the thoracic (n=3, 20%), lumbar (n=10, 67%), or sacral (n=2, 13%) levels. Both PmAVFs were located at the conus medullaris, and supplied by thoracic feeding arteries (T8 and T10). The list of initial diagnoses included transverse myelitis (TM) (n=8, 50%), spinal venous thrombosis (n=2, 13%), spine degenerative disease (DGD) (n=2, 13%), spinal stroke (n=1, 6%), or other (n=3, 18%). Twenty-one out the 26 the false negative angiograms were available for review. The reasons behind the negative studies could be categorized as follows: 1 - the level with the lesion was not investigated (11 cases). In this instance, the angiogram was either incomplete (e.g., no evaluation of the pelvis, 9 cases) or the level was skipped during the procedure (e.g., mislabeling, 2 cases), 2 - the level with the lesion was investigated, but the lesion was outside of the field of view (1 case) or the injection was inadequate (1 case) (see Figure 1), 3 - the lesion was documented by the angiogram, but not recognized (7 cases), 4 - in one instance, the level with the lesion was investigated adequately, but the lesion was not visible. This case represents the only instance of truly false negative spinal angiogram in this series.

Figure 1 legends: the left panel shows a right L3 SEAVF (arrow) draining into a radiculomedullary vein (arrowheads). The right panel shows a nonselective injection of the same vessel during the false negative study; while the ISA is opacified, the lesion is not detectable.

Conclusions
The most important lesson learned from our retrospective analysis of false negative spinal angiograms obtained in a series of 16 patients is that in all but one instance, the false negative result was related directly to a correctible, operator-dependent technical factor. Incomplete or missing investigation of the lumbosacral vasculature was singled out as the most common cause of false negative studies (52%), followed by the nonrecognition of angiographically documented lesions (33%). The potential for false negative studies therefore can be minimized by adoption of rigorous technical and training standards.

KEYWORDS: Spinal Angiography, Spinal Arteriovenous Malformation, Spinal Imaging
Susceptibility Clot Width >5 mm is a Highly Sensitive Marker for Development of Parenchymal Hematoma Following Intra-arterial Clot Retrieval in Acute Stroke

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\textsuperscript{1}Massachusetts General Hospital, Boston, MA, \textsuperscript{2}SUNY at Stony Brook, Stony Brook, NY
The degree of proximal middle cerebral artery (MCA) "blooming artifact" on susceptibility MR imaging (MRI) of acute ischemic stroke (AIS) patients is highly specific for occlusive clot burden, and hence – potentially – of the degree of endothelial vascular injury locally, in the adjacent MCA perforator vessels, and in the more distal capillary bed. Our purpose was to determine if there is a relationship between the width of clot-related susceptibility artifact and the likelihood of parenchymal hematoma (PH) following endovascular clot retrieval in these patients.

Materials and Methods
We retrospectively reviewed 213 consecutive AIS patients who received intra-arterial therapy (IAT) between 6/1/2004 and 12/1/2013. Of these, 138 met the following inclusion criteria: (1) MCA M1 or M2 occlusion; (2) Available admission gradient recalled echo (GRE) T2* and/or perfusion-weighted imaging (PWI); and (3) Follow-up noncontrast CT. We measured the maximum width of clot-related susceptibility artifact (CSW) and stratified patients into two groups: CSW≤5 mm (Group 1) and CSW>5 mm (Group 2). The findings were correlated with development of postprocedural parenchymal hematoma (ECASS PH1 and PH2).

Results
There were 74 patients in Group 1 and 64 patients in Group 2. Parenchymal hematoma occurred in 15 patients, of which 1/64 (2%) was from Group 1 and 14/74 (19%) were from Group 2. Thus, of the 15 PH bleeds, 14/15 (93%) had SCW>5 mm. Sensitivity, specificity, positive predictive value, and negative predictive value for determining the risk of PH following IAT using a SCW cutoff of 5 mm were 93%, 51%, 19%, and 98%, respectively.

Conclusions
Width of clot-related susceptibility artifact <5 mm on admission GRE T2* and/or PWI may identify patients at very low-risk (NPV 98%) of developing parenchymal hematoma following intra-arterial clot-retrieval therapy. We speculate that blooming artifact may not only be a marker for overall clot burden, but also may reflect the degree of regional vessel wall injury and blood-brain barrier breakdown – both risk factors for PH development.

KEYWORDS: Hemorrhagic Transformation, Intraarterial Thrombolysis, Stroke

O-851
11:54AM - 12:01PM
Mechanical Thrombectomy With The «ERIC »™ Device: Initial Experience

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1University Hospital of Rennes, Rennes, France, 2Rothschild Fondation, Paris, France, 3Laennec Hospital, University of Nantes, Nantes, France, 4University Hospital of Nantes, Nantes, France

Purpose
Ischemic stroke is one of the major causes of mortality and long-term disability (1). Mechanical endovascular thrombectomy recently merged as an efficient and safe technique to recanlize large occluded arteries, especially using stent retriever devices (2). We aimed at evaluating a device with an innovative design, the "ERIC" (Embolus Retriever with Interlinked Cage), in revascularization of patients with acute ischemic stroke.
Materials and Methods
Twenty-five patients (16 men; median age: 59.2 years) treated with the "ERIC" device (Microvention, Tustin, CA) for large intracranial artery occlusion at the acute phase of a stroke were included consecutively in three French centers, from April to November 2013. The "ERIC" is a 3rd generation device, differing from the "stent retriever": it is composed of five interconnected and mobile nitinol spheres, allowing to capture and withdraw the thrombus without delay. Main data about imaging, interventional technique and clinical status were recorded.

Results
The occlusion site was terminal carotid artery in eight cases and middle cerebral artery (M1) in 15 cases, associated with cervical carotid occlusion in seven cases; and basilar artery in two cases. Intravenous thrombolysis was associated for 18 patients. For 22 patients, « ERIC » was the first intention device, allowing complete recanalization (TICI ≥2B) in 19 cases (86%), after one to four passes (median: 2); in three cases of failure, a rescue stent was used (successfully in two cases). For three patients, "ERIC" was used after stent failure, then allowing complete recanalization in two cases. The median time from symptoms onset to recanalization was 325 min. The median time from groin puncture to recanalization was 78 min. Median baseline and at discharge NIHSS were 17 and 8.5, respectively. Five cases of asymptomatic secondary hemorrhagic transformation were recorded on the 24-hours CT scan.

Conclusions
The « ERIC » device can rapidly, safely and effectively retrieve clots from large intracranial arteries.

KEYWORDS: Stroke, Thrombectomy

O-852

Endovascular Management of Basilar Artery Occlusion: Clinical and Radiological Prognostic Factors for 3 Months’ Neurological Outcome

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¹Hopital de la Pitie-Salpetriere, Paris, France

Purpose
Basilar artery occlusion (BAO) is a rare (1%) but very severe subtype of stroke, with a very high mortality and disability rate. Intravenous thrombolysis is a poorly effective treatment, explaining the rise of endovascular treatment, which has gained acceptance in this indication. But even though recanalization rate is higher in endovascular treatment of BAO, a favorable neurological outcome, defined by a modified Rankin scale (mRS) = 0-2 at 3 months follow up, remains low (30%). Our study aimed to evaluate the effectiveness and safety of endovascular treatment of basilar artery occlusion, and to identify clinical and radiological prognostic factors that may help predict the clinical outcome.

Materials and Methods
We retrospectively analyzed the charts of 29 consecutive patients (21 males, 8 females; mean age/SD = 61.1 ± 14.1 years, range: 29-88) who presented BAO (diagnosed with a positive MRI
with 3D time-of-flight angiography or brain CT with CT angiography) and underwent endovascular treatment between April 2006 and June 2013 in our institution. Clinical data (including National Institute of Health Stroke Scale [NIHSS] at admission/day 1/day 7, delay between symptoms and beginning of endovascular procedure), radiological data [including prognostic scores on initial MRI and follow-up MRI within 48 hours after the procedure: Bern score (1), Cho et al. score (2), Renard et al. score (3), DWI-pc-ASPECTS (4)], angiographic data [including duration of the procedure, vascular anatomy, drugs and devices used during the procedure, recanalization rate using the following scales: Thrombolysis In Cerebral Ischemia (TICI) score, Thrombolysis In Myocardial Ischemia (TIMI) score and Arterial Occlusive Lesion (AOL) score] were assessed retrospectively. Patients were divided in two groups: good outcome was defined by a mRS=0-2 at three months follow up, whereas poor outcome was defined by a mRS=3-6 at three months follow up.

Results
Nine of 29 patients (31%) had a good outcome, and 20/29 patients (69%) had a poor outcome, including 8/29 deceased patients (27.6%). There was a statistically significant difference between the groups regarding NIHSS at day one and day seven (p<0.0001), all four prognostic scores on initial and/or follow-up MR imaging (MRI) (p<0.05 for each score), thalamic infarction on follow-up MRI (p=0.04), AOL score (p=0.02). There was no significant difference between the groups regarding delay from symptoms to endovascular procedure (p=0.272), TIMI score (p=0.1), TICI score (p=0.22).

Conclusions
Endovascular treatment of BAO is a safe and effective treatment. Recanalization seems to be a necessary but not sufficient prognostic factor for a good outcome. Further studies need to identify other clinical and/or radiological prognostic factors.

KEYWORDS: Endovascular Mechanical Recanalization, MR Imaging, Stroke

Clinical Data

<table>
<thead>
<tr>
<th>Good outcome (mRS=0-2)</th>
<th>Poor outcome (mRS=3-6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>9/29 (31 %)</td>
</tr>
<tr>
<td>Number of deceased patients</td>
<td>0</td>
</tr>
<tr>
<td>Number of male patients</td>
<td>8/9 (88.9 %)</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>59.1</td>
</tr>
<tr>
<td>Mean NIHSS at admission</td>
<td>22</td>
</tr>
<tr>
<td>Mean NIHSS at day 1</td>
<td>2.7</td>
</tr>
<tr>
<td>Mean NIHSS at day 7</td>
<td>1</td>
</tr>
</tbody>
</table>

Radiological Data before endovascular procedure

<table>
<thead>
<tr>
<th>Good outcome (mRS=0-2)</th>
<th>Poor outcome (mRS=3-6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of MRI before procedure</td>
<td>8/9 (88.9 %)</td>
</tr>
<tr>
<td>Mean Cho score</td>
<td>1.625</td>
</tr>
<tr>
<td>Mean Renard score</td>
<td>1.625</td>
</tr>
<tr>
<td>Mean Bern score</td>
<td>2.375</td>
</tr>
<tr>
<td>Mean pc-ASPECTS</td>
<td>8.125</td>
</tr>
<tr>
<td>Number of uni-/bilateral thalamic infarction</td>
<td>0/8</td>
</tr>
</tbody>
</table>

Endovascular Procedure
Mean delay between symptoms and procedure (min) 308.6 410.3 p=0.27
Mean procedure length (minutes) 106 119.5 p=0.53
Mean TIMI score 2.22 1.65 p=0.11
Mean AOL score 2.56 1.85 p=0.024
Number of patients with TICI = 2b-3 6/9 (66.7%) 7/20 (35%) p=0.23
Number of patients with use of Solitaire device 5/9 (55.6%) 4/20 (20%) p=0.09
Mean number of retriever tentatives (Solitaire only) 1 2.75 p=0.02
Radiological Data after endovascular procedure
Number of MRI 24-48 hours after procedure 9/9 (100%) 16/20 (80%) p=0.28
Mean Cho score 2 4.94 p=0.006
Mean Renard score 2.5 5 p=0.0005
Number of uni-/bilateral thalamic infarction 1/9 (11.1%) 11/20 (55%) p=0.04
Number of hemorrhagic transformation 1/9 (11.1%) 10/20 (50%) p=0.096

Thursday
10:30AM - 12:00PM
Palais des congres de Montreal, 524

87 - PARALLEL PAPERS: Excerptas
O-853

Location, Location, Location! – A Valuable Discriminator for Diagnosing Pigmented Villonodular Synovitis (PVNS) of the Cervical Spine.

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Purpose
Pigmented villonodular synovitis (PVNS) is an uncommon benign, but locally aggressive lesion characterized by synovial proliferation of synovial joints, usually the appendicular large joints. Pigmented villonodular synovitis of the spine is rare, typically involving the posterior elements. We present a case of PVNS of the cervical spine, highlighting useful imaging features and describing pathologic correlation.

Materials and Methods
A 49-year-old woman presented with a two-year history of progressive neck stiffness and occasional left jaw pain. MR imaging (MRI) revealed a heterogeneously enhancing low T1, markedly low T2 signal intensity (SI) mass involving the dens, extending across the atlanto-axial joint into the C1 anterior arch and into prevertebral space. NECT demonstrated a soft tissue density lesion with sharp zone of transition and thin, sclerotic margins with focal cortical...
disruption of the dens and C1 anterior arch. The lesion was hypermetabolic (max SUV 24.53) on FDG-PET/CT imaging. Histopathology from a CT-guided biopsy revealed numerous histiocytes, several multinucleated giant cells, foamy macrophages, and pigmented macrophages. The majority of the cells were CD68 positive on immunohistochemical stains, indicating a histiocytic differentiation.

Results
Three subtypes of PVNS (diffuse intra-articular, localized intra-articular, localized extra-articular) can affect virtually any joint. The lesion in this case is centered about the joint space, which is helpful in differentiating that this is a tumor of synovial origin (such as PVNS), rather than a juxta-articular lesion [such as giant cell tumor of bone or gout, which may demonstrate very similar imaging characteristics, particularly on MR imaging (MRI)]. On MRI, PVNS classically demonstrates intermediate to low signal intensity on T1- and T2-weighted sequences due to the presence of hemosiderin, accounting for the "blooming" artifact seen on GRE sequences. The absence of hemosiderosis does not exclude PVNS. Variability in SI may be due to varying amounts of blood products, fibrous tissue, and edema. Moderate, inhomogeneous postcontrast enhancement is typical. On CT, there are well defined erosions with sclerotic margins and a soft tissue component without matrix calcification. Lesions may be hypermetabolic on FDG-PET.

Conclusions
Pigmented villonodular synovitis is a benign but locally aggressive lesion of synovial proliferation that rarely occurs in the cervical spine and may pose a diagnostic dilemma for radiologists. The lytic nature and FDG-avidity may mimic a metastatic lesion and the low signal intensity on T1-weighted, T2-weighted imaging and gradient recalled echo (GRE) may mimic giant cell tumor of bone, gout, or amyloid. Recognizing that the lesion is centered about the joint space is a valuable discriminator to identify a synovial lesion, including the diagnosis of PVNS.

KEYWORDS: Differential Diagnosis, Spinal Neoplasm, Tumor-Like Conditions
Acute Cerebral Fat Embolism Secondary to Left Ventricular Assist Device Placement

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Purpose
Left ventricular assist device (LVAD) is a fairly common intervention that is used as a supportive measure for patients in circulatory failure usually from severe cardiomyopathy and are awaiting heart transplant. Common complications of this procedure include: hemorrhage (secondary to anticoagulation), infection, arrhythmias, pulmonary insufficiency, thromboembolic events (acute MI and cerebrovascular accidents). We present a rare case of acute central nervous system (CNS) fat embolism resulting from LVAD placement. Previously reported cases of CNS fat embolism have resulted from trauma, cardiac surgery or from angiography.

Materials and Methods
A 67-year-old male with past medical history of CAD w/ MI s/p CABG x 4, paroxysmal atrial flutter s/p ablation, stage 3b/4 heart failure (LVEF 15-20%) on heart transplant list was admitted to the hospital for left ventricular assist device placement. Postprocedure, when the patient woke up, he noticed right upper and lower extremity weakness. Physical exam revealed 0/5 strength in the right upper and lower extremity, otherwise, the remainder of the neurologic exam was unremarkable. Routine laboratory values were within expected postop range. The patient was last seen normal prior to the surgery and at the time of physical exam was intubated, but was alert and oriented * 3 and not on any sedations. No hemorrhage was seen on the noncontrast CT; however, it revealed diffuse hypodensity of the left ganglia and caudate nucleus with evidence of edema, concerning for acute ischemic infarct. Additionally, a long segment abnormal tubular low density was seen within the left MCA which correspond to the left MCA filling and perfusion defects seen on the angiogram and perfusion study, respectively. The tubular hypodensity measured fat density on CT, raising concern for fat embolus. The patient was unable to undergo brain MR imaging (MRI) because of his AICD. Computed tomography perfusion of the brain revealed decreased flow and perfusion in the left MCA territory.

Results
Noncontrast CT brain revealed a long segment left MCA tubular hypodensity measuring fat attenuation, suggestive of a fat embolus. Computed tomography brain with contrast revealed a long segment filling defect in the M1 branch of the left MCA measuring fat attenuation, compatible with a fat embolus. Computed tomography perfusion images revealed diminished blood flow and mean transit time, likely related to the fat embolus. However, there was less than expected perfusion defect, likely due to residual blood flood in the left MCA through the pliable fat embolus, resulting in more of an acute ischemic state rather than a total gross large territory infarction, which one would expect from a blood clot.

Conclusions
Although thrombotic stroke are reported to occur in up to 12 to 16% of patients, central nervous
system (CNS) fat embolism is rarely encountered. To our knowledge, there has not been a case reported of acute fat embolism in patients with LVAD placement. Most common reported cases of CNS fat embolism were seen in the setting of traumatic long bone fractures with subsequent embolization of bone marrow fat to the brain via patent foramen ovale. Given the degree of advanced atherosclerosis in our patient, placement of LVAD probably dislodged a cholesterol plaque from the heart or the aorta to the brain leading to CNS fat embolism. Unique imaging findings of CNS fat embolism include presence of tubular clot that measures fat attenuation on unenhanced CT head and follows MRI signal characteristics of fat on all sequences. Additional interesting finding is that there appears to be a less than expected size of brain infarct in these patients, possibly secondary to the pliable nature of the fat embolus which allows for passage for some blood thereby resulting in severe ischemia more so than gross infarction. Our patient was treated with anticoagulation and had gradually near full recovery to baseline. This perhaps suggests better prognosis in patients with CNS fat embolism as compared to those with same sized thrombotic embolus.

KEYWORDS: Fat Emboli
A SMART Case: Stroke Like Migraine Attacks after Radiation Therapy

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Purpose
We report a case of a patient with reversible clinical and radiologic features suggestive of SMART syndrome (Stroke-Like Migraine Attacks after Radiation Therapy), a late, uncommon and reversible complication after radiation therapy for brain tumors.

Materials and Methods
A 54-year-old man presented to an outside hospital with new onset of altered mental status and generalized seizures. His past medical history was significant for a left frontal lobe oligodendroglioma status postresection and chemoradiation therapy in 1991. Prior to his current presentation, the patient was doing well, without evidence of tumor recurrence; he was discharged from care with regards for his brain tumor for the past six years. Recurrent seizures characterized by staring and unresponsiveness were observed with progression to generalized seizure activity. Following transfer to our institution, the patient continued to have witnessed seizures. He was intubated and put on burst suppression on day eight. His work up included repeated cerebrospinal fluid (CSF) analyses, which revealed slightly elevated protein, but no evidence of bacterial, viral, fungal or tuberculosis. His CSF cytology revealed no malignant cells. The patient was treated empirically with antibiotics and antivirals, despite having no evidence of infection. During his hospital course, the patient seizures gradually improved, and his anti-seizure medications were tapered off. Upon discharge, the patient was seizure free, and EEG revealed no subclinical seizures or epileptic discharges.

Results
Admission MR imaging (MRI) demonstrated left frontal lobe cortical edema, mild patchy gyral enhancement, mild restricted diffusion, and normal vessel imaging. Subsequent imaging demonstrated increasingly prominent gyral enhancement, prominent cortical edema, and restricted diffusion with enhancement reaching peak intensity on day six. A small area of cortical laminar necrosis developed along the left middle frontal sulcus. By day 14, enhancement completely resolved, and cortical edema gradually decreased.

Conclusions
SMART is a rare syndrome with transient, reversible neurological symptoms often manifesting with headaches and seizures, occurring years after radiation therapy for brain tumors. While often mistaken on presentation for cerebral infarction, encephalitis, and recurrent malignancy, radiologic features are suggestive with salient findings including transient unilateral gyral enhancement and focal cortical edema. Early consideration of this entity can prevent unnecessary treatment including neurosurgical procedures with potentially significant neurologic sequelae.

KEYWORDS: Migraine, Seizure, Stroke
Transthyretin-related Familial Amyloidosis: a cause of leptomeningeal enhancement and superficial siderosis

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Purpose
Present the imaging findings of transthyretin-related familial amyloidosis, a rare and progressively disabling inherited disease.

Materials and Methods
A 43-year-old male presented with reported history of severe meningoencephalitis 10 years previously, manifesting as extremity paresthesias, severe aphasia, profound weakness, and incontinence. This was followed by spontaneous improvement without identification of a causative infectious, inflammatory, or autoimmune etiology. He experienced subsequent transient episodes of aphasia and extremity paresthesias superimposed on persistent mild gait and cognitive deficits from his initial event. The patient had experienced bowel and bladder dysfunction with progressive lower extremity fatigue in the nine months preceding his presentation at our tertiary referral center. Brain MR imaging (MRI) performed 18 months previously showed diffuse intracranial leptomeningeal enhancement and superficial siderosis which persisted on a repeat brain MRI. Lumbar puncture was notable only for elevated protein. PET/CT was negative for malignancy. Additional MRI of the spinal cord was performed demonstrating diffuse leptomeningeal enhancement and possible superficial siderosis. Enlarged vessels were noted at the time of lumbar spine MRI, raising suspicion of a dural arteriovenous fistula. However, two subsequent spinal angiograms were negative. Open biopsy of the dura and
leptomeninges was performed at L3. Although no gross dural or leptomeningeal abnormality was seen, engorged, but not arterialized, veins were present along the nerves of the cauda equina. Final pathology demonstrated prominent amyloid deposition with further analysis characterizing the amyloid as the transthyretin-type associated with familial amyloidosis, confirmed with gene sequencing. Liver transplant was considered, but ultimately not recommended due to severe leptomeningeal involvement. Four months following initiation of treatment with doxycycline and ursodeoxycholic acid, the patient had made marked subjective improvement with repeat MRI demonstrating objective improvement in leptomeningeal enhancement.

Results
Enhanced T1 and susceptibility-weighted imaging demonstrated diffuse cerebral leptomeningeal enhancement and superficial siderosis. Additional images (not shown) demonstrated leptomeningeal enhancement of the spinal cord, enlarged vessels along the inferior spinal cord and cauda equina nerve roots.

Conclusions
Differential considerations of leptomeningeal enhancement and superficial siderosis are broad. However, the presence of both in the setting of elevated cerebrospinal fluid (CSF) protein suggests the unifying diagnosis of leptomeningeal transthyretin related familial amyloidosis.

KEYWORDS: Amyloid, Leptomeningeal, Superficial Hemosiderosis
Cauda Equina Syndrome Secondary to Tophaceous Gout of the Spine

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Purpose
This report describes a case of cauda equina syndrome due to gouty tophus of the lumbar facet joints involving the epidural space, which caused marked epidural inflammation and compression. The clinical details of the symptoms, investigations, which included computed tomography (CT) and the results of operative treatment are presented. A Medline search of the literature for the past 50 years yielded only 11 other reported cases of tophaceous gout involving
the facet joints of the spine. This particular case illustrates the difficulties in making the diagnosis, especially from common lesions like spinal metastases.  

Materials and Methods  
A 85-year-old man was admitted to the Emergency Department (ED) because of the inability to pass urine and a 1-day history of right thigh pain. He had a history of hypertension and gouty arthritis with gouty tophi in both hands and both feet. Urinary retention and overflow incontinence developed on the day of admission. Physical examination showed that the power of the lower limbs was normal; however perianal sensation was impaired. Patient had a cardiac pacemaker, hence CT of the lumbar spine was ordered instead of MR imaging (MRI).  

Results  
Computed tomography revealed multiple juxta-articular erosions involving the lumbar facet joints with large posterior epidural soft tissue components causing severe canal stenosis and compression of the cauda equina roots at L2-L3 level (Figure 1). The epidural soft tissue was hyperdense. The joint space was relatively preserved. Emergency posterior decompression with L2-L5 laminectomies was performed. The facet joints were distended because of chalky material; the facet joint on the left side was affected more severely than the right. The chalky material was extending into the epidural space, which caused marked inflammation of the epidural tissue, as well as cauda equina compression. The chalky material was removed from the epidural space and the facet joints, and was sent for histological examination. Pathological examination revealed that the chalky material was a tophaceous deposit with an associated granulomatous response. The neurological deficit gradually improved postoperatively.  

Conclusions  
Although rare, pseudogout should be considered in the differential diagnosis of low back pain, radiculopathy or cauda equina syndrome in patient with known gouty arthritis. Making a correct diagnosis is difficult because symptoms and signs resemble those of degenerative lumbar spinal disease and radiological features of chondrocalcinosis may not be present. Classic imaging finding include a dense asymmetrical, well defined soft tissue mass, juxta-articular erosion, and relative preservation of the joint space.  

KEYWORDS: Cauda Equina, Gout
MR Imaging Findings in Acute Hyperammonemic Encephalopathy

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Purpose
Acute hepatic encephalopathy is a potentially reversible clinical disorder, with significant morbidity and mortality if prompt treatment is not initiated. Elevated plasma ammonia levels have been implicated as the major contributor in the development of hepatic encephalopathy, and
the degree of hyperammonemia has been shown to correlate with the severity of symptoms. We present the MR imaging (MRI) findings of acute hyperammonemic hepatic encephalopathy.

Materials and Methods
Three patients who presented with acute hyperammonemic encephalopathy resulting from acute or chronic hepatic failure and hepatic failure following hydrochlorothiazide-induced necrotizing pancreatitis were included. Peak plasma ammonia levels ranged from 123 - 472 umol/L. Each patient underwent MR imaging of the brain, with symmetric involvement of the cingulate gyri and subinsular cortices identified in all cases. Two of the three patients whose peak ammonia levels reached 423 umol/L and 472 umol/L died, as it was determined that their prognosis for a meaningful recovery was poor.

Results
Extensive cortical signal changes were seen in each case, with notable symmetric restricted diffusion and increased T2/FLAIR signal intensity involving the bilateral cingulate gyri and insular cortices visualized in all cases. Similar signal characteristics involving other regions of the brain were more variable.

Conclusions
Elevated ammonia levels can have serious central nervous system (CNS) consequences. Patients with acute hyperammonemic encephalopathy demonstrate characteristic regions of signal change on MR imaging. Thus, knowledge of the MRI findings in such patients can aid the clinician in early, aggressive treatment, and possibly minimize long term morbidity.

KEYWORDS: Encephalopathy, Hyperammonemic, MR Imaging

O-859
11:00AM - 11:05AM

Isolated Intracerebral Light Chain Deposition Disease: Novel Imaging and Pathologic Findings

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Purpose
The purpose of the abstract is to (1) describe the novel imaging and pathologic findings of a unique case of intracerebral light chain deposition disease mimicking an intracranial tumor and (2) to broaden our emerging understanding of the imaging features of light chain deposition disease within the central nervous system.

Materials and Methods
Light chain deposition disease (LCDD) is a rare clinicopathologic entity first described in 1976 and is characterized by a monoclonal gammopathy that results in nonamyloid immunoglobulin light chain tissue deposition. Light chain deposition disease most commonly presents in the setting of a plasma cell dyscrasia and is associated with multiple myeloma in two thirds of reported cases and also is associated with other B-cell neoplasms such as lymphoma and chronic lymphocytic leukemia. Renal involvement is the most common manifestation of LCDD but also can involve the heart, liver, lungs and in rare instances the central nervous system. Within the central nervous system, only four cases of intracerebral LCDD have been reported previously. The case presented herein is the first instance of an intracerebral LCDD in the absence of known
lymphoproliferative disease or the presence of local plasma cells and serves to widen our appreciation for the various clinical and imaging manifestations of LCDD within the central nervous system.

Results
MR imaging of the brain revealed a T1 hypointense, T2/FLAIR hyperintense, nonenhancing mass lesion centered in the right superior and middle frontal lobes measuring 4.7 x 3.9 x 3.8-cm (anteroposterior x transverse x craniocaudal) with local mass effect and effacement of overlying sulci and subjacent anterior horn of the right lateral ventricle. The large intracranial mass demonstrated no intrinsic magnetic susceptibility artifact, complete absence of postcontrast enhancement and homogeneous facilitated diffusion. Targeted dynamic gadolinium-enhanced axial perfusion imaging of the mass demonstrated no cerebral blood volume as compared to contralateral white matter.

Conclusions
The previous reports of intracerebral LCDD were discovered in the setting of a known plasma cell dyscrasia or in the presence of local mature plasma cells whose local synthesis of light chains generated the intracranial mass, both of which are conspicuously absent in the case presented here. Additionally, the imaging features of this unique case of LCDD also mirror the surprising pathologic findings. Unlike the previously reported cases of intracerebral LCDD, magnetic resonance imaging of our mass reveals no evidence of postgadolinium contrast enhancement on T1-weighted images and little to no evidence of perfusion on dynamic gadolinium-enhanced perfusion imaging. Both imaging features stand in stark contrast to the reported imaging findings of prior reports of LCDD, which demonstrated varying degrees of enhancement on postcontrast imaging. The lack of enhancement observed in our case, then, likely reflects the novel underlying pathologic findings. This unique case reflects a growing understanding of the varying radiologic and pathologic features of LCDD within the central nervous system and a growing appreciation of a more heterogeneous disease process than previously thought.

KEYWORDS: Masses, MR Imaging Brain
AIDS Related EBV Associated Smooth Muscle Tumor Mimicking a Meningioma.

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Purpose
The purpose of this excerpt is to describe the imaging and clinico-pathologic features of Epstein-Barr virus (EBV) associated smooth muscle tumors (SMT) in the central nervous system using an illustrative case of a dural-based SMT presenting as a suspected meningioma.

Materials and Methods
A 46-year-old man with a history of HIV/AIDS and disseminated histoplasmosis treated one year prior presented with recent onset of right-sided hearing loss and dizziness. The patient underwent magnetic resonance imaging (MRI) of the brain, which revealed the interval development of a dural-based mass arising from the right petrous apex (Figures 1, 2), not present on brain MRI one year prior. A right frontoorbitozygomatic craniotomy was performed with resection of the lesion, which upon pathologic examination revealed features compatible with an EBV-associated smooth muscle tumor.
Results
Figure 1: Axial T2-weighted image reveals a hypointense extra-axial mass (white arrow) arising from the right petrous apex with a central region of cystic/necrotic change. Figure 2: Coronal T1 postcontrast image shows an avidly enhancing extra-axial mass (white arrow) arising from the right petrous apex with a broad dural attachment and a central region of nonenhancing cystic/necrotic change.

Conclusions
Epstein-Barr virus-associated smooth muscle tumors are an increasingly reported non-AIDS defining neoplasm, with the majority of reported cases arising in young severely immunosuppressed individuals. As in this case, tumors generally demonstrate spindle cells with smooth muscle actin and muscle specific actin reactivity in addition to positive in situ hybridization with EBV RNA. These neoplasms are designated as leiomyoma versus leiomyosarcoma based on necrosis and mitotic activity; however the existing data do not demonstrate a strong histologic correlation with patient prognosis. The central nervous system (CNS) is the most common reported site of AIDS-associated SMT, with reported lesions presenting as extra-axial dural-based enhancing masses. Patient treatment options include lesion resection as well as chemoradiotherapy and highly active antiretroviral therapy (HART). Tumor-related death is seen in a minority of cases.

KEYWORDS: AIDS, Epstein Barr Virus, Meningioma

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A Case of Chronic Lymphocytic Inflammation with Pontine Perivascular Enhancement Responsive to Steroids (CLIPPERS) in a Child

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Purpose
Our purpose is to present a case of chronic lymphocytic inflammation with pontine perivascular enhancement responsive to steroids (CLIPPERS) in a nine-year-old boy. To the best of our knowledge this is the youngest patient reported with this entity in the English literature.

Materials and Methods
A nine-year-old boy presented to our neurology clinic with abnormal gait and abnormal left eye movement for one month. He had headache and repeated vomiting but reported no loss of consciousness. He gave a history of minor head trauma about a month before presentation. There was no significant past medical or family history. On examination, the patient was vitally stable and looked generally well. His central nervous system (CNS) exam showed no neurological deficits. He had mild ataxia with tendency to falling to the left side. The patient's electroencephalogram (EEG) showed inactive bi-occipital epileptic activity and he was sent home on Keppra pending his MR imaging (MRI) appointment. An MRI was performed in a private institute a week afterwards and showed bilateral brachium pontis lesions, which according to the outside report were concerning for a glioma. The patient underwent biopsy and received postoperative dexamethasone for brain edema. The patient was discharged and was later booked for a postoperative MRI in our institution where the pre-operative studies also were reviewed. The diagnosis of CLIPPERS was suggested on imaging and later confirmed by pathology. The patient currently is doing very well and is back to school. There is minimal ataxia and left eye nystagmus. He is currently on maintenance steroids.

Results
The initial MRI images showed solid enhancing low T1 and high T2 lesions in both middle cerebellar peduncles with mass effect on the fourth ventricle but no hydrocephalus. There was no diffusion restriction or blooming. Abnormal subtle punctuate perivascular enhancement also were noted in the pons. No supratentorial abnormalities were identified. The postoperative MRI showed interval development of a small surgical cavity in the left brachium pontis. The lesions however had become smaller in response to the steroids with very minimal residual enhancement.

Conclusions
CLIPPERS is a new inflammatory entity described in 2010. Since then only adult and adolescent cases have been reported. Knowing that this entity can affect young children will raise the index of suspicion and guide clinicians and pathologist to making the correct diagnosis to avoid unnecessary measures.

KEYWORDS: Inflammatory, MR Imaging
Another Boring Case of NF2 – NOT! Schwannomatosis

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Purpose
Schwannomatosis is an under-recognized entity characterized by multiple schwannomas without involvement of the vestibular nerves. Given its similarity to NF2, the two diagnoses are easily confused. We present a case of schwannomatosis predominantly involving the spine, describe the similarities and differences between schwannomatosis and NF2, highlight useful imaging and clinical discriminators, and discuss the importance of distinguishing between these diagnoses.

Materials and Methods
A 36-year-old woman with history of prior resection of a cervical schwannoma presented with severe back pain. Past medical history, family history, and physical examination were unremarkable. MR imaging (MRI) of the lumbar spine revealed numerous T1 hypointense, T2 hyperintense, enhancing extramedullary, intradural masses along the course of the cauda equina nerve roots, as well as within the paraspinal muscles and presacral pelvis. MR imaging of the cervical and thoracic spine revealed numerous other spinal and dural-based lesions, and MRI of the brain was negative for vestibular schwannomas. No pathologic mutation of the NF2 gene was found after comprehensive genetic analysis.

Results
Schwannomatosis is genetically different from NF2. Although the SMARCB1/INI1 gene plays a role in tumorigenesis, no genetic test exists to definitively make the diagnosis. For this reason, imaging plays a critical role in making the diagnosis. Patients who are older than 30 with two or more nonintradermal schwannomas or one pathologically confirmed schwannoma and a first degree relative with the diagnosis can be diagnosed with schwannomatosis, provided they do not
have a vestibular schwannoma on MRI, fulfill diagnostic criteria for NF2, have a first-degree relative with NF2, or carry a known constitutional NF2 gene mutation. MR imaging of the brain is the primary means of evaluating these patients and excluding vestibular schwannomas. Findings include multiple round-to-oval lesions along the course of peripheral nerves. Lesions are typically low-to-intermediate signal intensity on T1-weighted imaging, high signal intensity on T2-weighted imaging, PD, and STIR, and demonstrate variable contrast enhancement. On CT, lesions are usually hypo-to-isodense to skeletal muscle with variable contrast enhancement.

Conclusions
Schwannomatosis and NF2 are unique disorders that easily are confused by imagers. It is critical for radiologists to differentiate the two on imaging grounds, as there are important differences in clinical outcomes (schwannomatosis patients do not have a decreased life expectancy, unlike NF2 patients, and do not need to worry about future sensorineural hearing loss) and clinical management of the two disorders. Location of lesions is a critical imaging discriminator and the absence of vestibular nerve lesions strongly favors the diagnosis of schwannomatosis over NF2.

KEYWORDS: Differential Diagnosis, Neurofibromatosis, Schwannoma
Delayed Post Hypoxic Leukoencephalopathy (DPHL), A case report.

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Purpose
Delayed posthypoxic leukoencephalopathy (DPHL) is a rare consequence of hypoxic-ischemic brain injury. We describe the imaging and clinical findings of DPHL in a young patient after an episode of cardiac arrest.

Materials and Methods
The patient is a 19-year-old male who was admitted to hospital for viral cardiomyopathy and poor cardiac function. He developed cardiac arrest during his admission and was comatose for two days before gaining his normal level of consciousness. Brain MR imaging (MRI) after cardiac arrest showed restricted diffusion involving bilateral basal ganglia, corona radiata and parieto-occipital cortex with associated T2/FLAIR hyperintensity compatible with hypoxic ischemic injury. Three weeks after his arrest he developed behavioral changes and myoclonus. His level of consciousness gradually declined, developed involuntary movements of all extremities and did not follow commands. Second MRI examination six weeks after cardiac arrest revealed severe interval progressive cerebral volume loss with a central pattern predominance evidenced by enlargement of the cerebral lateral ventricles and reactive gliosis along areas of infarctions. Eventually he became comatose again, had another incident of cardiac arrest and passed away. The results of serum chemistry analyses, serum lactate and pyruvate level, thyrotropin, vitamin B12 complete blood cell count, coagulation studies, as well as CMV, HSV, West Nile virus of cerebrospinal fluid (CSF) were all normal. The result of autopsy revealed thinning of the gray matter with extensive neuronal loss in all layers of the cortex, gemistocytic astrocytes, and focal areas of laminar necrosis indicating ischemic/hypoxic encephalopathy with irreversible diffuse cortical injury.

Results
Diffusion-weighted MRI (left) after cardiac arrest shows restricted diffusion along occipitoparietal cortex and basal ganglia. FLAIR image (right) performed six weeks later reveals severe interval central predominant cerebral volume loss and reactive gliosis along the infarcted regions.

Conclusions
Delayed posthypoxic leukoencephalopathy is characterized by full or partial recovery from confusion or comatose state postcerebral hypoxia which then is followed days or weeks later by neurologic and neuropsychiatric findings including disorientation, amnesia, hyperreflexia, parkinsonism, or psychosis. Demyelination has been proposed as a pathophysiological mechanism. Widely spaced arterioles within the white matter render it vulnerable to hypoxic injury and subsequent demyelination. Delayed posthypoxic leuкоencephalopathy also has been associated with carbon monoxide poisoning, heroin inhalation, and occult abnormalities in arylsulfatase A. Prognosis is variable, usually ominous but recovery has been described in few cases.

KEYWORDS: Demyelination, Encephalopathy, Hypoxia
A case of calcified stylopharyngeus causing globus sensation.

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Purpose
To present a case of a calcified stylopharyngeus muscle causing globus sensation and mimicking a foreign body.

Materials and Methods
A 64-year-old man presented to the emergency department with globus sensation after eating boneless chicken the day before. Patient reported a dull pain radiating to the right jaw and ear. A computed tomography (CT) scan of the neck was performed from the emergency department, which revealed a linear radiodense structure in the right oropharyngeal wall, interpreted as a
foreign body. Patient underwent a transoral exploration, which failed to reveal a foreign body. Repeat CT scan after the exploration showed right lateral oropharyngeal edema and persistent linear radiodensity lateral to the constrictor muscles. The patient then underwent a pharyngotomy, and a calcified stylopharyngeus was excised. A month after surgery, the patient reported that the globus sensation and pain had resolved.

Results
Unenhanced CT of the neck revealed a linear radiodensity measuring approximately 5 cm in length arising just inferomedial to the distal tip of the right styloid process, extending inferomedially and terminating deep to the right lateral oropharyngeal wall (Figure 1). There was edema of the right lateral oropharyngeal wall. The styloid processes were top normal in length.

Conclusions
This case highlights a rare situation of a calcified stylopharyngeus causing pain and globus sensation. The insertion of the stylopharyngeus is comprised of a descending muscle bundle surrounding the piriform recess and a second shorter component inserting into the tonsillar bed (1). The latter was calcified in this case. Awareness of the course of the stylopharyngeus will help differentiate it from an elongated stylohyoid process or a calcified stylohyoid ligament (Eagle's syndrome).

KEYWORDS: Neck Lesions
Fig. 1. Coronal and sagittal MIP images demonstrate a calcified right stylohyoid greater cornu. SP, styloid process. NG, nasogastric tube. HB, hyoid body. HLC, hyoid lesser cornu. S, sialolith. CA, carotid artery calcification.

O-865

Delayed embolization of coil fragments with associated foreign body reaction

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Purpose
We describe a delayed complication of coil embolization of basilar tip aneurysm consistent of brain-enhancing lesions in the posterior circulation territory associated to susceptibility foci.

Materials and Methods
We report the case of a 38-year-old female who presented with a nonruptured basilar tip aneurysm and a strong family history of subarachnoid hemorrhage (grandmother who died of a subarachnoid hemorrhage at age 42 and a mother who suffered a subarachnoid hemorrhage with persistent neurological deficits at age 52). Treatment was decided and Microplex 10 Cosmos Complex and Microplex 10 Hypersoft Helical detachable coils were utilized to occlude the aneurysm.

Results
Postprocedure MR performed the next day after coiling showed a few infarcts in the posterior circulation. No susceptibility foci were present at this point on T2-gradient echo images. Follow-up MR imaging (MRI) studies at three months showed new susceptibility foci at the site of the infarcts with associated nodular and ring enhancement as well as surrounding edema. Eight months follow-up MR study showed complete resolution of prior enhancement and a new rim-enhancing lesion with surrounding edema associated to a previously identified susceptibility focus. Patient remained completely asymptomatic. These findings are most in keeping with foreign body reaction secondary to embolic material of unknown source.

Conclusions
Very few cases of brain foreign body reaction related to aneurysm coiling have been described in the literature. Recognition of this entity is essential to avoid unnecessary brain biopsies. Characteristic features of foreign body reaction related to aneurysm coiling are enhancing lesions associated to susceptibility foci, spontaneous improvement of lesions and absence or very mild symptoms (clinicoradiological dissociation).

KEYWORDS: Aneurysm Treatment, Foreign-Body Granuloma
A case of cerebral amyloid angiopathy inflammation mimicking cerebral metastasis

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A, B and C: Follow up MRI performed three months after coiling. A and B. T2 weighted gradient echo sequence showing three new susceptibility foci (black arrows). C, Contrast enhanced T1 weighted sequence showing enhancement of the lesions (white arrow).

D, E, F and G: Follow up MRI eight months after coiling new foci of enhancement associated to the susceptibility areas appeared (E and F, white arrows). Previous enhancement has completely resolved (G). Edema is noted adjacent to rim enhancing lesion in the left occipital lobe (E).

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Purpose
To describe a case of cerebral amyloid angiopathy inflammation and to highlight the salient imaging features of this condition.

Materials and Methods
A 75-year-old woman with a previous history of treated breast cancer presented with increasing confusion. She was normally cognitively intact. The patient underwent initial imaging with computed tomography (CT) both with and without contrast which were suspicious for cerebral metastasis and subsequent MRI imaging (MRI) was performed.

Results
The initial contrast-enhanced CT demonstrated three areas of vasogenic edema within the left frontal, left parietal and right temporal lobes but no discernible mass lesions were identified. The edema was presumed secondary to occult metastasis. A subsequent MRI was performed and this confirmed the presence of widespread vasogenic edema especially within the left parietal lobe but no enhancing lesions were identified. On diffusion imaging there was a subtle focal areas of susceptibility in the left parietal lobe. The patient was treated prophylactically with steroids and a subsequent MRI examination was performed two weeks later with additional gradient echo and spectroscopy sequences. The areas vasogenic edema had improved significantly since the previous imaging and the gradient echo showed multiple small focal susceptibility defects corresponding to the areas of vasogenic edema. The spectroscopy showed a subtle decrease in NAA but otherwise normal spectra within the edema. The appearances are in keeping with micro hemorrhages related to cerebral amyloid angiopathy, a diagnosis of inflammatory cerebral amyloid angiopathy. The diagnosis of cerebral metastasis was refuted.

Conclusions
Cerebral angiopathy with inflammation (CAA-I) is an uncommon manifestation of amyloid angiopathy. Cerebral angiopathy with inflammation presents with acute or subacute onset of headaches, cognitive and behavioral changes, seizures and focal neurological deficits. It is an important differential to consider in an elderly patient with behavioral change and the addition of gradient echo/susceptibility-weighted imaging is of significant diagnostic value. The condition is steroid responsive in approximately 50% of cases. This case highlights CAA-I as a possible differential diagnosis in acutely cognitively impaired patients.

KEYWORDS: Amyloid, Microbleeds, MR Spectroscopy
Langerhans Cell Histiocytosis Presenting as a Thalamic Lesion and Resulting in Obstructive Hydrocephalus

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Purpose
To report to the best of our knowledge the first case of Langerhans cell histiocytosis presenting as enhancing thalamic lesion and resulting in obstructive hydrocephalus.

Materials and Methods
A 27-year-old female presenting with headache and neck pain was referred for a brain MR imaging (MRI) and was found to have a nodular, ring enhancing lesion of the left thalamus abutting the third ventricle with surround T2 hyperintensity. Lesion fluctuated in size over short interval follow-up examinations, but ultimately increased in size to involve the contralateral right thalamus and resulted in mild obstructive hydrocephalus within six months of presentation. Subsequent imaging studies revealed an additional punctate enhancing lesion in the right temporal lobe and nonspecific vertebral endplate abnormalities at T8 and T10. Biopsies of the left thalamic lesion were performed and ultimately were diagnostic for Langerhans cell.
histiocytosis. The patient was managed with corticosteroids, chemotherapy, ventricular shunting and third ventriculostomy. On subsequent imaging the lesion showed regression, and the hydrocephalus resolved.

Results
MR imaging performed approximately six months after presentation reveals an enlarging, enhancing lesion involving both thalami. Significant surrounding edema is present extending into the medulla, and there is mass effect on the third ventricle and aqueduct resulting in mild obstructive hydrocephalus. An additional punctate enhancing lesion is noted in the right temporal lobe (arrow).

Conclusions
To the best of our knowledge we present the first case of biopsy-proven Langerhans cell histiocytosis presenting as a thalamic mass and resulting in obstructive hydrocephalus.

KEYWORDS: Hydrocephalus, Langerhans Cell Histiocytosis, Thalamic
Growing Spectrum of Rhabdoid Brain Malignancies: Case of Cribriform Neuroepithelial Tumor of Intraventricular Origin.

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Purpose
Expanding use of genetic and neuropathologic markers in brain malignancies allows for advances in classification of central nervous system (CNS) neoplasms. However, their clinical and radiologic differentiation remains a challenging diagnostic dilemma. Atypical teratoid rhabdoid tumor (ATRT) is a devastating group of highly aggressive pediatric brain neoplasms with poor prognosis and overall survival. Meta-analysis of available cases implies that ATRT might be under-diagnosed radiologically but yet represents the most common brain malignancy in infant population. It recently has been suggested that ATRT may not constitute a single entity. Cribriform neuroepithelial tumor (CRINET) is recognized as a distinct desmoplastic neoplasm based on specific histopathologic markers and favorable clinical behavior. We present a case of CRINET with unique supratentorial manifestation arising in the lateral ventricle. Using the index case and data published elsewhere, we exemplify imaging characteristics of CRINET in attempt to increase awareness of this new type of pathology and explicate its role in differential diagnostics of pediatric CNS malignancies.

Materials and Methods
A 14-month-old male infant with unremarkable developmental milestones presented with mental status change and lethargy following a minor head trauma. Subsequent CT head performed in ER incidentally found a multiloculated lesion in the right hemisphere. Further MR imaging suggested a broad range of differential diagnoses including PNET, ATRT, ependymoma or choroid plexus carcinoma. Craniotomy and surgical exploration achieved a subtotal tumor resection. Postoperative recovery was uneventful with induction chemotherapy consisted of cisplatin, cyclophosphamide, etoposide and vincristine, reinforced by high-dose methotrexate. Subsequent chemotherapy and radiation will be contemplated depending on follow-up imaging. Histopathology found a highly cellular biphasic neoplasm with cells forming distinct cribriform strands specific for CRINET. Characteristically, tumor cell nuclei showed no immunohistochemical staining for INI1 tumor suppressor protein. Molecular analysis confirmed bi-allelic INI1 inactivation due to microdeletion of 22q accompanied by a somatic nonsense mutation. It is unclear however, as to what extent genetic alterations may affect clinical aggressiveness of CRINET and its imaging manifestations.

Results
Multimodal MR imaging of the brain demonstrated a large complex right parietal mass emanating from the atrium of the lateral ventricle. It was composed of mixed cystic and solid components with the latter exhibiting impeded water diffusion suggestive of high cellularity. Solid areas revealed subtle signal prolongation on both T1- and T2-weighted sequences and heterogeneously enhanced. It contained foci of hemosiderin staining on gradient MRI due to varying age intrinsic hemorrhage accompanied by some perilesional vasogenic edema. Marked
mass effect resulted in solid component extrusion into basal cisterns with ventricular and midbrain displacement. Despite the size of a primary lesion, there was no evidence of cerebrospinal fluid (CSF) dissemination or extracranial spread.

Conclusions
Cribriform neuroepithelial tumor is a newly described neuroepithelial CNS tumor with distinct histopathologic cribriform pattern and relatively benign prognosis. It further contributes to a genetic continuum of INI1-deficient pediatric malignancies but remains an under-recognized clinical entity and not yet included in 2007 WHO nomenclature. We discuss CRINET presentation and its pictorial profile to familiarize radiologists with growing spectrum of ATRT neoplasms. Specific genetic alterations may provide future avenues for molecular imaging of CRINET and other INI1 brain malignancies. However, a limited number of known observations warrants additional analysis to further corroborate association of specific imaging pattern in CRINET.

KEYWORDS: ATRT, Neurogenetics, Pediatric Brain Tumors
A rare case of duplication of the pituitary gland in an adult with multiple associated congenital midline cranial and cervical lesions.
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Purpose
To demonstrate a rare case of adult pituitary gland duplication with multiple associated midline cranial and cervical abnormalities, and to discuss potential clinical implications.

Materials and Methods
A 33-year-old lady with a history of cleft palate underwent outpatient neurosurgical assessment for posterior neck pain over the preceding 12 months. Neurological examination was normal except for slightly brisk upper limb reflexes. MR imaging (MRI) and computed tomography (CT) of the spine demonstrated congenital cervical and cervico-occipital segmentation and fusion anomalies. MR imaging of the brain and pituitary region showed callosal dysgenesis and callosal lipoma, a likely left frontal epidermoid cyst, probable midline sphenoid dermoid lesion, hypothalamic hamartoma, duplication of the pituitary gland and pituitary stalk, and duplication of the distal basilar artery. The left frontal extraaxial epidermoid lesion was not associated with mass effect or adjacent parenchymal signal abnormality. The configuration of the basilar artery duplication suggested a low risk of aneurysm formation. Pituitary function tests were normal. Clinical symptoms were felt to be unrelated to the radiological findings. The patient was reviewed by skull base, neuro-oncology and endocrine multidisciplinary teams, with a plan for conservative management including clinical and radiological follow up.

Results
Computed tomography and MRI of the cervical spine demonstrated nonsegmentation of the C2-C3 and C3-C4 vertebrae, atlanto-occipital fusion anomalies, nonfusion of the anterior and posterior C1 arches and asymmetric jugular foramina. Junctional degenerative changes were seen at C4-5 and C5-6. MR imaging of the head and pituitary region, including diffusion-weighted imaging, demonstrated multiple midline abnormalities as follows: 1) Callosal dysgenesis with callosal lipoma, 2) Likely left frontal epidermoid cyst, 3) Fat-containing sphenoid lesion most suggestive of a dermoid lesion, 4) Likely hypothalamic hamartoma, 5) Duplication of the pituitary gland and stalk, separated by a bony septum on CT, 6) Distal basilar artery duplication, giving rise to superior cerebellar and posterior cerebral arteries.

Conclusions
Pituitary gland duplication, a rare embryonic anomaly with a poorly understood pathogenesis, is found most often in childhood, with many patients not surviving beyond puberty. Pituitary gland duplication may be associated with basilar artery duplication (with the potential for aneurysm formation) as well as several other craniofacial abnormalities such as cleft palate, agenesis of the corpus callosum, hypothalamic hamartoma and nasopharyngeal teratoma. The wide range of lesions may be assessed by a combination of CT and MRI/MRA; we believe this is the first documented case of a midline inter-sellar bony spur in pituitary gland duplication with an intracranial epidermoid. In adult patients presenting with such lesions, the need for clinical and radiological follow up should be based on the size, nature and site of the lesions, with assessment of the likelihood of future neurological and endocrine complications, following appropriate multidisciplinary review.

KEYWORDS: Callosal Dysgenesis, Epidermoid, Pituitary Gland
1000 Clinically Isolated Syndromes: the “Barcelona cohort” Defines a New Natural History Study

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Purpose
To determine the effect of baseline demographic, clinical, MR imaging (MRI) and biological
factors on conversion to clinically definite multiple sclerosis (CDMS) and development of disability in a prospective cohort of patients with clinically isolated syndromes (CIS).

Materials and Methods
From 1995 to 2012, 1058 CIS patients underwent clinical and MRI follow-up (within 5 months of the CIS, at 12 months and every five years). We studied the influence of age, gender, topography, number and location of lesions at baseline (Barkhof criteria-BC) and IgG oligoclonal bands (OB) on the risk of CDMS and development of disability (EDSS 3.0) using Cox univariate and multivariate regression analysis.

Results
We included 1015 patients followed for a mean of 81 (SD 57) months with positive OB in 453/798 (57.2%) and normal MRI in 299/951 (31%). Thirty-eight percent of the patients and 57% of those with abnormal MRI were on disease modifying treatment (DMT). Gender was not associated with the development of CDMS [HR 1 (0.8 - 1.3)] or disability progression [HR 0.7 (0.5 - 1.1)]. Younger age at onset showed a higher risk of CDMS [HR 1.9 (1.1 – 3.1)] but no effect on disability progression. Patients with ON had a lower risk of conversion [HR 0.6 (0.5 - 0.8)] and disability progression [HR 0.5 (0.3 – 0.8)], however this protective effect disappeared when adjusting for MRI and DMT. Presence of OB increased the risk of CDMS [HR 1.5 (1.1 – 2)] and EDSS 3.0 [HR 2.3 (1.3 – 4.0)] independently of other factors. In the adjusted model, the presence of 3-4 BC criteria increased the risk of CDMS [HR 6.6 (4.6 – 9.5)], and disability progression [HR 2.4 (1.3 – 4.2)]. Treating patients before the second attack resulted in a reduced risk of CDMS [HR 0.6 (0.4 - 0.8)] and disability progression [HR 0.5 (0.2 - 0.9)] irrespective of MRI and other factors.

Conclusions
MR imaging baseline characteristics have a high impact in the long term. OB and topography/demographic characteristics are of medium and low impact, respectively. Early DMT decreases the risk of CDMS and accumulation of disability.

KEYWORDS: MR Imaging Brain, Multiple Sclerosis

O-872

Asymptomatic progressive multifocal leukoencephalopathy in multiple sclerosis patients treated with natalizumab

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Purpose
To evaluate MR imaging (MRI) findings and clinical outcomes in natalizumab-treated multiple sclerosis (MS) patients who were asymptomatic at the time they were diagnosed with progressive multifocal leukoencephalopathy (PML).

Materials and Methods
Asymptomatic patients, diagnosed by MRI findings consistent with PML and JC virus DNA detected in cerebrospinal fluid (CSF), were compared with patients who were symptomatic for PML at diagnosis. Demographics, MRI, functional status, and survival data were analyzed.
Expanded Disability Status Scale (EDSS) and Karnofsky Performance Scale (KPS) scores were recorded pre-PML, at diagnosis, and at six and 12 months post-PML diagnosis.

Results
As of June 5, 2013, 372 natalizumab-associated PML cases were confirmed in multiple sclerosis patients. At diagnosis, 30 PML patients (8.1%) were asymptomatic (mean age 42.7 years; 70% female; median natalizumab exposure 40.5 months) and 342 were symptomatic (mean age 45.1 years; 70.8% female; median natalizumab exposure 40.0 months). Progressive multifocal leukoencephalopathy lesions on MRI in asymptomatic versus symptomatic patients were 68% versus 37% unilobar, 21% versus 24% multilobar, and 11% versus 40% widespread, respectively. In both groups, frontal lesions predominated. Symptoms developed in eight of 19 asymptomatic patients a median of 20 days (range 3–130) after PML diagnosis, including five patients with cognitive deficits and/or behavioral changes. Prior to PML, mean EDSS and KPS scores in asymptomatic and symptomatic patients were similar. At PML diagnosis, mean EDSS score in asymptomatic patients was significantly lower than symptomatic patients [4.1 (n=11) versus 5.4 (n=193); P=0.038]. These differences persisted six months after PML diagnosis [4.9 (n=11) versus 6.6 (n=87); P=0.007] but not 12 months after diagnosis [5.1 (n=6) versus 6.5 (n=59); P=0.169]. Similarly, mean KPS scores in asymptomatic patients showed significant improvement compared with symptomatic patients at six months [71.5 (n=10) versus 47.1 (n=108); P<0.001] but not at 12 months [56.0 (n=5) versus 46.6 (n=67); P=0.178] after PML diagnosis. As of June 5, 2013, 96.7% (29 of 30) of asymptomatic patients and 75.4% (258 of 342) of symptomatic PML patients were alive.

Conclusions
Preliminary data suggest that PML in asymptomatic patients was associated with better survival and functional outcomes compared with PML patients who were symptomatic at diagnosis. Additional research is needed to evaluate whether routine MRI monitoring may improve outcomes in natalizumab-treated patients developing PML, as a result of earlier PML detection.

KEYWORDS: Leukoencephalopathy, MR Imaging Brain, Multiple Sclerosis

O-873

1:14PM - 1:21PM

Changes in white matter fiber tracts in patients with systemic lupus erythematosus.

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Purpose
Systemic lupus erythematosus (SLE) is a chronic inflammatory, immune-mediated, autoimmune, connective tissue disease that affects 0.1% of the general population. Neuropsychiatric SLE (NPSLE) is a severe and life-threatening condition, reported to occur in 30% to 72% of patients with SLE and associated with increased morbidity and mortality. The purpose of this study was to investigate with tractographic analysis of diffusion tensor imaging, if there are differences in white matter integrity in specific white matter tracts in NPSLE and SLE patients.

Materials and Methods
Using a 3 T MR scanner (Philips, Netherlands) DTI MR images (15 gradient directions at
b=800s/mm², plus one b=0 image) were obtained of 18 healthy controls (HC), 19 NPSLE patients and 19 non-NPSLE patients. Groups were matched for age and sex. Tractographic analysis was performed for genu of corpus callosum (GCC), inferior fronto occipital fasciculus (IFO), anterior corona radiata (ACR), anterior limb internal capsule (AIC), superior longitudinal fasciculus (SLF), external capsule (EC), posterior limb internal capsule (PIC), inferior longitudinal fasciculus (ILF), cingulate gyrus part (CGC) and frontal part of uncinated fasciculus (UNC). Lesion burden also was analyzed on conventional MR imaging (MRI).

Results
Statistical analyses revealed decreased fractional anisotropy in GCC, IFO, ACR, AIC, SLF, EC. On the conventional MRI, severe lesion burden was seen in 10.5% (2/19), moderate in 21% (4/19), and mild in 38.8% of the NPSLE patients (7/19). Moderate lesion burden was seen in 15.8% (3/19), and mild in 42% of the non-NPSLE patients (8/19). In the HC group, six patients had mild, one patient had moderate and one patient had severe lesion burden.

Conclusions
Our data suggest that decreased fractional anisotropy is seen in some of the frontal white matter tracts in patients with NPSLE and SLE as compared to healthy volunteers.

KEYWORDS: Diffusion Tensor Image, Systemic Lupus Erythematosus

O-874

Feasibility Study of Flow Compensation to Improve Diagnostic Quality of T1 Post Contrast Spin Echo Magnetic Resonance Images

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Purpose
Phase-related pulsation artifact has long been a problem with T1 postcontrast MR imaging (MRI). Flow compensation can be applied to decrease this phase-related artifact which results in increased image clarity and improved diagnostic accuracy. In this study, we compared flow compensated (FC) with conventional nonflow compensated (non-FC) T1 postcontrast MR images.

Materials and Methods
Forty-two patients (29 F, 8 M, mean age 53 years old, age range 6-82 years old) who underwent routine contrast-enhanced MRI of the brain had both FC T1 postcontrast MR images (TR/TE 535/18) and non-FC (TR/TE 550/7.7) after intravenous injection of 0.1 mmol/kg of gadolinium contrast. Image series were randomized, reviewed blinded, and scored on a four point scale as follows: 4: Excellent image quality, none to minimal pulsation artifact. 3: Mild flow artifact; no hyperintensity that can be confused for a lesion and less than six slices with pulsation artifact. 2: Prominent pulsation artifact, with hyperintensity that may be confused for a lesion; or pulsation artifact on six or more slices. 1: Poor image quality, not interpretable. Data were analyzed with an ANOVA using the ratings as the dependent variable and condition (FC versus non-FC) and reader as independent variables. Interobserver agreement was tested with Spearman rank correlation.
Results
Twenty-eight of 42 (66%) of studies were rated nondiagnostic (score <=2) in non-FC technique versus 6/42 (14%) in FC group. The image quality score was statistically significantly higher (F = 106.502, p < 0.0001) for FC technique versus non-FC. The mean +/- SD of image quality score were 2.124 (sd = 0.413) for non-FC and 3.036 (sd = 0.633) for FC technique. The Spearman rank correlation and 95% CI for image quality scores between readers were 0.64, 95% CI 0.25-0.73 for FC and 0.56, 95% CI 0.20-0.67 for non-FC technique.

Conclusions
Postcontrast T1 with flow compensation significantly improves pulsation artifact which can help with diagnostic accuracy.

KEYWORDS: MR Imaging, MR Imaging Brain, Quality Improvement
Cervical Cord Atrophy and Clinical Disability in Primary Progressive Multiple Sclerosis Patients

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Purpose
To measure spinal cord atrophy in a group of patients with primary progressive multiple sclerosis (PPMS); and assess correlations between spinal cord atrophy and different brain measures (T2 lesion load, brain atrophy, magnetization transfer ratio), and clinical disability.

Materials and Methods
3D T1-weighted isotropic MR images of the cervical cord were acquired from 67 PPMS patients (34 men, 33 women; mean age: 48.7 years, range: 31–65 years; median expanded disability status scale—EDSS—score: 6.0, range: 3.0–7.0; median disease duration: 10 years, range: 0–33 years). An additional group of 9 healthy control subjects (5 men, 4 women; mean age: 45.0 years, range: 37–56 years) was also included for comparison. Spinal cord from C1 to C5 was segmented in each subject using a segmentation method [Horsfield, 2010] based on the application of an active surface model of the cord surface. Using this method we evaluated cross-sectional spinal cord area (CSA) from spinal cord volume divided by cord length. CSA was then normalized (CSAn) to the intra-cranial cross-sectional area (ICCSA). T2 lesion load (T2LL), brain parenchymal fraction (BPF), and magnetization transfer ratio (MTR) in normal appearing brain tissue (MTRNAB) and the whole parenchyma (MTRWP) were calculated. Apart from EDSS, 25-feet timed walk test (TWT) and the inverse of the nine-hole peg test (1/NHPT) were also evaluated. Partial correlations controlled for age, gender and disease duration were performed to evaluate relationship between clinical (EDSS, TWT, 1/NHPT) and radiological variables (T2LL, BPF, MTRNAB, MTRWP, SCAn). Stepwise multiple linear regression analyses controlled for age, gender and disease duration were also carried out to investigate the ability of radiological variables to predict clinical outcomes.

Results
CSAn had a moderate correlation with EDSS (r=-0.381, p=0.002) and TWT (r=-0.269, p=0.038). CSAn was also the only predictor of grater disability as measured by EDSS and TWT, resulting in a significant improvement of a 12.5% and a 6.3% of the variance being explained by covariate variables, respectively. Models including CSAn and covariate variables also presented significance predicting EDSS (p=0.001) and TWT (p=0.013). Finally, none of the brain MR measures correlated with clinical data.

Conclusions
The findings of this study indicate that normalized cross-sectional spinal cord area measure is clinically relevant in PPMS patients. These results also suggest that CSAn seems to be more relevant than brain MRI variables to predict clinical disability.

KEYWORDS: Atrophy, Multiple Sclerosis, Spinal Cord

O-876
**Molecular Magnetic Resonance Immunoradiology Reveals Differential Effects of Interferon-β and Glatiramer Acetate on Murine Multiple Sclerosis**

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**Purpose**

Conventional contrast-enhanced MR imaging (MRI) measures blood-brain barrier breakdown, but not necessarily inflammation in multiple sclerosis (MS). We hypothesized that MPO-Gd (bis-5HT-DTPA-Gd), a molecular MRI probe sensitive and specific for the inflammatory enzyme myeloperoxidase (MPO) (1), can detect the immunotherapeutic effects of Interferon-β (Ifn-β) and Glatiramer Acetate (GA), two current first-line drugs on the molecular level noninvasively.

**Materials and Methods**

Thirty female SJL mice were injected with proteolipid protein (PLP139-151) to induce experimental autoimmune encephalomyelitis, a mouse model of MS, and treated with Ifn-β (1μg/day), GA (150 μg/day), or saline. To determine effects of these drugs on MPO, mice underwent MRI at 4.7 T with MPO-Gd at the disease peak (day 11-13). Lesion volumes and contrast-to-noise ratio (CNR) at 10 and 60 minutes post MPO-Gd injection were quantified. Myeloperoxidase activity and secretion experiments were conducted.

**Results**

Disease severity was ameliorated with both Ifn-β and GA (p<0.05 compared to saline). Myeloperoxidase-Gd-enhanced MRI detected decreased number of lesions with GA (2.4±1.1, p<0.01) but not with Ifn-β (6.2±2.2, p=0.90) compared to saline (6.0±1.8). Total lesion volume was decreased significantly with both Ifn-β and GA compared to saline (123.0±92 mm² for GA, 273.3±193.8 mm² for Ifn-β, and 669.0±395.8 mm², p<0.01). Lesion CNR at 10 minutes post MPO-Gd injection, which mostly represents blood-brain barrier breakdown, was not changed with either treatment (4.41±1.44 for GA, 3.82±1.84 for Ifn-β, and 4.37±1.51 for saline, p=0.81). Interestingly, lesion CNR at 60 minutes post MPO-Gd injection, which represents specific MPO activity in vivo, was reduced with Ifn-β treatment (2.95±0.94, p<0.01) but not with GA treatment (6.10±1.49, p=0.43) compared to saline (6.74±0.29). Neither Ifn-β nor GA directly inhibited MPO activity in vitro (p>0.05). Myeloperoxidase secretion experiments on isolated myeloid cells revealed that Ifn-β significantly reduces extracellular MPO activity upon stimulation with a secretagogue (1.45±0.30 Units/second for 10ng/ml Ifn-β and 0.11±0.15 for 100ng/ml versus 3.68±0.11 for vehicle, p<0.01), while no such effect was detected for GA (3.88±1.36 for 1μg/ml GA and 3.56±1.92 for 15 μg/ml GA, p>0.05).

**Conclusions**

Myeloperoxidase-Gd-enhanced MRI detected unique treatment effects of two first-line therapeutics for MS. While Ifn-β markedly decreases MPO activity, it does not reduce the number of inflammatory lesions. This corresponds to a novel, hitherto undescribed mechanism of action: Ifn-β directly acts on myeloid cells to decrease MPO secretion. In contradistinction, GA does not decrease lesion MPO activity, but instead decreases the number of inflammatory lesions seen on MRI. Upon translation, MPO-Gd molecular imaging could be used to monitor treatment efficacy in MS patients.

**KEYWORDS:** Imaging Biomarker, Molecular Imaging, Multiple Sclerosis
MPO-Gd Enhanced Molecular MRI Detects Murine Multiple Sclerosis Disease Activity at Remission and Relapse better than DTPA-Gd
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Purpose
Clinical diagnosis of multiple sclerosis (MS) is challenging. DTPA-Gd enhanced imaging often under-reports active MS lesions and correlates poorly with clinical disability. We aim to evaluate if MPO-Gd, a molecular MR imaging (MRI) probe that specifically detects the inflammatory enzyme myeloperoxidase (MPO) activity (1), can detect disease activity at remission and relapse better than DTPA-Gd in a mouse model of MS.

Materials and Methods
A total of 18 female SJL mice were injected with proteolipid protein (PLP139-151) to induce experimental autoimmune encephalomyelitis, a mouse model of MS. To investigate detection of chronic disease, mice underwent MRI with MPO-GG or DTPA-Gd at the interval between acute disease and relapse (=remission, day 21 postinduction) and at the relapse (days 24-30 postinduction). Lesion number and volumes were quantified on postcontrast T1 images. Flow cytometry for brain leukocytes and MPO was conducted.

Results
There was no difference in clinical disease severity or disease onset between mice imaged with MPO-Gd versus DTPA-Gd (p>0.05). At remission, when disease activity is thought to be silent, more MPO-active lesions (5.5±0.84 versus 1.25±0.96, p<0.01) and a greater total lesion volume (0.047±0.02 versus 0.010±0.006 cm3, p<0.05) were detected with MPO-Gd compared to DTPA-Gd. Significantly more lesions (9.0±4.1 versus 2.7±2.1, p<0.05) and a greater total lesion volume (0.219±0.186 versus 0.013±0.011 cm3, p<0.05) also were detected at the relapse with MPO-Gd. The majority of MPO-active lesions appeared in areas previously unremarkable compared to imaging at remission (arrowheads in figure represent new lesions, while arrows represent lesions already present at remission), suggesting that MPO-Gd not only detects higher disease activity at remission, but also is capable of revealing the highly dynamic nature of this inflammatory disease model noninvasively in vivo. Flow cytometry demonstrated a marked increase of MPO-positive inflammatory cells even during remission compared to sham (2392±894 versus 132±43 cells/brain, p<0.01). At relapse, MPO-positive inflammatory cells were further increased (4245±1430 cells/brain, p<0.01). The majority (62±14%) of these MPO-positive cells were found to be Ly-6C-high inflammatory monocytes.

Conclusions
MPO-Gd-enhanced MRI can detect disease activity at remission and relapse better than nonspecific enhancement from DTPA-Gd. This corresponds to the presence of MPO-secreting inflammatory immune cells, and most of them were identified as monocytes. Upon translation, earlier and more sensitive detection of subclinical disease activity could greatly improve timely diagnosis in MS patients, and could be used as a better surrogate to evaluate treatment efficacy.

KEYWORDS: Imaging Biomarker, Molecular Imaging, Multiple Sclerosis
In Search of Criteria Supporting Chronic Cerebrospinal Venous Insufficiency (CCSVI) in Patients with Multiple Sclerosis

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Purpose
Chronic cerebrospinal venous insufficiency (CCSVI) is a proposed condition to cause or be closely associated with multiple sclerosis (MS) and is caused by stenoses within the venous drainage of the brain and spinal cord. The original observation was based on Doppler ultrasound and criteria for its diagnosis were defined by Paolo Zamboni. We undertook the current study to confirm if these observations are present in a cross-section of MS patients.

Materials and Methods
This was a single-center, prospective, observational study of 50 subjects with confirmed multiple sclerosis and 50 age-matched controls undergoing Doppler ultrasound evaluation. Ethics approval and informed consent were obtained. Subjects were randomly selected from a list of volunteers divided into six MS categories [relapsing remitting (RR), secondary progressive (SP), and primary progressive (PP) of less than or greater than 10 years duration]. Ten subjects were selected from each RR and SP MS category and five subjects from the two PP MS categories. Controls were age-matched acquaintances. An ultrasonographer blind to subject group evaluated the intra and extracranial venous circulation. Deep cerebral veins (DCV) were insonated through temporal bone windows. The evaluation order of subject-control pairs was assigned randomly. Two neuroradiologists blind to subject group independently evaluated CCSVI criteria. A positive study had two or more criteria present. Evaluators were asked to reach consensus on positive studies.

Results
Recruitment was completed over five months. Median ages were 52 (range 27-72) for patients and 52.5 (range 25-73) for controls. The female to male ratio was 1.9 for patients and 0.6 for controls. Interobserver variability for CCSVI criteria was good [ICC 0.89 (0.85-0.93)]. Consensus between observers was required for four positive CCSVI results and no adjudication was required. Our primary outcome of a positive CCSVI score ≥ 2 was found in 13 subjects in the patient group with no positive results in the control group (p < 0.001, Fisher's exact test). No interaction with MS categories was observed. Deep cerebral veins signal was identified in 77% of subjects but there was no reflux and DCV measures did not contribute to the CCSVI scores.

Conclusions
We identified CCSVI criteria in a small subset of subjects with MS. While this can suggest some degree of association, our results do not support CCSVI as a cause or key pathogenetic factor in MS.
Predictive Value of Susceptibility Weighted Imaging appearance of Multiple Sclerosis Lesions

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Purpose
Multiple sclerosis (MS) lesions display different imaging characteristics in susceptibility-weighted imaging (SWI) phase in comparison to T2- and T1-weighted images. The purpose of this study was to evaluate SWI phase signal intensity characteristics of MS lesions and their association with overall lesion number and their predictive value for lesion development.

Materials and Methods
Twenty-eight patients with relapsing remitting MS underwent MR imaging (MRI) examination on a 3 T Siemens scanner including T2-weighted, T1-weighted imaging and SWI. Seventeen of these underwent a second MRI follow up (FU) after 6-12 months. Total number of T2 lesions and number of lesions appearing clearly bright in SWI phase was determined for each patient. For patients with FU, the number of new T2 lesions was determined. Patients were dichotomized due to a new T2 lesion in FU scans. The number of black holes was generated from T1-weighted images.

Results
The number of lesions displaying clearly bright signal in SWI phase images showed significant correlation with T2 lesion number (p<0.001, R=0.71) and number of black holes (p<0.01, R=0.79). Additionally the accuracy of bright phase lesion number to predict the occurrence of a new T2 lesion in FU was 0.94 with an optimal cut off value of six hyperintense phase lesions. The positive predictive value of bright phase lesion number greater or equal to six for prediction of a new T2 lesion in the next 6-12 months was 0.91 (CI 0.62 – 0.99, p<0.01).

Conclusions
Bright SWI phase lesions can be found regularly in MS patients. High SWI phase signal might indicate increased iron deposition or other changes associated with inflammation. A higher number of bright phase lesions seems to be associated with new lesion formation and therefore higher activity in MS patients.

Temporal Evolution of Multiple Sclerosis Lesions in Susceptibility Weighted Imaging

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Purpose
Multiple sclerosis (MS) lesions visualized in susceptibility-weighted imaging (SWI) display different imaging characteristics if assessed in phase in comparison to regular T2- and T1-weighted imaging. The purpose of this study was to evaluate SWI phase signal intensity characteristics of acute, contrast enhancing MS lesions and their temporal development.

Materials and Methods
Ten MS patients underwent baseline MR imaging (MRI) examination on a 3 T Siemens MRI scanner including T1- and T2-weighted imaging and SWI and follow-up scans after one and two months. Thirty-one contrast enhancing lesions were identified on baseline T1-weighted and signal characteristics of lesions were evaluated on SWI phase images on baseline and follow-up images.

Results
In baseline scans 16 of the contrast enhancing lesions were identified as hyperintense lesions on phase images, 13 were not visible, one showed a hyperintense ring configuration and one lesion presented as prominent vein. Among the invisible lesions in the baseline phase scan two remained invisible in both monthly follow-up scans, while seven emerged as hyperintense lesions and two as hyperintense ring lesions on follow-up SWI phase scans. Of those lesions that appeared with hyperintense signal in baseline scans, three lesions showed decreasing signal intensity in follow-up scans.

Conclusions
Contrast-enhancing MS lesions display different characteristics in SWI phase images and show variable temporal evolution. Most MS lesions seem to display characteristics of iron deposition either initially with contrast enhancement or during their temporal evolution. Nevertheless, these changes can be reversible and lesions are still evolving months after their initial appearance.

KEYWORDS: MR Imaging, MR Imaging Brain, Multiple Sclerosis

Clinical significance of dural enhancement on magnetic resonance imaging.

K Lam¹, P Lee¹, P Shen¹, M Bobinski¹, A Nidecker¹
¹University of California Davis, Sacramento, CA

Purpose
Dural (pachymeningeal) enhancement is a common yet potentially confounding finding on brain MR imaging (MRI) with broad differential diagnosis including postoperative or procedural enhancement, spontaneous intracranial hypotension, infection or inflammation as well as malignant processes such as dural metastasis or primary brain tumors. Typically, the diagnosis is made with relevant clinical history and imaging follow up. This management strategy creates a diagnostic dilemma for radiologists, due to frequent lack of clinical history and prior imaging at the time of interpretation. In this single institutional study, our objective was to systematically determine clinical and imaging outcomes of patients with dural enhancement.

Materials and Methods
We retrospectively studied 50 consecutive patients with imaging findings of dural enhancement
on MRI using the PACS imaging system and Electronic Medical Record at UC Davis between 01/2002 – 05/2013. Patients greater than 10 years of age with dural enhancement on one or more MRI studies were included in the study. We excluded cases that involved focal dural enhancement (either directly under a surgical cavity or associated with an extra-axial mass), immediate postoperative, immediate post-traumatic with intracranial injuries, or lost to clinical follow up. All patients were imaged on a 1.5 T General Electric Healthcare (Waukesha, WI) MRI with contrast-enhanced T1-weighted sequences. Any thin and discontinuous meningeal enhancement was considered normal. Dural enhancement patterns were further classified as focal (smooth only, smooth with nodular, or mass-like) versus diffuse (smooth only, smooth with focal nodular pattern, or mass-like). Dural enhancement was defined as focal when present fewer than 75% and diffuse over 75% of the dural surface of one cerebral hemisphere on all imaging planes. Mass-like dural enhancement was defined as greater than 10mm in thickness.

Results
The 50 included cases were grouped into four major etiologic categories, including 28 intracranial hypotension [recent lumbar puncture (5), chronic cerebral shunts (17), or spontaneous (6)], 13 metastasis, five inflammatory or infectious causes, three chronic postoperative effects, and one idiopathic hypertrophic pachymeningitis (IHP). In the intracranial hypotension category, we observed only focal-smooth, diffuse-smooth and diffuse-smooth/nodular patterns (14%, 68%, 18%, respectively). Inflammatory/infectious and chronic postoperative categories also demonstrated only focal-smooth/nodular and diffuse-smooth/nodular patterns. None of benign etiologies demonstrated mass-like dural enhancement. The metastasis category showed enhancement patterns of focal-smooth/nodular (23%), focal mass-like (23%), diffuse-smooth only (7%), diffuse-smooth/nodular (16%), diffuse mass-like (31%). Among the metastatic foci, 8% of the cases had concurrent intraparenchymal metastases, 16% had concurrent leptomeningeal metastases, 69% had concurrent calvarial metastases and 54% had secondary dural metastases on contralateral hemisphere or posterior fossa; however these are not mutually exclusive. The case of IHP showed diffuse-smooth enhancement pattern.

Conclusions
Uniform dural enhancement on MR imaging has a relatively broad differential of diagnoses, thus clinical correlation proves to be crucially important in identifying the underlying cause(s). Within our small cohort of 50 patients, smooth dural enhancement pattern is seen predominantly in the intracranial hypotension, inflammatory/infectious and chronic postoperative categories. Conversely, cases with metastasis have more nodular and/or mass-like dural enhancement pattern. Interestingly, 100% metastases were observed to have concurrent intraparenchymal, calvarial and/or remote dural metastases, thus significantly improving diagnostic confidence of metastasis in the setting of dural enhancement.

KEYWORDS: Dural

O-882

Infratentorial Lesions in Multiple Sclerosis: Double Inversion Recovery superior to FLAIR and T2

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¹Icahn School of Medicine at Mount Sinai, New York, NY
Purpose
Magnetic resonance (MR) techniques have had a major impact in understanding and managing multiple sclerosis (MS). At present, multiplanar or 3D T2 FLAIR is the dominant method to evaluate the presence and extent of disease, however it has well documented shortcomings for cortical and infratentorial pathology, some of which are compensated for with T2WI. Double inversion recovery (DIR) is a recently available 3D imaging technique in which both white matter (WM) and cerebrospinal fluid (CSF) signals are suppressed, greatly increasing the conspicuity of cortical lesions. Early experience suggests that WM suppression increases the relative conspicuity of white matter lesions as well as cortical/subcortical lesions with particular benefits below the tentorium where FLAIR is particularly challenged. The purpose of this retrospective study is to investigate the incremental benefit of DIR over the traditional diagnostic MR sequences, T2WI and FLAIR, with focus on the detection of posterior fossa lesions in the study of MS. We expect this validation study to serve as a foundation for widespread use of DIR for the follow up of MS patients.

Materials and Methods
Thirty patients with MS lesions involving the posterior fossa were enrolled in this retrospective study from among 44 consecutive patients who underwent 3 T MRI for the study of MS between 6/2013 and 12/2013. MR protocol included 3D DIR, T2 and 3D FLAIR. All studies were performed on Siemens Aera 1.5 T and Skyra 3 T scanners using commercially available software. Two reviewers recorded the number of lesions identified in the posterior fossa and visualized upper cervical spinal cord on independent serial, randomized consensus reviews of the DIR, T2 and FLAIR sequences. Two experienced neuroradiologists used a five-point scale to assess individual lesion conspicuity and image quality. Only lesions larger than 1 mm in diameter were included in the analysis. The data were analyzed as medians and the groups were compared with the use of the Wilcoxon signed-rank test.

Results
Double inversion recovery is significantly better than FLAIR and T2 in identifying MS lesions of the posterior fossa (p<0.005) (Table 1). The number of lesions detected with DIR was 212 versus 166 identified with FLAIR, and 131 with T2, representing a 28% and 66% improvement over traditional sequences. Qualitative analysis demonstrated superior lesion conspicuity on DIR than the traditional T2 and FLAIR sequences (Figure 1).

Conclusions
Double inversion recovery is superior in identifying MS lesions in the posterior fossa adding to its documented benefits for cortical and subcortical lesions. Double inversion recovery will augment and may supplant FLAIR in combination with T2 and for the routine evaluation of patients with symptoms suggesting MS.

KEYWORDS: MR Imaging Brain, Multiple Sclerosis, Posterior Fossa

| Table 1. Comparison of the average of the numbers of lesions identified in DIR, FLAIR and T2 |
| DIR | FLAIR | p | DIR | T2 | p | FLAIR | T2 | p |
| 7.07±9.20 | 5.53±8.03 | 0.0001 | 7.07±9.20 | 4.37±7.49 | <0.0001 | 5.53±8.03 | 4.37±7.49 | 0.0002 |
### Comparison of Visual Conspicuity between Contrast-Enhanced T1-Weighted Gradient Echo and Spin Echo Sequences in the Detection of Multiple Sclerosis Lesions with 3.0T MRI

<table>
<thead>
<tr>
<th>Patient</th>
<th>DIR (3mm)</th>
<th>FLAIR (3mm)</th>
<th>T2 (5mm)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>49</td>
<td>42</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>30</td>
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</tbody>
</table>

**N° of lesions**: 212, 166, 131

---

**Comparison of Visual Conspicuity**

**DIR (3mm)**

**FLAIR (3mm)**

**T2 (5mm)**

---

**N° of MS lesions**
Purpose
High field MR imaging (MRI) (3.0 T) offers higher contrast-enhancing multiple sclerosis (MS) lesion detection rates than lower field MRI equipment. However, it is not well established whether gradient-echo (GE) or spin-echo (SE) is the sequence of choice for this purpose. The aim of this study was to compare the ability of these two sequences to detect active MS lesions.

Materials and Methods
One hundred relapsing MS patients [73 women; mean age, 35.8 years; age range (23, 50) years, median EDSS, 3; EDSS range, (0, 8)], underwent 3.0 T brain MRI including enhanced GE and SE T1-weighted sequences. Gradient echo images were acquired 15 minutes after injection of a double dose (0.2 mmol/kg) of gadobutrol. In half of patients, SE images were acquired just before, and in the other half just after, acquisition of the GE images. To define the gold standard, an experienced neuroradiologist identified and marked contrast-enhanced MS lesions in these sequences using Jim 5.0 software. Differentiation of MS lesions in GE and SE images was evaluated using a 5-point qualitative scale. The anatomical location (periventricular, subcortical, infratentorial, and juxtacortical) and the pattern of contrast uptake (nodular, ring, open-ring, and heterogeneous) also were assessed. Each of the two sets of contrast-enhanced T1-weighted scans then was evaluated in a random fashion and using objective image interpretation criteria by three experienced neuroradiologists. The results were compared with the gold standard reference to obtain the number of true-positive (TP), false-negative (FN), and false positive (FP) evaluations.

Quantitative assessment of lesion conspicuity and the effect of spatial location were based on image contrast and the contrast-to-noise ratio between lesions and their 3-pixel-width surroundings, and division of the intracranial region into four quadrants in each slice.

Results
We found 607 MS lesions (105 periventricular, 274 subcortical, 165 juxtacortical, and 63 infratentorial). Most lesions showed a nodular pattern of contrast uptake (nodular, 527; ring, 13; open-ring, 34; heterogeneous, 33). The qualitative approach showed slightly better lesion differentiation with SE images. However, analysis of agreement between readers and gold standard segmentations showed better sensitivity to detect lesions with GE images (0.828) than with SE (0.767), and a similar mean number of FPs (GE, 16.33; SE, 16.67). Spin echo images showed a higher image contrast ratio (TP, 0.37; FN, 0.20; FP, 0.25) than GE images (TP, 0.23; FN, 0.11; FP, 0.16), whereas the contrast-to-noise ratio was higher for GE (TP, 37.76; FN, 17.02; FP, 20.71) than for SE (TP, 27.26; FN, 13.69; FP, 14.85). Both comparisons presented significant statistical differences (p<0.05) using ANOVA and the post-hoc T3 Dunnett test. Finally, in both SE and GE sequences, most misclassifications occurred in the right posterior quadrant.

Conclusions
Selection of the best sequence requires the use of visual indices that study greater surrounding complexity of lesions than the image contrast ratio. The results obtained suggest that visual conspicuity of MS lesions in images acquired at 3.0 T is better in GE sequences than in SE.

KEYWORDS: Contrast Enhancement, MR Imaging, Multiple Sclerosis
Thursday
1:00PM - 2:30PM
Palais des congres de Montreal, 517d

89 - MINI SYMPOSIUM STROKE - PART IV: ENDOVASCULAR THERAPY:
WHERE ARE WE NOW?
O-885

Endovascular Thrombolysis and Devices

Yoo, A.
Massachusetts General Hospital
Boston, MA

O-886

Endovascular Therapy of Anterior Circulation Stroke: Clinical, Radiological and
Angiographic Prognostic Factors for 3 Months’ Neurological Outcome

R Fahed¹, H Redjem¹, R Blanc¹, B Bartolini¹, S Pistocchi¹, A Rouchaud¹, E Shotar¹, G Ciccio¹,
B Gilboa¹, T Robert¹, M Piotin¹
¹Fondation Rothschild, Paris, France

Purpose
Despite recent studies that did not show any superiority of endovascular treatment of ischemic
stroke versus iv thrombolysis, mechanical thrombectomy (MT) is getting more and more
importance in the management of acute ischemic stroke. Recent devices have drastically
increased efficiency in terms of revascularization with a relatively low rate of complications.
However, patient selection for MT remains challenging.

Materials and Methods
We prospectively gathered the charts of 88 consecutive patients (50 males, 38 females; mean
age/SD = 63.4±14 years old) who presented anterior circulation acute ischemic stroke and
underwent MT from December 2011 to September 2013 in our institution. Initial NIHSS score,
DWI-ASPECT score, therapeutic data (iv thrombolysis prior to MT, time from initiation of MT
to revascularization, procedure duration), angiographic prognostic scores as Capillary Index
Score (CIS), Collateral Flow Grading System (CFGS) and TICI score. NIHSS scores (at
admission, at day one and at discharge) and the three-month mRS were analyzed. Patients were
dichotomized into two groups: favorable (mRS≤2) and poor (mRS≥3) outcomes at three-month
follow up.

Results
Forty-seven out of 88 patients (53.4 %) had a good outcome. The three-month mortality was
17.0 % (15/88). Intravenous thrombolysis was performed in 30/47 (63.8%) patients with a good
outcome, and 22/41 (53.7%) patients with a poor outcome (p=0.45). Recanalization (TICI ≥ 2b)
was obtained in 66.7% (58/87) of the patients. Mean procedure duration was 71.2 minutes.
Patients with a three-month good outcome had statistically lower NIHSS at admission, at day one and at discharge (p<0.0001), a higher CIS and CFGS score (p<0.05), a higher recanalization rate (p=0.0004). An initial CT instead of a MR imaging (MRI) was statistically associated with a poor outcome (p=0.02). There was no statistical difference between the two groups regarding DWI-ASPECTS (p=0.07), delay between symptoms and iv thrombolysis (p=0.19), delay between stroke onset and recanalization (p=0.32), procedure duration (p=0.1). Seven out of 88 patients (7.9%) had a delayed intracerebral hemorrhage, including five patients with an ECASS-1 or ECASS-2 hemorrhage.

Conclusions
Intravenous thrombolysis prior to MT does not confer better outcome. Time from stroke onset to revascularization does not influence the outcome. A low initial NIHSS is associated with a better outcome. The most striking prognostic factor regarding outcome is the presence of arterial collateral supply. Further studies should focus on better collateral scoring in order to select patients that are more likely to benefit from MT.

KEYWORDS: Collateral Circulation, Endovascular Revascularization, Stroke

**Clinical Data:**

<table>
<thead>
<tr>
<th>Good Outcome (mRS=0-2 at 3 months follow-up)</th>
<th>Poor Outcome (mRS=3-6 at 3 months follow-up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Data:</td>
<td></td>
</tr>
<tr>
<td>Number of patients</td>
<td>47/88 (53.4 %)</td>
</tr>
<tr>
<td>Number of male patients</td>
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<tr>
<td>Mean age (years)</td>
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<tr>
<td>High blood pressure</td>
<td>26/47 (55.3 %)</td>
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<tr>
<td>Diabetes</td>
<td>5/47 (10.6 %)</td>
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<tr>
<td>Dislipidemia</td>
<td>16/47 (34 %)</td>
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<td>Smoking</td>
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<td>Antiplatlet drugs</td>
<td>6/47 (12.8 %)</td>
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<tr>
<td>Anticoagulant drugs</td>
<td>7/47 (14.9 %)</td>
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<tr>
<td>Mean NIHSS at admission</td>
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<tr>
<td>Radiological data:</td>
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<tr>
<td>Initial brain CT</td>
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<tr>
<td>Initial brain MRI</td>
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<td>Mean DWI-ASPECTS score</td>
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<tr>
<td>Right brain stroke</td>
<td>25/47 (53.2 %)</td>
</tr>
<tr>
<td>Left brain stroke</td>
<td>22/47 (46.8 %)</td>
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<td>Angiographic and endovascular data</td>
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<td>Patients with previous IV thrombolysis</td>
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<td>Mean delay between symptoms and IV thrombolysis (minutes)</td>
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<td>Mean delay between symptoms and recanalization (minutes)</td>
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<tr>
<td>Mean procedure duration (minutes)</td>
<td>62.3</td>
</tr>
<tr>
<td>Capillary Index Score (CIS) = 0</td>
<td>1/32 (3.1 %)</td>
</tr>
</tbody>
</table>
Successful Intra-Arterial Reperfusion Therapy Improves Clinical Outcomes in Acute Stroke Secondary to Large Vessel Occlusions – TICI Based Analysis.

S Mangla, R Loganathan, P Moh, T Victor, B Kanna, M Schori

SUNY Downstate Health Science Center, Brooklyn, NY, Lincoln Medical Center, Bronx, NY

Purpose
Acute ischemic stroke secondary to large vessel occlusion within the proximal vessels of the circle of Willis remains a devastating clinical event. Intravenous tPA remains as first-line therapy in patients presenting within early (<4.5 hours) windows however, has had limited success in achieving reperfusion and favorable clinical outcomes in large vessel occlusions. Our study analyzed our experience utilizing currently available intra-arterial reperfusion strategies, technical success at achieving reperfusion, and its effects on clinical outcomes at discharge.

Materials and Methods
We performed an IRB-approved retrospective review of a prospectively maintained clinical database of patients receiving intra-arterial reperfusion therapy at Lincoln Medical Center from 9/1/2009 – 1/31/2013. Forty-seven consecutive patients triaged with CTA/CTP imaging for large vessel occlusions within eight hours of symptom onset underwent intra-arterial therapy IA alone (25/47 – 54.2%), or iv followed by IA (22/47 - 46.8%) based on the presence of a large vessel occlusion, independent of perfusion imaging parameters. Combinations of therapies were employed, primarily mechanical thrombectomy with the Penumbra aspiration system (42/47 – 89.4%), secondarily MERCI device (8/47 – 17.0%), with low dose (1-10 mg) IA tPA (16/47 – 34.0%). Clinical imaging (CT, DSA, and MRI), and clinical outcomes (NIHSS, mRS) were
reviewed through discharge. Angiographic outcomes were graded based on thrombolysis In cerebral ischemia system (TICI).

Results
TICI 0, 1, 2a, 2b, 3 was achieved in five (10.6%), one (2.1%), 12 (25.5%), 18 (38.3%), 11 (23.4%) patients respectively. Favorable mRS outcome at discharge (0-2) was associated positively with higher grades of TICI reperfusion (mRS), TICI 0 (0/5 – 0%); 1 (0/1 – 0%); 2a (2/12 – 16.7%); 2b (6/18 – 33.3%); 3 (5/11 – 45.5%) (Figure). Twenty-one of 47 (44.7%) patients experienced an eight-point or greater improvement in NIHSS at discharge, overall 13/47 (27.7%) achieved mRS (0-2) at discharge, with 5/47 (10.6%) mortality and symptomatic intracranial hemorrhage in 4/47 (8.5%).

Conclusions
Our experience with IAT suggests that significant clinical improvement can be experienced in prolonged therapeutic windows (< 8 hours); however, the threshold for reperfusion to achieve favorable clinical outcome may be higher than previously thought (TICI 2b or greater). A significant percentage of patients may still suffer significant functional brain injury despite reperfusion.

KEYWORDS: Acute Ischemic Stroke, Clinical Outcome, Mechanical Thrombectomy

(Filename: TCT_O-887_IATsummarytableMangla.JPG)
Opportunities for Reducing Delays in Endovascular Reperfusion Therapy of Acute Ischemic Stroke Patients

A Honarmand¹, S Prabhakaran¹, R Beck², C Beck², J Conners³, V Lee³, A Shaibani¹, M Hurley⁴, S Ansari⁴
¹Northwestern University, Chicago, IL, ²Northwest Community Hospital, Arlington Heights, IL, ³Rush University, Chicago, IL, ⁴Northwestern University Feinberg School of Medicine, Chicago, IL

Purpose
It has been demonstrated that every 30-minute delay in time to revascularization is associated with 10% absolute decrease in the probability of a good outcome from intra-arterial therapy (IAT) in acute ischemic stroke (AIS) patients. We investigated the potential critical time intervals among patients with direct presentation compared to inter-hospital transfers to comprehensive stroke centers (CSCs) for IAT.

Materials and Methods
We performed a retrospective review of consecutive AIS patients who underwent IAT at four institutions since 2012 and abstracted symptom onset time (SOT), first emergency department arrival time (EDAT), and time of groin puncture (GP). Patients were categorized into those who were transferred from outside institutions and those who presented directly to the CSCs (nontransferred). We compared times using Mann-Whitney tests and proportions using Fisher's exact tests.

Results
Sixty-three patients (59% male, mean age 65.4 years) were studied, of which 34 (54%) patients were interhospital transfers. Of the studied time intervals, SOT to CSC arrival time in nontransferred group was significantly less than that of transferred group (mean: 53.4 versus 271.1 min, respectively; p<0.0001). Additionally, SOT to GP time was reduced significantly in nontransferred group (233.6 versus 308.5 min; p=0.004). Likewise, first EDAT to GP was reduced significantly in nontransferred compared with transferred group (186.3 versus 215.7 min; p=0.01). In nontransferred group, eight (27.6%), 18 (62%), and three (10.4%) patients and in transferred group two (6%), 26 (76%), and six (17%) patients achieved SOT to GP time of <3, 3-6, >6 hours, respectively (p=0.06). Additionally, first EDAT to GP time of <120 minutes was achieved in only four cases in both groups (4.3%).

Conclusions
Although SOT to GP time is significantly lower in direct referrals, among direct referrals and interhospital transfer patients, onset and initial arrival to treatment times are far from optimal. Majority of the delay (90%) from symptom onset to treatment is accounted for prior to CSC arrival among transfers while nearly 80% of the time elapses at CSCs among nontransfers. There are considerable opportunities for reducing delays in several key steps in the process including early team activation, interhospital transport, and rapid multimodal imaging protocols.

KEYWORDS: Endovascular Therapy, Stroke

O-889

Carotid Stenting
Sunshine, J.
University Hospitals Case Medical Center
Cleveland, OH

Abstract/Presentation Summary
We will discuss the major antecedent randomized prospective clinical trials that directly affect treatment decisions for carotid stenosis. The conclusions from the North American Symptomatic Carotid Endarterectomy Trial (NASCET) and the Asymptomatic Carotid Atherosclerosis Study (ACAS) will be quickly reviewed. The presentation will then focus on the (CREST) data and its implications for selection of today's patient for endovascular placement of a carotid stent or surgical endarterectomy. These data will be parsed to review implications for specific subsets of patients for whom one technique may offer a more complementary alignment. We will then turn our attention from use of carotid stent for stroke prevention to use in treatment of acute onset of cerebral ischemia in any attempts to restore flow and rescue cerebral tissue. In particular we will discuss use of carotid stents when faced with revascularization through tandem lesions most often of the cervical internal carotid and the ipsilateral middle cerebral artery. As time permits we will show some of the advanced imaging techniques for image characterization of the carotid plaque and how these may be useful in patient selection or treatment guidance. These can include high-resolution black blood MRI, intravascular ultrasound or most recently intravascular optical coherence tomography. We will look at restenosis occurrence, stent placement soon after thrombolysis, and in relation to patient age or life expectancy. The discussion will close by offering one or more models to guide treatment choice in either the setting of acute vascular occlusion or the more common application to prevent new or recurrent cerebral infarction.

O-890
1:45PM - 1:51PM

Safety and Outcomes of Carotid Endarterectomy versus Stenting: Evidence from a Large National Hospital Discharge Database

R McDonald¹, J McDonald¹, T Therneau¹, D Kallmes¹, H Cloft¹
¹Mayo Clinic, Rochester, MN

Purpose
Clinical equipoise of carotid revascularization therapies remains controversial. We sought to determine if adverse outcomes following carotid endarterectomy (CEA) or carotid angioplasty and stenting (CAS) were equivalent on a population scale by using propensity score matched analysis of a large hospital discharge database.

Materials and Methods
All surgical cases of CEA (ICD9: 38.12) or CAS (ICD9: 00.63) were identified from the 2008-2012 Premier Perspective database and grouped by clinical presentation (asymptomatic (ICD9: 433.10 or 433.30); symptomatic (ICD9: 435.9, 362.34, or 433.11)). Additional data associated with each revascularization procedure including demographics, clinical characteristics, and outcomes were also retrieved. The primary outcomes for this study were in-hospital mortality, intra- or post-operative stroke (subarachnoid hemorrhage (SAH, ICD9: 430) or intracranial hemorrhage (ICH, ICD9: 431)), or acute myocardial infarction (AMI, ICD9: 410). Outcomes
were evaluated individually, as a composite endpoint (mortality, stroke, or AMI), and as a modified composite endpoint (mortality or stroke only). All CEA and CAS records were subjected to 1:1 matching on the propensity score, derived from 33 covariates associated with clinical status or established treatment assignment criteria, to simulate the randomization of an RCT. Multivariate-adjusted odds ratios (OR) and/or hazard ratios (HR) from cox-proportional hazard models were computed to determine if individual or composite outcomes were similar between CEA and CAS.

Results
Among 109,632 carotid revascularizations recorded within the 2008-2012 Perspective database, 95,742 CEA and 13,980 CAS procedures were performed. Asymptomatic stenosis comprised 90% (N=98,729) of all carotid revascularizations. Following 1:1 propensity score-based matching, 24,004 asymptomatic (12,002 CEA : 12,002 CAS) and 3,506 symptomatic (1,753 CEA : 1,753 CAS) procedures were included for further study. Asymptomatic patients who underwent CAS had significantly higher rates of in-hospital mortality (0.7% vs. 0.5%, HR = 1.47 (1.04-2.08), p = .02), SAH (0.2% vs. 0%, OR = 24.51 (4.54-402), p = .0012), and ICH (0.3% vs. 0.1%, OR = 3.23 (1.54-7.14), p = .0013) compared to a matched cohort of patients who received CEA. Similarly, symptomatic patients who received CAS also had significantly higher rates of mortality (mortality: 4.1% vs. 0.9%, OR = 4.55 (2.64-8.33), p< .0001), SAH (1.1% vs. 0.2%, OR = 6.67 (1.98-33.4) p = .0022), ICH (1.4% vs. 0.3%, OR = 5.00 (1.89-16.7), p = .0010) compared to CEA recipients. Using the composite endpoint (mortality, stroke, or AMI), CAS recipients had worse overall outcomes than CEA recipients for both asymptomatic (3.0% vs. 2.2%, HR = 1.40 (1.19-1.65), p < .0001) and symptomatic presentations (11.1% vs. 5.1%, HR = 2.31 (1.78-3.00), p < .0001); the treatment effect on the entire matched cohort was not modified by age (p = .28) or sex (p = .35). Similar results were observed using the modified composite endpoint (mortality or stroke alone) for both asymptomatic (CAS = 2.5% vs. CEA = 1.7%, HR = 1.49 (1.25-1.78), p < .0001) and symptomatic presentations (CAS = 10.0% vs. CEA = 3.5%, HR = 3.02 (2.25-4.07), p < .0001).

Conclusions
Among individuals treated for atherosclerotic disease of the carotid artery in a large sample of hospitals in the United States, CAS was associated with higher risk of peri-operative mortality, stroke, and unfavorable discharges when compared to CEA for all ages and clinical presentations.

KEYWORDS: Carotid Artery Stenting, Comparative Effectiveness, Outcomes
Entire Matched Cohort:
Effect of Age on Carotid Revascularization Outcome

Hazard Ratio for Composite Endpoint with CAS

Age (yr)

55 60 65 70 75 80 85

CEA better

CAS better
Safety evaluation of primary carotid stenting: Embolic detection on intraprocedural transcranial Doppler and correlation with diffusion-weighted imaging lesions on postprocedural MRI.

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Purpose
A major limitation of carotid artery stenting (CAS) is the potential for embolic stroke. Standard CAS technique involves placement of an embolic protection device (EPD) distal to the stenosis, stent insertion, pre- and post-insertion balloon angioplasty. It has been shown that every step, particularly stent deployment and balloon angioplasty, generate emboli. Our experience has shown that balloon angioplasty is not required to successfully treat the majority of patients. Decreasing the number of manipulations and avoiding the use of balloons may reduce the risk of distal embolization and stroke. We evaluated the safety of primary carotid stenting (PCS), using self-expanding stents alone without deliberate use of balloons and EPDs, by correlating the findings of intraprocedural transcranial Doppler (TCD) with diffusion weighted imaging (DWI) on postprocedural MR imaging (MRI).

Materials and Methods
A sample size of 30 consecutive patients was chosen for feasibility. Between March and December 2013, 14 patients were prospectively enrolled. Transcranial Doppler monitoring was performed in all patients during CAS procedures, which were divided into six steps. Embolic signals on TCD were counted and classified based on their relative energy index of microembolic signals (REIM) as either benign (<1) or malignant (≥1). Prestenting (within 30 days) and poststenting (within 24 hours) MRI with diffusion-weighted imaging (DWI) was performed in all cases.

Results
Preliminary results in 14 patients (15 stents deployed) are described. All patients were symptomatic with atherosclerotic stenosis >60% by NASCET criteria (median 80%). All patients underwent primary carotid stenting, bilateral in one patient. Balloon angioplasty was required in two cases. The median embolic signal count was 90 (70 benign, 22 malignant). The stent deployment stage generated the highest median embolic signal count (66). Three patients (21.4%) had new DWI lesions post CAS. The median DWI count was one. There was no correlation between incidence of malignant microemboli and DWI lesions, although the sample size is small. One patient (7.1%) had a postoperative transient ischemic attack (TIA) within 12 hours postprocedure. None of the patients had new or worsening postprocedural clinical deficits.

Conclusions
Although numerous microembolic signals were observed during PCS, the numbers of both benign and malignant emboli are remarkably lower than those observed with standard CAS techniques. Only 21.4% of patients developed new DWI lesions, also lower than reported with standard techniques, and none developed new clinical deficits. There was no correlation between malignant microemboli and DWI lesions in this small, preliminary sample. Initial results suggest
that PCS may be safer than standard CAS techniques. Results from the full sample of 30 patients will be presented.

KEYWORDS: Carotid Artery Stenting, MR Imaging/Diffusion, Transcranial Ultrasound

O-892

Intracranial Stenting

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Abstract/Presentation Summary
The current landscape of angioplasty and stenting for intracranial occlusive disease is still dominated by emerging data from the recently completed Stenting and Aggressive Medical Management for the Prevention of Recurrent Ischemic Stroke (SAMMPRIS) trial [1]. Final results with long term follow up were published in the Fall of 2013 [2]. The early superiority of the medical arm persisted, with similar late recurrent stroke rates in the medical and interventional arms. SAMMPRIS has provided critical information on the benefit of aggressive medical management (dual antiplatelet medication for 90 days as well as good blood pressure and lipid control) in patients presenting with recent ischemic stroke or TIA secondary to severe atherosclerotic stenosis of a major intracranial artery. These data have narrowed the definition of the patient population that may have benefit from angioplasty and stenting and provided new information on the nature of early and late complications of angioplasty and stenting [3]. This short talk will review this recent information, discuss current indications for intracranial angioplasty and stenting, and explore future directions for research in this area.

O-893

Iatrogenic Reactions Due To Polymer Coatings Originating From Vascular and Interventional Devices: Neuroradiological Findings with Pathological Correlation

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Purpose
Hydrophilic polymers are commonly applied as coating on endovascular device surfaces. These materials have the potential to dissociate during clinical use, occasionally causing embolic and other iatrogenic phenomena. Rare reports document morbidity in affected patients. The focus of this study was to evaluate neuroradiological features associated with this phenomenon.

Materials and Methods
On retrospective review of the literature and the archives at a tertiary care hospital (1997-2013), 16 cases of intracerebral iatrogenic polymer reactions were identified. Twelve cases with available neuroradiological data were reviewed retrospectively.
Results
Mean patient age was 54 years (age range: 2.5 months to 87 years; four patients were male). Patients had undergone aneurysm coil embolization (n=6), angiography (n=4), cardiac catheterization (n=1) and Norwood procedure (n=1). Radiologic changes on magnetic resonance (MR), magnetic resonance angiography (MRA) and/or computed tomography (CT) studies included acute multifocal embolic infarcts (n=4); hydrocephalus (n=3); parenchymal hematoma (n=2); white matter lesions (n=2); perianeurysmal enhancement (n=2); perianeurysmal wall thickening (n=1); perianeurysmal parenchymal edema (n=1); small intra-arterial clot at site of coiled aneurysm (n=1); vessel occlusion (n=1); focal abscess formation (n=1); and intraventricular hemorrhage (n=1). Histopathologic data, available on eight patients (66%), confirmed neuroradiological changes due to embolic and/or inflammatory (neutrophilic, mononuclear, and/or granulomatous) sequelae associated with iatrogenic polymer deposits. Iatrogenic changes were symptomatic in all cases. Four patients without available pathological correlation exhibited aseptic chemical meningitis that was clinically attributable to polymeric reactions. On postmortem analysis, associated scattered microinfarcts directly resulted in death of two patients (17%).

Conclusions
Intracerebral polymer deposits may elicit variable neuroradiological patterns of injury within the brain. The primary findings include embolic and/or inflammatory changes. Since neuroradiologic features may be nonspecific, increased awareness of this potential iatrogenic phenomenon and clinical correlation may facilitate earlier diagnosis. Additional studies are needed to further characterize this iatrogenic complication resulting from modern interventional techniques.

KEYWORDS: Foreign-Body Granuloma, Hydrocoil, Hydrophilic Catheters

O-894

Emergent Intracranial Angioplasty with or without Stenting for Underlying Atherosclerosis in Patients with Acute Ischemic Stroke

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Purpose
The goal of our study was to evaluate the outcome of emergent angioplasty with or without stenting for treatment of underlying atherosclerotic steno-occlusive lesions in patients with acute ischemic stroke.

Materials and Methods
Between January 2011 and March 2013, a total of 175 acute stroke patients presented within eight hours of stroke onset and were treated with endovascular revascularization therapy at a tertiary academic center. Thirty-eight of these 175 patients who underwent emergent angioplasty with (n=24) or without stenting (n=14) for treatment of underlying atherosclerotic lesions were included in this study. Successful recanalization was defined as thrombolysis in cerebral ischemia grades 2b to 3. Outcome measure was the modified Rankin Scale (mRS) score of 0-2 at 3 months. All patients underwent follow-up CT angiography within one week after the treatment.
Results
Data from 38 patients were analyzed. Nineteen patients had atherosclerotic lesions in M1 segment of middle cerebral artery (MCA), 12 patients had lesions in basilar artery, and seven patients had lesions in intracranial internal carotid artery. Twenty-four patients were treated with intracranial angioplasty after mechanical thrombectomy with Solitaire stent, and 14 patients were treated with angioplasty alone. Successful recanalization was achieved in 95% (36/38) of patients. Twenty-three patients (61%) had a good clinical outcome at three months. Arterial rupture occurred in one patient. Mortality rate was 18% (7/38). Acute reocclusion of treated vessel occurred in 16% (6/38) of patients on follow-up CT angiography.

Conclusions
This study suggests that emergent intracranial angioplasty is feasible and safe for treatment of underlying atherosclerotic steno-occlusive lesions in patients with acute ischemic stroke.

KEYWORDS: Acute Ischemic Stroke, Angioplasty And Stenting

Thursday
1:00PM - 2:38PM
Palais des congres de Montreal, 517a

90 - PARALLEL PAPERS: Spinal Cord and Trauma
O-895

Radiologic and Clinical Features of Radiation Induced Myelitis

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Purpose
Radiation-myelitis (RM) is a rare but dreaded complication of radiation exposure to the spinal cord. Symptom-onset may be delayed and can range from a few weeks up to several years following exposure. The extent of RM in a given patient is influenced by several factors, including the radiation technique, individual radiosensitivity, exposure to radio-sensitizing chemotherapies, and co-morbidities. We present a systematic review of clinical and magnetic resonance imaging (MRI) findings in RM patients treated at a tertiary care institution during the last 20 years.

Materials and Methods
The Institutional Review Board approved this retrospective study. A radiology departmental database of MRI spine studies between 1993 and 2013 was searched using keywords 'myelitis' and 'radiation'. A neuro-oncologist and a neuro-immunologist reviewed clinical records of the queried scans and identified patients with a history of radiation treatment and subsequent myelitis. A single neuroradiologist (II) confirmed the diagnosis and identified relevant imaging characteristics in these patients.

Results
The database inquiry yielded 15935 MRI scans (6759 individual patients), of which 550 scans had diagnostic features of transverse myelitis. Eleven patients fulfilled criteria for final analysis
Six males, 5 females; mean age: 30 years (range 5-38 years). Six received whole body radiation with mediastinal boost with autologous stem cell transplantation for recurrent non-hodgkins lymphoma. Five others received radiation for recurrent multiple myeloma, gastric carcinoma, acute lymphocytic lymphoma, brainstem glioma and medulloblastoma. All patients received at least one radio-sensitizing chemotherapy before or concurrently with radiation. Cervical and/or thoracic cord was involved in all patients in a longitudinally extensive pattern. Maximum myelopathic changes corresponded to the central field of radiation identified by apparent fatty vertebral bone marrow on T1-weighted images. The central 2/3 of the cord on axial T2-weighted images was involved in 10 patients, and one patient presented with focal small area of central and dorsal cord involvement. Lower extremity sensorimotor dysfunction and bladder dysfunction were the predominant presenting complaints (8 of 11 patients). Median time to symptom-onset was 14 months (range 1 month to 180 months). All received steroids while two received hyperbaric oxygen at initial presentation. Seven improved on follow up while one did not. Follow up was not available for three patients.

Conclusions
Radiation-induced myelitis (RM) is a rare but potentially devastating complication of radiation treatment to the central nervous system (CNS). Because clinical presentations of RM may be delayed, diagnosis requires a high index of suspicion and long term follow-up. This study provides relevant clinical background and associated MRI findings that may be helpful in making a diagnosis of RM. Further studies are necessary to ascertain the optimum radiation dose to the CNS in the context of radio-sensitizing chemotherapy in patients with recurrent malignancies, who have received prior treatments with potentially neuro-toxic agents.

KEYWORDS: Radiation, Spinal Cord, Transverse Myelitis

Super-resolution tract density images of the spinal cord derived from probabilistic tractography predicts functional impairment in patients with cervical spondylosis

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Purpose
The purpose of this study was to explore the use of super-resolution tract density images (TDI) derived from probabilistic tractography performed using diffusion tensor images (DTI) of the spinal cord as a biomarker for microstructural integrity and functional impairment in patients with cervical spondylosis.

Materials and Methods
All experiments were performed on a 3 T Siemens Trio (Siemens Healthcare, Erlangen, Germany). Structural MR imaging (MRI) and DTI were collected on 27 patients with cervical spondylosis with (N=21) or without (N=6) functional impairment as defined by the modified Japanese Orthopedic Scale (mJOA). Diffusion tensor imaging was performed axially through the site of compression using a custom 2D RF excitation pulse combined with a reduced field-of-view EPI readout (Zoomed-EPI) in a total of 20 directions with 10 averages. Probabilistic...
tractography was performed at 0.5 mm isotropic spatial resolution using the streamline technique combined with constrained spherical deconvolution (model order=4, 0.1-mm step size, 1 million seed points randomly placed throughout the volume). Measurements of maximum tract density at the site of compression, average tract density in rostral normal-appearing spinal cord, the ratio of max tract density to normal tract density, and the volume of tissue with tract density > 3000 tracts/voxel were calculated for each patient.

Results
Qualitatively, results demonstrated elevated fiber tract density at the site of compression in all people compared to normal tissue, and a higher fiber tract density in focal areas at the site of compression in patients with functional impairment. Quantitative results suggest that there was a negative correlation between maximum tract density and mJOA (R2=0.6324, P<0.0001) and the ratio of maximum tract density to normal tract density (R2=0.6648, P<0.0001). A weak negative correlation also was observed between the volume of tissue with tract density > 3000 tracts/voxel and mJOA (R2=0.1619, P=0.0375). When grouped according to severity of impairment (mild, 18>mJOA>16; moderate, 15>mJOA>11; severe, mJOA<11), results showed a significant difference in the ratio between groups (Kruskal-Wallis, P=0.0015) and a significant difference between severe and both no impairment (P<0.01) and mild impairment (P<0.05). No correlation between standard MRI measures of compression or T2 hyperintensity correlated with impairment.

Conclusions
Super-resolution TDI provides unique information about the compression and functional integrity of specific fiber tracts within the spinal cord.

KEYWORDS: MR Diffusion, MR Imaging Spine, Spinal Stenosis
Radiation Injury Can be Detected with Neurographic Molecular Imaging

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Purpose
The goal of this study was to detect changes in the spinal cord in response to radiation injury by means of molecular imaging.

Materials and Methods
The lower thoracic spinal cord of adult female BALB/c mice was irradiated with single doses of 2, 10, and 80 Gy. Fluorescently labeled Tetanus Toxin C-fragment (TTc) was used to evaluate changes in the retrograde axonal transport mechanism by means of optical imaging. Hematoxilin-Eosin staining served to assess pathologic changes in radiated cords.

Results
Transport of TTc in the spinal cord was impaired in a dose-dependent manner as early as two days after radiation. Transport was decreased significantly by 16 days in animals exposed to...
either 10 or 80, while animals exposed to 2 Gy remained unaffected. Further, animals exposed to the highest dose also experienced significant weight loss by 9 days and developed posterior paralysis by 45 days. Pathologic changes of radiation damage could be seen in radiated cords after 30 days in mice exposed to 80 Gy.

Conclusions
Radiation of the spinal cord induces dose-dependent changes in the axonal transport mechanism which can be monitored by molecular imaging. This approach suggests a novel diagnostic modality to assess nerve injury and monitor therapeutic interventions.

KEYWORDS: Nerve Imaging, Radiation Injury, Radiation Protection

Intrathecal Chemotherapy and Reversible Cord Myelopathy: Critical identification of treatable myelopathy

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Purpose
Intrathecal chemotherapy, such as methotrexate, can induce an acute/chronic myelopathy by interruption of the B12 pathway. This treatable pathology in a subacute combined degeneration pattern may be underreported in patients receiving intrathecal chemotherapy. The goal of this paper is to examine the clinical manifestation and imaging occurrence of subacute combined degeneration (SCD) of spinal cord in patients receiving intrathecal chemotherapy. Additional complicating risk factors, such as radiation therapy, also were characterized. It is hypothesized that the high local concentration of chemotherapeutics that interrupt B12 metabolism can cause SCD in the cord while systemic levels of B12 are normal. Homocysteine may be a more sensitive marker of B12 metabolism. Recognizing this treatable form of myelopathy in patients receiving intrathecal chemotherapy is critical, as "rescue" B12 can be administered early in the onset of symptoms to prevent permanent loss of dorsal column function.

Materials and Methods
Retrospective clinical chart review and imaging database review was performed over eight years. All patients receiving intrathecal chemotherapy in radiology were identified. Those with concurrent MR of the brain, cervical and thoracic spine were identified. Clinical chart review was performed by neurologist. Subsequently, imaging on those patients was reviewed retrospectively by a CAQ neuroradiologist. The presence of abnormal T2 signal in the dorsal or lateral columns of the medulla, cervical, and thoracic cord was characterized. Clinical laboratory data were collected where available including MCV, Hb, or homocysteine levels. Clinical presentations were blinded to the neuroradiologist on imaging review.

Results
Three hundred forty-seven intrathecal chemotherapeutic injections (methotrexate, cytarabine) were identified in 118 separate patients over eight-year duration. Of the 118 patients receiving intrathecal methotrexate (iMTX), 36 patients had imaging of the brain and spine after iMTX. Clinical symptoms included: lower extremity weakness, paresthesia, loss of reflexes and
proprioception, decreased pain and temperature, ataxia, imbalance. These neurologic symptoms were present clinically and diagnosed in 17/36 patients. Of these patients, clear dorsal column abnormality was present in 1/36. Subtle dorsal column cord or medullary T2 hyperintensity was present in four additional patients on axial T2 imaging. A patient with unilateral dorsal column T2 signal with associated enhancement was excluded due to presence of widespread leptomeningeal disease. Of the five patients with florid or subtle dorsal column signal abnormality, an average of six doses of iMTX were administered. The patient with classic holocord SCD presentation received eight doses of iMTX, doxorubicin, and spinal radiotherapy. Cord abnormality presented two months after iMTX. High dose B12 was administered to this patient with resolution of clinical symptoms.

Conclusions
Intrathecal chemotherapy, such as methotrexate, can cause an acute or subacute presentation SCD pattern of cord myelopathy. High local concentrations, possibly potentiated by radiation therapy, may contribute to this treatable pathology. If suspected or documented on imaging, "rescue" intravenous B12 can treat symptoms. Consider early spine imaging in any patient undergoing intrathecal chemotherapy presenting with loss of dorsal column function. B12 and homocysteine levels can be assessed. However, systemic B12 levels often are normal in patients with clear clinical symptoms of dorsal column involvement.

KEYWORDS: Drugs, Metabolic, Spinal Cord
The Periconal Arterial Anastomotic Circle and the Posterior Thoracolumbar Watershed Zone of the Spinal Cord

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Purpose
The concept of spinal cord watershed territories was suggested in the 1950s, but their location remains ill-defined. Isolated spinal gray ischemia constitutes one type of watershed injury related to the higher metabolic need of the gray substance. This report describes the existence of another type of watershed territory related to the particular configuration of the spinal vasculature in the region of the conus medullaris.

Materials and Methods
The MR imaging (MRI) and angiographic data of three patients (56-year-old man, 53-year-old woman, 11-year-old boy) with documented ischemic injuries in the posterior thoracolumbar watershed zone of the spinal cord are presented.

Results
In all three cases, intersegmental arteries providing one or more significant radiculomedullary contribution for the lower cord were compromised by a compressive mechanism responsible for decreased spinal cord perfusion (diaphragmatic crus syndrome in two cases, disk herniation in one). The ischemic injury, located at the junction of the anterior and posterior spinal artery territories along the dorsal aspect of the conus medullaris, was consistent with a watershed mechanism. An example is shown in Figure 1A (arrow). Figure 1B illustrates the periconal arterial anatomy; note in particular the direction of flow, indicated by arrows, with ascending flow in the most caudal segment of the posterior spinal arteries. This portion of the posterior spinal distribution is therefore, from a functional standpoint, under the dependence of the anterior spinal artery.

Conclusions
The posterior thoracolumbar watershed zone of the spinal cord represents an area at increased risk for ischemic injuries, in particular in the context of partial flow impairment related to arterial compression mechanisms.

KEYWORDS: Anatomy, Spinal Angiography, Spinal Vascular Disorders
The Diaphragmatic Crus Syndrome - A Treatable Cause of Spinal Cord Ischemia
The diaphragmatic crus syndrome (DCS) was described in 2000 by Rogopoulos and co-authors. The DCS is linked to the compression of lumbar intersegmental arteries (ISA) as they pass through the tendinous portion of the crus, generally at the L1 and L2 levels. Medullary ischemia can result from crus compression when the involved vessel provides a significant contribution to the spinal cord vascularization. This report describes six cases of DCS.

Materials and Methods
The clinical and imaging findings of six observations of DCS (1 woman and 5 men, average age 35 years, range 11-56) were reviewed.

Results
In each patient, a spinal cord stroke was documented by MR imaging (MRI), while compression of an ISA providing significant supply to the spinal cord was confirmed by angiography (Figure 1). The symptomatology was progressive in four cases, unclear in the other two. The onset followed heavy physical activity in three instances. The initial diagnosis was transverse myelitis in three cases, spine degenerative disease, nonspecific myelopathy or spinal stroke in one case each. At the time of accurate diagnosis, four patients were paraplegic, and one had stable leg monoplegia. Only one patient with progressing symptoms was considered a good candidate for surgical therapy. In this case, section of the diaphragmatic crus was performed, with excellent outcome. Figure 1 legends: A shows a selective injection of the left L1 ISA, which provides the artery of Adamkiewicz (arrowheads). The compression by the diaphragmatic crus, indicated by an arrow in A, is confirmed by an axial reconstruction of the selective left L1 flat-panel catheter angiotomography (FPCA). (Asterisk=diaphragmatic crus).

Conclusions
Although rarely reported, the DCS may represent a more common cause of spinal cord ischemia than usually appreciated. While accurate anatomical diagnosis requires spinal angiography, the prospect of a potentially treatable etiology of spinal cord ischemia is exciting, particularly if one considers the young age of presentation in ours series (average of 35 years). Two-thirds of our patients had a progressive course consistent with worsening ischemia. In half of the cases, the ischemic event followed unusual physical activity.

KEYWORDS: Spinal Angiography, Spinal Imaging, Spinal Stroke
Intramedullary Spinal Cord Metastases: Prognostic Value of MRI and Clinical Features from a 13-year Institutional Case Series

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Purpose
Intramedullary spinal cord metastases (ISCM) are rare. Recent studies have elucidated MR imaging MRI features of ISCM (1, 2). Our goal was to identify both MRI and clinical features with prognostic value among patients with ISCM from a large single-institution retrospective series.
Materials and Methods
Search of our radiology and clinical databases previously identified patients with ISCM from 1999 to 2011. The relevant MRI examination for each patient from a consecutive group of ISCM patients had been reviewed previously by two neuroradiologists for various imaging characteristics, and baseline clinical data had been obtained. Additional relevant clinical data were extracted. Influence of the clinical and imaging characteristics on survival was assessed by Kaplan Meier survival curves and log rank test for categorical characteristics, and by Cox models for continuous characteristics.

Results
Forty-nine patients harbored 70 ISCM, with 10 (20%) having multiple ISCM. Lung cancer was the most common primary malignancy (49%). From the date of ISCM diagnosis, the median survival for all patients was 3.5 months. One clinical feature was associated with decreased median survival: lung or breast primary malignancy compared to all other malignancy types (p=0.0004); 1.9 months for lung/breast primary malignancies, versus 10.3 months for patients with all other types of primary malignancies. Three MRI features were associated with decreased median survival: 1) multiple ISCM (p=0.0217); 1.8 versus 4.0 months for multiple versus solitary ISCM; 2) greater longitudinal extent of cord T2 hyperintensity (p=0.0184); 3.7 months for patients with ≥3 segments, versus 6.1 months for patients with ≤2 segments; and 3) visualization of the primary tumor or non-CNS metastases on the reference MRI (p=0.0124); 1.9 versus 10.3 months for patients in whom these findings were present versus absent.

Conclusions
This study describes the prognostic value of pertinent clinical and MRI features in a large single institution series of patients with ISCM. Spinal cord edema spanning multiple segments, the presence of multifocal ISCM, and evidence for non-CNS metastases or the primary tumor should be specifically sought, as these MRI features are associated with decreased survival. Patient with either a lung or breast primary malignancy are expected to have decreased survival. The visualized lungs should be evaluated carefully on MRI since lung cancer is the most common primary malignancy and imparts a worse prognosis compared to other nonlung/nonbreast malignancies.

KEYWORDS: Metastases, Spinal Cord, Spinal Neoplasm

O-903

Does Lumbar Epidural Fat Amount Affect Spinal Canal CSF Volume?

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Purpose
Female obesity is a risk factor for idiopathic intracranial hypertension (IIH). The exact mechanism however is not yet understood. Thickness measurements of epidural fat suggest that there is no direct link between the amount of body fat and epidural fat. We aimed to study whether the amount of epidural fat affects the spinal canal cerebrospinal fluid (CSF) volume, and thus spinal canal compliance, as a potential link between obesity and IIH.
Materials and Methods
High resolution whole spine 3D T2W FSE and 3D T1W GRE volumes covering the lower portion of the spine was used to scan young (age range 22-30 years) female subjects with a wide range of BMI values (range 20-40) and 2 female IIH patients with ages 17 and 25 years with BMI values of 31 and 25 for the purpose of quantifying spinal canal CSF volume and posterior epidural fat. The study was performed on a 1.5 T Siemens Symphony scanner. The imaging parameters for the 3D T2-weighted sequence with isotropic voxel size of 1.0 mm, TR/TE of 1500/250ms and the 3D T1-weighted sequence with isotropic voxel size of 1.0 mm, FA :12 degrees TR/TE: 10.5/4.8 ms. The epidural fat was delineated manually from T12-L1 through L5-S1 levels on T1-weighted images, and the CSF within the spinal column was segmented using FSL FAST on T20weighted images. Associations between the CSF and epidural fat volumes, and BMI and epidural fat volumes were determined using linear regression.

Results
An example demonstrating the segmentation of the epidural fat and the segmentation of CSF in the lumbar spine is shown in Figure 1 (top). A scatter plot of the epidural fat volumes versus CSF volumes in lumbar spine is shown in Figure 1 (bottom). While there seems to be no association between epidural fat volume and BMI (R=-0.16, P=0.75) there was a moderate inverse correlation between the epidural fat volumes and the CSF volumes (R=-0.62, P=0.19).

Conclusions
In agreement with previous reports, no association was demonstrated between epidural fat volume and BMI. However, epidural fat seems to restrict the CSF space in the lumbar spinal canal, which provides the majority of the spinal canal compliance. These preliminary results suggest that further investigations of the role of epidural fat and how it is being affected by weight gain and/or loss are warranted for understanding of the underlying link between obesity and IIH.

KEYWORDS: Epidural Space, Idiopathic Intracranial Hypotension, Image Processing
Predictors of Vertebral Artery Injury in Isolated C2 Fractures Based on Fracture Morphology Using CT Angiography

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Purpose
The incidence of C2 fractures have increased 21% within the last decade. C2 fractures have a known association with vertebral artery injury as the vertebral arteries frequently course through the C2 transverse foramen. We determine predictors of vertebral artery injury defined on CTA in isolated C2 fractures based on fracture pattern using previously published orthopedic and neurosurgical imaging-based fracture classification schemes.

Materials and Methods
Three hundred CTs containing the words "C2 fracture" based on keyword search performed at a single, large academic institution in the past 10 years were evaluated retrospectively after obtaining IRB approval. Studies were excluded if there was a history of penetrating injury, if there were additional cervical or occipital condyle fractures, or if no CTA was subsequently performed. Three blinded reviewers classified fractures based on multiplanar CT images and independently evaluated CTA images. Disagreements were resolved by consensus. Fractures were classified based on fracture pattern, angulation, and displacement criteria set by Bono et al., Levine et al., and Benzel et al. Morphology was classified into Type I-III spondylolisthesis of the axis, Type I-III odontoid fractures, foramen transversarium involvement with or without comminution, and miscellaneous coronal/sagittal vertebral body fractures. Vertebral artery injury on CTA was defined as the presence of luminal irregularity, luminal narrowing, dissection, pseudoaneurysm, occlusion, or transection. Chi-square, Fisher exact, and logistic regression were performed using Minitab statistical software (Minitab, State College, PA) to determine the association between C2 fracture morphologies and vertebral artery injury.

Results
Seventy-one patients met inclusion criteria. Patient ranged from 17-99 years (mean 57.1, SD 22.2) and included 39 males and 32 females. Fifteen patients (21.1%) had vertebral artery injury on CTA. Thirty-three patients (46.5%) had traumatic spondylolisthesis type fractures. Twenty-three patients (32.4%) had dens fractures. Fifty-five patients (77.5%) had fractures involving the foramen transversarium. Fracture patterns significantly associated with vertebral artery injury were significant traumatic spondylolisthesis fractures (type II - defined as 3-12 mm of displacement and angulation between 0-25 degrees) (p=0.028), dens fractures (p=0.015), and comminuted foramen transversarium fractures (p=0.016).

Conclusions
Isolated C2 fractures demonstrating statistically significant association with vertebral artery injury as defined on CTA were significant traumatic spondylolisthesis fractures, dens fractures, and comminuted foramen transversarium fractures. Simple fractures extending through the foramen transversarium did not demonstrate a statistically significant association with vertebral artery injury. Fracture angulation, translation, and maximum displacement were not significant
predictors of vertebral artery injury. These data can be used to determine which patients with isolated C2 fractures should obtain further evaluation with CTA.

KEYWORDS: Cervical Fractures, Thrombosis, Vertebral Artery Dissection

O-907

MRI and Pediatric Cervical Trauma: Is Bright Always Bad?

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Purpose
Imaging evaluation of the pediatric cervical spine in the setting of trauma remains controversial, as no universally accepted standards exist. Typically, institutional patterns dictate imaging protocol ranging from routine use of radiographs to computed tomography (CT) and/or MR imaging (MRI) when cervical spine injury is apparent or suspected. Age and mechanism of injury are important considerations in evaluating cervical spine injury in children because anatomical and physiologic maturity of spinal structures varies tremendously, especially in early childhood. These factors and a child's ability or inability to provide history or participate in, and cooperate with, physical exam emphasize that reliable radiographic imaging findings are essential in children. Traumatic injuries of the cervical spine in children most often involve ligaments, cartilage, spinal cord and the peri- and para-spinal soft tissues rather than bone fracture. While CT or radiographs may readily reveal findings of fracture, STIR and other heavily weighted T2 MRI sequences are most sensitive to detection of joint and soft tissue injury or radiographically occult fracture. Alternatively, the presence of fluid signal in or surrounding a growing joint or ligament may represent a normal physiologic finding. It is therefore paramount to recognize normal MRI findings of cervical spine structures in children in order to differentiate pathologic from normal physiologic findings. The purpose of our study is to recognize and compare the appearance of paraspinal soft tissues and hyperintense STIR signal in cervical spine joints and other structures in children receiving cervical spine MRI both in the absence of trauma as well as in the evaluation of trauma.

Materials and Methods
IRB approval was granted. An electronic query was used to identify patients with cervical spine MR, age 0 – 17 years from 10/1/2010 to 11/13/2013 (n = 1871). Patients were first stratified by exam indication into two groups: "trauma" and "nontrauma," and into seven age groups based on spinal maturity, ability to reliably provide clinical history, and likely types of trauma, such as participation in sports. Exams were eliminated due to artifact, absent STIR sequence, or congenital, neoplastic, infectious pathology and postsurgical changes in a nontrauma patient. Sagittal STIR images were reviewed by two board certified radiologists (one with Neuroradiology MOC and one with Neuroradiology CAQ eligibility) and hyperintense signal in the atlanto-occipital and atlanto-axial joints, spinal ligaments, and peri- and para-spinous tissues was recorded as the binary observation of "present" or "absent".

Results
In the nontrauma group, hyperintense STIR signal was identified in atlanto-occipital and atlanto-axial joints in 96% and 98% of all patients, respectively. Hyperintense STIR signal also was
identified within the paraspinal tissues in 90% of nontrauma patients. In the pediatric group receiving cervical MRI for suspected traumatic injury, hyperintense STIR signal was identified in the atlanto-occipital and atlanto-axial joints in 95% and 99% of all patients, respectively. In these patients, hyperintense STIR signal also was identified in the paraspinal soft tissues in 99% of patients.

Conclusions

STIR hyperintense signal frequently is seen in atlanto-occipital and atlanto-axial joints of children of all ages without and with traumatic injury. Peri- and para-spinal and spinal ligament signal hyperintensity may be seen due to vascular flow artifact. Findings should not be diagnosed as indication of traumatic injury.

KEYWORDS: Cervical Spine, Pediatric Spine

Thursday
1:00PM - 2:31PM
Palais des congres de Montreal, 520

91 - PARALLEL PAPERS: Spine: Interventional
O-909

Development of quantitative and objective method to predict fracture risk in patients with vertebral metastases

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Purpose
Breast and prostate cancer are the second leading cause of cancer death in the western world in women and men respectively (1). Vertebral bone is the most frequent site of skeletal metastasis. Although pathologic vertebral fractures (PVF) represents the most dreaded complication associated with metastatic disease in the spine, no objective or quantitative method exists for
estimating PVF risk in patients with spinal metastasis. This study is the application of quantitative computed tomography-based structural analysis system (CTA-FRx) to accurately predict the failure of human lumbar spinal units with simulated lytic defect (1).

Materials and Methods
Twenty-eight three-level human cadaveric spine segments (T6-T8, T9-T11, T12-L2, L3-L4), obtained from four male and six female donors aged 48-57 years, were CT scanned (Aquilion 64, Toshiba Medical, USA) using a clinical scanning protocol (field of view: 16 cm, 125kV, Matrix:512^2). A six-chamber calcium hydroxyapatite phantom (0-1.5 g/cc3, CIRS, Norfolk, VR) was imaged with the spines to allow bone density calibration. Clinically relevant lytic defects, identified to impose a high risk of failure (Figure 1A) were created in the middle vertebra of each segment. The segments were rescanned in the same spatial orientation, prepared for mechanical testing and tested to failure under axial compression. Using a novel segmentation algorithm, the vertebrae were segmented and the stack of segmented gray level (Hounsfield units) CT images mapped, on a pixel by pixel basis, to density values using the calibration phantom data and the resulting apparent density values converted to elastic modulus. For each vertebral cross-section the following structural parameters were computed; Axial rigidity: estimating the axial load carrying capacity of the vertebra; sagittal EImax and transverse (Elmin) bending rigidities: (estimating the vertebra's resistance to bending load in a chosen axis). The latter were computed about the section modulus-weighted centroid (GCw) with the section's principal axes (Eigenvectors) and second moment of area's computed from the tensor. This computation established the CT-FRx parameters.

Results
For each of the segmented spines with simulated osteolytic defects, CT-FRx was used to compute the expected failure load. Regression models (JMP 9.0, SAS, NC), fitted to the predicted CT-FRx versus test failure loads, showed a highly significant correlation (ANOVA, F=16.6, p<0.001) with a coefficient of determination (R2 =0.71), Figure 1B. As observed from the scatter plot, the failure loads of several spine segments presented a large departure from that predicted. These outliers were attributed to the existence of large osteophytes, often bridging across the disk space, significantly altering the loading acting on the spine.

Conclusions
In agreement with previous studies the location of the defect had no significant effect on the prediction. This study demonstrating high correlation between CT-FRx theoretically predicted spinal failure loads and the measured test values, demonstrates the ability of our protocol to predict failure loads for human vertebrae with lytic defects with a high degree of accuracy. This work will provide a qualitative, and importantly, objective assessment of the changes in the risk of vertebral fracture for breast and prostate cancer patients. We expect this novel approach to facilitate patient management and resource utilization by providing guidelines for selecting among the various treatment options based on fracture risk.

KEYWORDS: Algorithm, CT, Metastases
Safety and Effectiveness of Sacroplasty in a Large Single Center Experience

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Purpose
Sacral insufficiency fractures (SIF) are a common cause of severe low back pain and immobilization in the osteoporotic and cancer populations. Frequently missed on plain film radiography, SIF lesions often require computed tomography (CT) or magnetic resonance imaging (MRI) for diagnosis. Current practice guideline recommendations range from physical therapy with analgesia to surgical fixation/resection in those patients who qualify. For many patients, these options may be ineffective and associated with significant morbidity. Sacroplasty has emerged as a minimally invasive therapeutic strategy for such fractures. Here we study the safety and effectiveness of sacroplasty in a single-center cohort of 53 patients.

Materials and Methods
Under institutional review board approval, we retrospectively reviewed 53 sacroplasty cases completed at our institution from January 2004 to September 2013. Informed consent was obtained prior to procedure and HIPAA compliance was maintained. Chart review was
performed to obtain patient demographics and to assess pre- and post-treatment assessments on the Visual Analog Scale (VAS), Functional Mobility Scale (FMS), and Analgesic Scale (AS). Also, a four-point pain improvement scale was used to assess overall response rate to sacroplasty intervention (1 – complete resolution of pain; 2 – improvement of pain; 3 – no change; 4 – worsened pain). Statistical correlation was assessed using the Wilcoxon signed-rank test.

Results
A total of 53 procedures was completed. In this cohort (83.0% female), sacral fracture etiology included metastatic (54.7%), osteoporotic (30.2%), and traumatic (15.1%). Among 27 patients with available pre- and post-treatment scores, there was a statistically significant decrease in patient VAS score (p < 0.001), FMS score (p < 0.001), and AS score (p < .01). Pretreatment median [IQR] VAS (9.0 [8.0-10]), FMS (3.0 [2.0-3.0]) and AS (3.0 [3.0-4.0]) were reduced to median post-treatment [IQR] VAS (3.0 [0.0-5.8]), FMS (1.0 [.25-2.8]), and AS (3.0 [2.0-3.8]). There were no major complications or procedure-related morbidity reported. Using the four level pain scale, greater than 93% of the total 53 patients reported either complete resolution of pain or improvement in overall pain. Average time to follow up was 27.0 (23.2 – 30.7) days.

Conclusions
In this single-center experience, sacroplasty is a safe and effective procedure for the palliation and treatment of sacral insufficiency fractures. Our results show significant short-term gains in pain relief, increased mobility, and decreased dependence on pain medication.

KEYWORDS: Bone Metastases, Sacroplasty, Spine Interventions
Chronic Back Pain after Percutaneous Vertebroplasty: Risk Factors

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Purpose
Nearly 25% of patients enrolled in a recent randomized controlled trial comparing vertebroplasty (VP) versus conservative treatment (CT) in patients with symptomatic vertebral fractures (VF)
developed severe chronic back pain (CBP). We analyzed the risk factors related to the development of CBP.

Materials and Methods
Severe CBP was defined as residual pain of VAS≥7 at the end of follow up (12 months). Several risk factors were evaluated: visual analog scale (VAS) at baseline and during follow up, age, gender, symptom onset time, number, type and severity of VF at baseline, number of vertebral bodies treated, incidental VF, and antiosteoporotic treatment.

Results
Severe CBP was observed in 23% of patients treated with VP and same percentage was found in the CT arm. Patients developing CBP after VP showed a longer symptom onset time (82%≥4 months). In the univariate analysis, female gender, number of acute VF (>1), VAS≥7 two months after treatment and the type of antiosteoporotic therapy (teriparatide) were risk factors related to CBP development in both groups. In the multivariate analysis the main risk factors were having a baseline and a post-treatment VAS value ≥7, longer symptom onset time and type of antiosteoporotic treatment.

Conclusions
Nearly 25% of patients with symptomatic osteoporotic VF developed severe CBP independently of type of treatment. Symptom onset time previous to VP and persistence of severe CBP after treatment were the main factors related to CBP. Treatment with teriparatide was related to decreased risk of this complication.

KEYWORDS: Osteoporosis, Vertebral Augmentation, Vertebral Compression Fractures

O-912

A SECOND LOOK AT SPINE MRIs: Adding Clinical Focus for Optimal Care.

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Purpose
Many patients may suffer without a diagnosis of a treatable source for their spine pain, if imaging reports are too general or fail to report relevant findings. Our purpose was to determine if second interpretations of spine MRIs by a neuroradiologist, in collaboration with the neurosurgeon, were concordant with the initial interpretation provided by a nonsubspecialized radiologist. The interpretations then were correlated with clinical findings and a surgical intervention or nerve root block was offered.

Materials and Methods
We retrospectively reviewed second reports of MRI exams of the cervical, thoracic or lumbar spine by one neuroradiologist in collaboration with one referring neurosurgeon. Second interpretations were compared with the outside interpretation. Discordant interpretations were defined as failure to describe an epidural or spinal canal lesion, cord contusion, degree of spinal canal and lateral recess stenosis, disk extrusion with migration or sequestration, nerve root impingement, and acute fracture. Radiologic interpretations were compared to clinical records, surgical notes, and postoperative symptoms.
Results
Sixty MRIs (26 cervical, 5 thoracic and 29 lumbar spines) were reviewed in 57 patients. There were 33 out of 60 concordant interpretations. Out of the 33 concordant interpretations, 20 were offered surgery or nerve root block. There were 27 out of 60 discordant interpretations. Out of the 27 discordant interpretations, 21 were offered surgery or a nerve root block. A total of 19 surgeries were performed on 18 patients. Of the 19 surgeries, 10 were from discordant interpretations. In all 19 surgeries, the described pathological disks or foramina were confirmed.

Conclusions
A collaborative approach to spine pain contributes to effective treatment. Detailed history and exam findings are vital to spine MRI interpretation. Reports by a neuroradiologist, with detailed description of pathology, more than doubled the population of patients offered surgery. Interpretations by neuroradiologists permits the neurosurgeon to devise a targeted treatment approach beyond analgesics and offers patients an avenue for a reduction or cure for their pain. We hope that future studies may demonstrate improved outcomes with this approach.

KEYWORDS: Second Opinion Consultation, Specific Findings, Spine Interventions

O-913
1:28PM - 1:35PM

Spontaneous Intracranial Hypotension: Long Term Clinical Outcomes after Treatment with Image-guided Epidural Blood Patch

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Purpose
Spontaneous intracranial hypotension (SIH) is an under-diagnosed cause of persistent and often debilitating headaches. Patients commonly present with orthostatic headaches associated with decreased cerebrospinal fluid (CSF) volume and low opening pressure without history of prior instrumentation or trauma. Etiologies of CSF leakage include tears of spinal nerve root sleeves,
cervical bone spurs, meningeal/arachnoid diverticula, underlying connective tissue disorders, and perineural cysts. Recent literature reports associate SIH with degenerative disk disease, specifically calcified thoracic intradural disk herniations. In most cases, SIH responds well to conservative management which includes bed rest, increased fluid intake and caffeine. Image-guided epidural blood patches have been shown to be effective treatment for CSF leaks in patients who do not respond to conservative measures. Only a handful of studies have evaluated the long-term outcomes of image-guided epidural blood patches for treatment of spontaneous intracranial hypotension. The aim of this study is to evaluate the long-term outcomes of image-guided blood patches for treatment of refractory SIH.

Materials and Methods
An IRB-approved retrospective single institution review was performed of all patients who underwent image-guided epidural blood patch for treatment of refractory SIH and had a minimum of one year follow-up. The diagnosis of SIH was established by either a neurologist or neurosurgeon prior to the procedure and in some patients was confirmed with lumbar puncture and/or cross-sectional imaging. Patient demographics, technical details, complications, and clinical outcomes were reviewed. For long term follow up, patients were contacted by a trained nurse from our interventional spine service for a short telephone interview. Participation was voluntary and no compensation was provided. Survey questions followed the diagnostic criteria for headache attributed to spontaneous (or idiopathic) low CSF pressure as defined by the International Headache Society (IHS). In cases where patients reported diffuse and/or dull headaches with or without a postural component, the Headache Disability Index was administered. Any additional treatments that patients underwent for persistent symptoms also were recorded. A total of 42 patients were identified and six patients were excluded (n=4 could not be reached for follow up and n=2 could not recall undergoing the blood patch procedure).

Results
Thirty-six patients (M:F = 8:28) with a mean age of 43 years (range 19-65) underwent a total of 74 image-guided blood patch procedures (34 blind lumbar and 40 targeted) without complications. The average volume of blood injected was 23.9 mL for blind injections and 6.5 mL for targeted injections. The mean follow-up period was 3.4 years (range 1.4-6.9 years). Fifty percent of patients (n=18) reported immediate and complete relief of symptoms. 8.3% of (n=3) patients reported an initial partial response with eventual complete relief of headache symptoms. 5.5% of patients (n=2) patients reported immediate initial relief, however symptoms recurred within <6 months. 36.1% (n=13) did not respond to blood patch treatment and had persistent symptoms. Of these 13 patients, nine underwent surgical intervention and the remaining four patients continued medical management. After surgery, 55.5% (n=5) patients had complete relief of symptoms while 44.4% (n=4) reported continued symptoms. Of the four patients who elected for medical management, 50% had complete relief of symptoms while the remaining had persistent symptoms. Patients who reported complete relief of symptoms at follow up had undergone 29 procedures (15 blind, 14 targeted) with mean number of 1.4 blood patch procedures. Patients who reported persistent symptoms at follow up had undergone 45 procedures (19 blind, 26 targeted) with mean number of three blood patch procedures.

Conclusions
Image-guided epidural blood patches have been shown to be effective treatment for patients with refractory spontaneous intracranial hypotension. Although no consensus as to the optimal method between targeted and blind epidural blood patch can be reached, an overall 58% success rate of long term symptom relief supports image-guided epidural blood patches as first-line
therapy. The minimally invasive technique and low complication rate make it an ideal treatment for SIH. In patients who do not respond to epidural blood patch therapy, surgery may be considered; however cure rates are only slightly higher than medical management.

KEYWORDS: Epidural Blood Patch, Intracranial Hypotension, Spinal CSF Leak

O-914

1:35PM - 1:42PM

Rebound Intracranial Hypertension: A Complication of Epidural Blood Patching for Intracranial Hypotension

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Purpose
To describe the presentation of patients with confirmed rebound intracranial hypertension (RIH), a complication of epidural blood patching characterized by increased intracranial pressure, with an emphasis on common features that may suggest the diagnosis and potential treatment strategies.

Materials and Methods
Patients treated for intracranial hypotension with epidural blood patch (EBP) who subsequently developed symptoms consistent with elevated intracranial pressure, and who were confirmed to have cerebrospinal fluid (CSF) pressure >20 cm H2O measured by lumbar puncture were included in this retrospective review. Pre-EBP and post-EBP clinical symptoms, CSF pressure measurements, and treatment details were recorded.

Results
Nine cases were identified; eight patients had been treated for spontaneous intracranial hypotension, and one for post-LP headache. All patients had positional headache prior to EBP. Mean pre-EBP opening pressure was 8.6 cm H2O (range, 1.0-15.0). Median time to onset of RIH was one day (range, 2 hours-1 year). Six of nine patients (66%) developed symptoms of RIH within 48 hours of blood patching. Mean opening pressure measured after development of RIH was 30 cm H2O (range, 22-55). Headache location associated with RIH was different compared to pre-EBP location in 66% of cases; occipital headaches were most common prior to EBP (66%), while frontal (44%) and peri- or retro-orbital (33%) headaches were most common after RIH development. Most patients with RIH reported new blurred vision (78%) or new nausea/vomiting (89%). All patients improved after drainage of cerebrospinal fluid. In eight of nine cases, patients subsequently were treated with oral acetazolamide, ranging in duration from 5 days to 3+ years.

Conclusions
Rebound intracranial hypertension is a potential complication of epidural blood patching that should be considered in patients who report headache after treatment. Particularly suggestive features include change in headache phenotype, development of new nausea, vomiting, or blurred vision, and symptom development in close relationship to blood patching. Patients should be monitored closely for development of these symptoms, and can be treated with CSF drainage and/or acetazolamide.
**Transforaminal versus intra-articular facet steroid injections for the treatment of cervical radiculopathy: a randomized, double-blind, controlled study.**

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**Purpose**

Transforaminal steroid injections (TFSI) are part of the management of cervical radiculopathy (CR). In recent years, catastrophic complications following TFSI have been reported. This study aims to evaluate and to compare the efficacy of TFSI and of intra-articular facet steroid injections (IFSI) in the treatment of chronic CR.

**Materials and Methods**

This study was approved by the institutional review board and all study subjects signed an informed consent. We randomly assigned 56 subjects diagnosed with chronic CR by a neurosurgeon (D.S., M.L.) or a physiatrist (B.E.L., J.D.) according to standardized criteria, to receive CT-guided TFSI (15 men, 13 women; mean age 52 years; range 29 - 72 years) or CT-guided IFSI (8 men, 20 women; mean 44 years; range 26 – 60 years). The CT-guided injections were performed by one of two musculoskeletal radiologists (N.B., T.M.) with 18 and 10 years experience respectively. The subjects were blinded to the type of injection they received. The subjects were evaluated on the day of the procedure (Pre) and one month later (Post) by a research assistant who also was blinded to the type of injection administered to the subjects. A pain score, using a Visual Analog Scale (VAS), and the Neck Disability Index (NDI) were used as outcome measures. Two outcome variables, the VAS_Diff and the NDI_Diff (difference between Post and Pre scores, relative to the Pre score, in percentage) were used. The efficacy of each technique, in terms of pain score reduction and of NDI improvement, was defined as a VAS_DIFF > 30% and a NDI_DIFF > 10%, respectively. To compare the efficacy between both techniques, in terms of the VAS pain score and NDI outcomes, ANCOVA analysis was used with the Pre VAS pain score as covariable. Noninferiority of the IFSI to the TFSI was claimed when the mean and 95% confidence interval (CI) of the outcome variables of IFSI were superior to, or not less than 15% the outcome variables of TFSI.

**Results**

In the intention-to-treat and per-protocol analyses, for a mean Pre VAS pain score, IFSI demonstrated a significant pain score reduction of 35% (CI: 17.7% - 52.4%) and of 30.9% (CI: 12.7% - 49.3%) respectively, while TFSI showed nonsignificant pain score reduction of 12.6% (CI: +4.7% - 29.9%) and 15.7% (CI: +3.3% - 34.7%) respectively. Regarding the NDI outcome, both techniques demonstrated a significant improvement, in the intention-to-treat analysis with IFSI 24.5% (CI: 5.5% - 43.5%) and TFSI 25.5% (CI: 6.5% - 44.5%) and in the per-protocol analysis with IFSI 24.5% (CI: 5.9% - 43.2%) and TFSI 25.5% (CI: 6.2% - 44.8%). When comparing both techniques, an interaction between both groups and the Pre VAS pain score was
found. Hence, in the intention-to-treat and per-protocol analyses, noninferiority of IFSI to TFSI was demonstrated for Pre VAS pain score ≤ 60, while the efficacy of IFSI was inferior to TFSI for Pre VAS pain score ≥ 80. Regarding the NDI outcome, noninferiority of IFSI to TFSI was demonstrated in both analyses.

Conclusions
Intra-articular facet steroid injections are effective for the treatment of chronic CR. The efficacy of IFSI is noninferior to TFSI when the initial level of pain score is low to moderate. IFSI can be an effective and a safer alternative to TFSI for the treatment of CR as no serious complications have been reported to date with this approach.

KEYWORDS: Cervical Spine, Nerve Root, Spine Injections

O-916

3D T2 MR-based Measurements of the Posterior Cervical Thecal Sac in Flexion and Extension for Cervical Puncture.

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Purpose
Current technique for cervical puncture traditionally is performed with neck extension. The purpose of this study is to compare anatomical measurements of the posterior cervical thecal sac during neck flexion and extension in normal volunteers using high resolution MR imaging to aid in positioning for cervical puncture.

Materials and Methods
High resolution 3D T2 SPACE magnetic resonance imaging (MRI) images were obtained of the cervical spine in 10 subjects. Subjects included healthy volunteers of age 18 or older. Exclusion criteria included: history of cervical spine injury or surgery, acute or chronic neck pain, and history of degenerative disk disease. Sagittal T2 SPACE images were obtained in the following neck positions: supine extension, supine flexion, prone extension, and prone flexion.

Measurements of the degree of flexion and extension were recorded for each of the four positions. The AP dimension of the posterior cervical thecal sac (distance between the spinal cord and the posterior spinal canal at the C1-C2 level) was measured in each of the four positions.

Results
Mean angle of extension was 38 degrees for supine and 35 degrees for prone position. Mean angle of flexion was 20.5 degrees for supine and 21 degrees for prone position. Mean size of the AP dimension of the posterior thecal sac at the C1-C2 level were as follows: 0.37 cm for supine extension, 0.26 cm for supine flexion, 0.4 cm for prone extension, and 0.33 cm for prone flexion.

Conclusions
Based upon our measurements of healthy volunteers, the posterior cervical thecal sac is larger with neck extension than with neck flexion. This difference is independent of prone or supine positioning. This suggests that extension is the ideal neck position for performing cervical puncture and that the decision for prone versus supine positioning can be made based on operator comfort and patient preference.
Reducing the Dose for CT-guided Spine Biopsies: Let’s Shift the Paradigm

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Purpose
Imaging-guided biopsies are a commonly used method to obtain tissue sample for diagnosis in suspected cases of malignancy. In particular, CT guidance provides a reliable method of image guidance for spinal lesions. The purpose of this study is to demonstrate that using a low-dose (LD) protocol for CT-guided spine biopsies can be as effective in tissue sampling, procedural time and complication rate as a regular-dose (RD) protocol.

Materials and Methods
After obtaining Institutional Review Board approval, we retrospectively reviewed all patients who underwent CT-guided spine procedures at our institution between May 2010 and October 2013. Patients who underwent disk space aspirations for suspected diskitis/osteomyelitis and spinal pain injections were excluded. Patients for whom dose reports were not available in our institution's PACS were excluded. Sixty-four patients were included. The following data were recorded: age, gender, lesion biopsied, kVp, mAs, pitch, CT dose index (CTDIvol) per series (mGy), total CTDIvol, dose length product (DLP) per series (mGy-cm), scan range (mm), total DLP, number of biopsy-guiding scans, number of pre- and post-biopsy diagnostic scans, number of needle passes, total number of scans, duration of each biopsy, pathology results and complications. Low-dose biopsies were defined as those with a kVp of 80, mAs of 40-60 and pitch of 0.875-1.35. Regular-dose biopsies were defined as those with a kVp of 120 and mAs >200. Scans performed at kVp and mAs parameters outside the above-mentioned criteria for LD and RD biopsies were classified based on average CTDIvol (CTDIvol <10mGy LD; CTDIvol >10mGy RD). Age, biopsy duration, total number of scans, total CTDIvol and total DLP of LD and RD groups were compared using unpaired t-test. Diagnostic tissue yield was compared using Fisher exact test. P <0.05 was considered to be statistically significant.

Results
Thirty-one patients underwent LD CT-guided spine biopsies and 33 patients underwent RD biopsies. There was no significant difference in patient age between the two groups (64.13 ± 2.44 years for LD versus 58.97 ± 2.54 years for RD; p=0.149). There was a statistically significant difference in total CTDIvol between the LD and RD groups (79.06 ± 8.336 mGy versus 289.3 ± 23.48 mGy respectively; p< 0.0001) as well as in total DLP (667.2 ± 62.2 mGy-cm for LD versus 1536 ± 115.9 mGy-cm for RD; p< 0.0001). There was no significant difference in total number of scans obtained (11.42 ± 0.78 for LD versus 12.48 ± 0.79 for RD; p=0.3422), duration of procedure (34.55 ± 2.15 min for LD versus 38.18 ± 1.57 min for RD; p=0.1732) or diagnostic tissue yield (21/31 or 67.74% for LD versus 20/33 or 60.61% for RD positive for malignancy; p=0.61). There were sufficient specimens for diagnosis in all patients in both biopsy groups. No significant complications were noted in either group.
Conclusions
Low CT-dose spine biopsies have a significantly lower cumulative radiation exposure (CTDvol and DLP) when compared to regular CT-dose biopsies without significantly affecting procedural time or diagnostic tissue yield. Use of a LD protocol should be considered as an alternative to RD protocol when performing CT-guided spinal biopsies, thus allowing the operator to reduce ionizing radiation dose while maintaining overall quality and efficiency of the procedure.

KEYWORDS: Biopsies, Dosimetry, Spinal Neoplasm

(Filename: TCT_O-917_graphs.jpg)

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Purpose
Computed tomography (CT) myelography has been employed to distinctly delineate neural structures, allowing for precise treatment of tumor with high-dose irradiation. Here, we discuss collaborative efforts between the Departments of Diagnostic Radiology, Radiation Oncology, and Neurosurgery in the creation of a robust spine stereotactic radiosurgery pre-treatment planning program at a large cancer center designed to increase patient throughput and enhance therapeutic accuracy.

Materials and Methods
In November 2012, a spine tumor board was created to review patients with metastatic disease to the spine and to explore a variety of treatment options, including conventional radiation therapy, chemotherapy, stereotactic radiosurgery, minimally invasive and conventional surgery, vertebral augmentation with vertebroplasty/kyphoplasty, and palliative care. The enhancement of the spine radiosurgery program was largely sought because of increasing numbers of patients with spinal metastatic disease and the difficulty of acquiring efficient co-registration from MR imaging (MRI) and CT simulation scan data sets with conventional radiation planning. In cases where tumor closely approximated radiosensitive neural structures, a decision was made to obtain CT myelography for pretreatment planning. Calibration between the diagnostic radiology CT and radiation oncology simulation CT were evaluated and documented by both diagnostic and therapeutic radiology physicists. Electronic transfer of data from the diagnostic radiology CT scanner to the radiation oncology simulation CT also was tested and found to be successful.

Results
Patients were scheduled for CT myelography-based simulation approximately one week prior to treatment. The patient arrived in the Diagnostic Radiology department as the first case in the morning. Patient registration, chart review, consent, and iv access were performed, and the patient was on the table within one hour of arrival. A lumbar puncture was performed with instillation of a standard dose of 20 mL of Omnipaque 180 into the thecal sac to opacify the subarachnoid space. Approximately 1-3 mL of CSF fluid was obtained for analysis in each patient. Contrast was advanced into the area of interest and fluoroscopic spot films obtained. For tumors in the thoracic area, a gold fiducial localization marker was placed to provide an internal fiducial for correlation with the external fiducials and the immobilization bag. The spinal needle was removed and the patient was immediately transported across the hall to a CT scanner with flat table top. There, the radiology and radiation oncology technologists met the patient, and the patient was immobilized in a pre-molded standard mask system or stereotactic body frame system utilizing double-vacuum technology to provide motion stability. The patient then was positioned on the CT table and scanned using a 60-65 cm FOV to include the immobilization device, and the images checked by the radiologist for diagnostic quality. The CT myelographic dataset subsequently was reformatted with a smaller field of view and thin sections, including sagittal and coronal reconstructions, for diagnostic interpretation. Following this, the patient was
taken to the diagnostic radiology recovery area for monitoring for 1-2 hours following the procedure prior to home discharge. The pretreatment CT imaging was immediately available to the radiation oncologist and neurosurgeon for treatment planning utilizing inverse planning IMRT software.

Conclusions
We performed CT myelography pretreatment planning in 20 patients between December 2012 and December 2013. None of the patients in our series experienced radiation myelitis or compression fractures as a complication of radiosurgery. We have documented tumor type and primary versus recurrent, time from initial consult to pretreatment planning CT myelogram, time from CT planning stage to radiation treatment, and mean radiosurgical doses. Our overall experience has been positive, and has fostered a close working relationship between the radiologists, oncologists, and neurosurgeons, which we expect to translate into improved clinical outcomes.

KEYWORDS: Radiation Therapy, Spinal Imaging, Spine Interventions

O-919

2:10PM - 2:17PM

Radiation Induced Osteoradionecrosis and Osteomyelitis of the Sub-axial Cervical Spine Following Radiation Therapy and Posterior Pharyngeal Wall Surgery

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Purpose
To report our experience with radiation-induced osteoradionecrosis (RIORN) of the subaxial cervical spine. RIORN is a serious long term complication of radiation therapy (RT) for head and neck cancers (HNC). RIORN involving the mandible is well documented. RIORN of the skull base, C1 and C2 also has been documented in patients being treated for nasopharyngeal carcinomas. However, RIORN of the subaxial cervical spine is described much less frequently, and can lead to vertebral instability, kyphosis and pain requiring aggressive surgical intervention and hyperbaric oxygen therapy.

Materials and Methods
This is a single-institution retrospective review of patients diagnosed and treated for RIORN of the subaxial cervical spine following treatment for HNC. From January 2000 through January 2013, all radiologic imaging, operative reports and pathologic findings were retrieved from the Department of Radiology, Radiation Oncology and Otolaryngology databases and reviewed.

Results
Four patients were identified, each with an extensive history of recurrent HNC treated with surgery and multiple courses of RT with a cumulative dose of $\geq 100$ Gy. All patients had previous surgical treatment involving the posterior pharyngeal wall (PPW). RIORN involved multiple cervical vertebrae between C3 and T1. Positron emission tomography (PET)/ computed tomography (CT) imaging was performed for two patients and initially was interpreted as recurrent disease. MR imaging was performed for all patients and initially was interpreted as
diskitis and osteomyelitis. Two patients were treated with intravenous antibiotics and/or antifungal medication, and two were treated with surgical debridement and fixation.

Conclusions
RIORN of the subaxial spine has variable imaging appearance and needs to be differentiated from recurrent or metastatic disease. We propose that surgical violation of the PPW on top of compromised vasculature in HNC patients treated heavily with RT may predispose the subaxial cervical vertebrae to RIORN. Previous irradiation combined with exposure to upper aerodigestive tract secretions from PPW defects may lead to vertebral body osteomyelitis, systemic infection, vertebral compression fracture and fistula formation.

KEYWORDS: Cervical Spine, Radiation Necrosis

O-920

18F-NaF PET Evaluation of Facet Joints of the Lower Lumbar Spine Compared with CT and MRI Graded Arthropathy

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1University of California San Francisco, San Francisco, CA, 2University of California San Francisco Medical Center, San Francisco, CA

Purpose
Lumbar facet syndrome is a major cause of morbidity in the United States. Commonly employed radiographic studies, including CT, show poor correlation with outcomes following diagnostic facet blocks. Noninvasive imaging techniques that more accurately identify patients who will benefit from interventional therapies for facet syndrome are needed. As a measure of bone turnover and blood flow, 18F-NaF (NaF) PET may identify functional changes in the facet joint not reflected by simple structural abnormalities seen on CT. Correlation between NaF uptake and CT grade of facet arthropathy was tested. Additionally, separately obtained MRI in a subset of patients was compared to findings in the PET and CT studies.

Materials and Methods
Thirty patients who underwent NaF PET-CT imaging over a year period (2009-2013) for cancer restaging were identified retrospectively. No patient had imaging or clinical evidence for metastatic disease. Whole body PET-CT images were acquired approximately 45 minutes following iv administration of 160 MBq 18F-NaF. Maximum (SUVmax) and mean (SUVavg) NaF uptake within the bilateral L3-L4, L4-L5, and L5-S1 facet joints was measured using a volumetric region of interest (ROI) encompassing the entire facet joint. Values subsequently were standardized to uptake within the normal mid-femoral diaphysis. Facet arthropathy was graded on CT images using Pathria classification. Facet joints were divided into three groups: high uptake (SUVavg ≥ 4), moderate uptake (4 > SUVavg ≥ 2) and low uptake joints (SUVavg < 2) on the basis of their SUVavg. Computed tomography scores of facet arthropathy were averaged within each of these groups and compared via Student's t-test and ANOVA. Correlation analyses also were performed. In a subset of patients. MR imaging of the lumbar spine performed within 12 months of the PET-CT also was reviewed. Pathria CT grading and modified Pathria scoring for MRI facet arthropathy was compared with NaF SUV using ANOVA and Student's t test.
Results
Compute tomography evidence for facet arthropathy was present in 91% (grade 1 through 3) of interrogated joints (n= 180), with 53% of joints graded as moderate (grade 2) or severe (grade 3) by Pathria CT criteria. The mean SUVavg within a facet joint was 3.4 (range 1.4 - 9.8, SDEV = 1.5) while the mean SUVmax was 7.0 (range 2.3 - 30.4, SDEV = 4.3). A statistically significant variation between groups by ANOVA was present (F = 4.19, p = 0.017), with significant individual group CT Pathria score differences between high NaF uptake group and moderate and low uptake groups (p < 0.015). Overall, only weak correlation between SUVavg and CT grade of arthropathy (ρ = 0.30) was observed. In the subset of patients with recent MRI, the presence of pathologic facet joint fluid was associated with elevated SUVavg (p < 0.05).

Conclusions
High NaF uptake within a facet joint is associated with significantly worse facet arthropathy as assessed by Pathria grading. However, overall weak correlation between NaF PET and CT arthropathy grade suggests that NaF PET and CT findings might reflect different ongoing abnormalities in the setting of chronic ongoing facet arthropathy. Interestingly, the presence of pathologic facet joint fluid on MRI is highly associated with increased NaF uptake. Further prospective studies utilizing NaF-PET in low back pain patients are warranted to correlate with clinically confirmed sites of facetogenic pain.

KEYWORDS: Bone Scan, Facet, PET/CT

O-921

Intracardiac Cement Embolism During Percutaneous Vertebroplasty: Incidence, Risk Factors and Clinical Management

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1Pitié-Salpêtrière Hospital, Paris, Ile de France, 2Hôpital de la Pitie-Salpetriere - Service de Neuroradiologie Interventionnelle - Pr. CHIRAS, PARIS, France, 3Hôpital de la Pitie-Salpetriere, PARIS, France, 4Pitié-Salpêtrière Hospital, Paris, France

Purpose
To evaluate the incidence of intracardiac cement embolism during percutaneous vertebroplasty (PV).

Materials and Methods
Single-center retrospective analysis of 1512 consecutive patients (996 females, 516 males; mean age = 68 y) who underwent 1855 PV with PMMA cement for thoracic and/or lumbar vertebral compression fracture (VCF) (tumor lesion: 45.5%, osteoporosis: 33.7%, trauma: 10%, other: 10.8%). A chest imaging (plain X-ray and/or CT-scan) was performed when a venous leakage was suspected by the operator during the procedure. The rate of cement cardiac migration (CCM) was evaluated. Age, sex, operator's experience, lesion type (tumor, osteoporosis, trauma), sub-type of tumor lesions (blastic, osteolytic or mixed) were evaluated as risk factors for CCM. Clinical consequences of CCM were evaluated in post-procedure and at 1-month follow-up.

Results
In 65.4 % post-PV chest imaging was available. Seventy-one patients (4.7%) had CCM during the 1855 procedures. These CCMs were isolated in 14% of the cases and associated with lung
cement embolism in 86% of the cases. The rate of CCM was independent from age, sex, operator's experience, lesion type, tumor lesions' sub-type. Five patients (7%) with CCM had symptoms potentially related to this complication: one cardio-respiratory arrest, that immediately recovered and without any clinical consequence, one pericardial effusion, and 3 cases of transitory dyspnea without further consequence. All these patients had an associated lung cement migration.

Conclusions
CCM during PV with PMMA cement are not exceptional (4.7% the cases) but are asymptomatic in most cases (93%).

KEYWORDS: Cement, Cement Augmentation, Complications

Thursday
1:00PM - 2:38PM
Palais des congres de Montreal, 524

92 - PARALLEL PAPERS: Structural and Volumetric Analysis in the CNS

Purpose
Measurement of posterior fossa volume (PFV) has been proposed to have diagnostic utility and physiologic significance in the Chiari malformation type 1 (CM1), however, this remains debatable in adults. This study evaluated the effects of demographics on PFV and total intracranial volume (TICV) in adult CM1 patients, patients with idiopathic intracranial hypertension (IIH) who may share some imaging features of CM1, and in healthy controls using reproducible methods of MRI-based volumetric assessment.

Materials and Methods
Twenty-eight confirmed CM1 patients, 21 IIH patients, and 113 asymptomatic control subjects underwent brain MR imaging (MRI) including contrast-enhanced 3D GRE T1-weighted imaging. Linear measurements of the posterior fossa (PF) and intracranial (IC) space were obtained, and manual segmentation of the PF and IC was performed to yield PFV and TICV (Figure 1). Intra and inter-observer measurement variability and the utility of using linear measurements to predict PFV and TICV were assessed. The effects of age, gender, race, and BMI on PFV and TICV were evaluated in controls, and differences in these demographic variables were controlled for in comparisons of linear and volumetric measurements between CM1, IIH, and control patients.

Results
Three of the 12 linear measurements were significant predictors of TICV (accounting for 74% of variance), and four predicted PFV (accounting for 54% of variance). Both linear and volumetric
measurements demonstrated good to excellent intra and interobserver reliability, with greater variability for linear dimensions than volumes. Age, race, gender, and BMI each significantly influenced PFV and TICV in controls. White race, male sex, and high BMI correlated significantly with both larger PFV and larger TICV, while older age corresponded with smaller volumes. No significant differences in PFV, TICV, or PFV:TICV ratio were seen between the CM1 group and the control group after controlling for demographics; however, IIH patients were more likely to have smaller PFVs (OR 1.81, p = 0.1) and trended towards having larger TICVs (OR 1.24, p = 0.06). The figure demonstrates two-dimensional tracing and three-dimensional volume renderings of TICV. Similar images were generated for PFV.

Conclusions
Linear measurements of the PF and IC space are not strong predictors of PFV and TICV. Age, race, gender, and BMI have significant effects on intracranial measurements that must be considered, particularly with respect to PFV in CM1. Even when these demographic variables are appropriately accounted for, other similarly presenting diseases may demonstrate small PFVs. Overall, this emphasizes the need for caution in interpreting the significance of differences in intracranial dimensions between various groups.

KEYWORDS: Chiari Malformation Type 1, Idiopathic Intracranial Hypotension, Volumetric Analysis

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O-923
Changes in Total Intracranial Vascular Volume and Dural Sinus Volume following Lumbar Puncture in Patients with Suspected Idiopathic Intracranial Hypertension

A Saindane¹, V Bioussé², N Newman², B Bruce², A Saindane¹, L Albin²
¹Emory University, Atlanta, GA, ²Emory University School of Medicine, Atlanta, GA
Purpose
Intracranial pressure (ICP) is determined by contributions of brain volume, cerebrospinal fluid (CSF) volume, and vascular volume. In conditions of abnormally elevated ICP such as idiopathic intracranial hypertension (IIH), the dural venous sinuses have been demonstrated to be abnormal with stenosis of the distal transverse sinuses. In the setting of low intracranial pressure from a CSF leak, the dural venous sinuses have been shown to increase in size. This pilot study assessed the changes in total intracranial vascular volume and dural venous sinus volume following lumbar puncture (LP) with CSF removal.

Materials and Methods
Six patients with suspected IIH underwent imaging evaluation including contrast-enhanced MR venography at 1.5 T (Siemens Avanto, Erlangen, Germany or GE Signa, Milwaukee, Wisconsin) using a standard head coil. MRV precontrast and postcontrast sequences were obtained in the axial plane with TR of 4-6 ms, TE of 1-2 ms, and flip angle of 22-30 degrees with slice thickness of 0.8-1.4 mm. A subtracted dataset was generated from the precontrast and postcontrast sources images. All patients underwent MRV evaluation both prior to and following LP for opening pressure assessment and CSF removal. Subtracted MRV datasets were segmented manually to determine the total intracranial volume (TICV) inside the cranial vault. This volumetric dataset then was thresholded to yield only enhancing vascular intracranial structures as a measure of total vascular volume (TVV). The superior sagittal, straight, transverse, and sigmoid sinuses then were manually segmented from the TVV dataset to yield dural sinus volume (DSV). Measures of TICV, TVV, and DSV, as well as %TVV/TICV and %DSV/TICV were compared within patients pre- and post-LP.

Results
There were five female and one male patients with median BMI was 44.5. Median OP was 30.0 cm water (range 10 to 54). Four of six patients ultimately met diagnostic criteria for IIH. The median time from the initial MRV to LP was five days (range 0 to 29 days), and the median time from the LP to the MRV was 0 days (four patients with LP on same day as MRV, two others with MRV 51 and 171 days following LP). Pre- and Post-LP volumes are summarized in the table. Only minimal difference in TICV between MRV examinations was noted (0.3%, p=0.218) indicating good reproducibility of the segmentation process. Following LP and CSF removal, TVV increased by 14.0% (p=0.010), as did TVV normalized to TICV (13.3% increase; p=0.007). While on average the DSV increased 10.8% following LP, this did not achieve statistical significance (p=0.166). The mean increase in TVV following LP was 14 cc, while the mean increase in DSV was only 3 cc. The figure demonstrates pre-LP (A) and post-LP (B) appearance of the dural venous sinuses.

Conclusions
Following LP and CSF removal there is a significant increase in intracranial TVV as well as TVV normalized to TICV. The dural venous sinus volume increases in size in some patients following LP but across all patients this was not a significant increase. The overall increase in TVV also is not be accounted for by the dural venous sinuses, indicating that small venous and perhaps arterial and capillary bed increases in vascular volume account for this change post LP and CSF removal.

KEYWORDS: Dural Sinus, Idiopathic Intracranial Hypotension, Lumbar Puncture

<table>
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<tr>
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<th>TICV</th>
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<th>DSV</th>
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<td>Pre-LP</td>
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<td>P</td>
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O-924

Is the foramen magnum line reliable for measuring cerebellar tonsil position? An interobserver study of cerebellar tonsillar tip location using three different imaging landmarks

A Moore\(^1\), D Gomez-Hassan\(^2\), D Quint\(^1\), H Garton\(^1\), C Maher\(^1\), A Srinivasan\(^1\)

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Purpose
The aim of our study was to evaluate the interobserver agreement in assessment of cerebellar tonsil position using three different bony landmarks on magnetic resonance imaging (MRI) (foramen magnum, C1 arch and C2 arch).

Materials and Methods
Our IRB approved, HIPAA-compliant retrospective study consisted of consecutive brain MRIs performed at our institution between January 2010 and December 2012. Exclusion criteria included skull base osseous abnormalities (e.g., basilar invagination/impression, platybasia, Paget's disease, etc.), poor quality sagittal T1-weighted images, significant motion artifacts, and congenital or acquired osseous abnormalities of C1 and C2 vertebrae. Sagittal T1-weighted images in these patients were interpreted by two board certified neuroradiologists (blinded to underlying clinical diagnoses) with measurement of bilateral tonsil position based on lines drawn perpendicular from the tonsillar tip to the: (i) Foramen magnum (FM) line (joining the anterior and posterior margins), (ii) C1 arch line (joining superior cortical margins of the anterior and posterior arches), (iii) C2 line (joining the anterior and posterior margins of the inferior

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endplate). The readers evaluated the entire stack of sagittal images on each scan and measured the tonsil position on the image that showed the most caudal position of a tonsil. Pertinent medical records including surgical reports also were reviewed. Nonparametric Spearman correlation coefficients between the readers were calculated for each of the three techniques. Interobserver agreement between the readers was assessed using Bland-Altman analysis.

Results
A total of 130 cerebellar tonsils on 65 patients (mean age -22 + 13 yrs; 41 females, 24 males) were studied that included 13 patients with Chiari I malformation suspected based on clinical and radiologic features (>5mm tonsillar descent below FM) and 52 without Chiari I malformation. The Spearman correlation coefficients for the three techniques were 0.864, 0.939 and 0.899 respectively for FM, C1 and C2 landmarks. Bland-Altman analysis showed the best interobserver agreement for C1 line (0.25mm bias) and the least for C2 line (3.2 mm bias), implying that the differences in measurements between the two readers were the least when the C1 line was employed.

Conclusions
Our results demonstrate better interobserver agreement in localization of the cerebellar tonsillar tip when osseous landmarks based on C1 vertebra are used compared to the FM line (which is currently widely used). This may be due to better delineation of the bony cortices at C1 compared to the margins of the FM on sagittal T1-weighted images. We plan to expand this study in the future to include a larger sample group and to evaluate the differences in "misclassification" rates of patients with respect to the presence or absence of Chiari I malformations using these three different techniques.

KEYWORDS: Cerebellar Tonsils

(Filename: TCT_O-924_Chiari-pic.jpg)
Surface Expansion of the Hippocampal Dentate Gyrus in Multiple Sclerosis: an In-Vivo Evidence of Neurogenesis?

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¹San Raffaele Scientific Institute, Vita-Salute San Raffaele University, Milan, Italy

Purpose
The subgranular zone of the dentate gyrus (DG) of the hippocampus has long been thought to support neurogenesis in the adult mammalian brain (1, 2). Inflammatory responses within the central nervous system (CNS) have the potential to alter the homeostasis of the staminal niche and enhance neurogenesis within the DG, but the functional significance of adult neurogenesis in CNS pathology is still debated. (3, 4). The purpose of our work was to assess, using magnetic resonance (MR) radial mapping analysis of hippocampal surface, whether there are detectable morphological alterations of the DG in patients with multiple sclerosis (MS).

Materials and Methods
Brain 3D T1-weighted scans were acquired from 115 MS patients [28 relapsing remitting (RR), 34 secondary progressive (SP), 27 primary progressive (PP), and 26 benign (B) MS] and 28 healthy controls (HC)]. Hippocampal segmentation was performed manually according to standardized procedures (5). From contours, radial distances were calculated and between-group vertex analysis performed (independent sample t-test, age adjusted). Percentage difference of average medial distance (AMD) in clusters of significant difference (p<0.05) was calculated. Results are reported for the DG region only.

Results
Compared to HC, all MS phenotypes revealed an increase AMD in correspondence of the DG. The percentage change of AMD and the cluster dimensions (number of vertices) were, for RRMS vs HC: right DG +24.5%, 55; left DG +31.5%, 235; for SPMS vs HC: right DG +24.2%, 18; left DG +20.8%, 234; for PPMS vs HC: right DG +11.5%, 102; left DG +22.2%, 122, and for BMS vs HC: right DG n.s.; left DG +21.2%, 33. Comparisons among MS clinical phenotypes revealed a significant increase in AMD, for the left hippocampus only, in RRMS compared to SPMS (+14.2%, 17).

Conclusions
Surface expansion of the DG of the hippocampi might represent an inflammation-induced alteration of the neurogenic niche in the adult subgranular zone. This seems to be strengthened by the pronounced effect found in the early and most inflammatory phase of the disease. In vivo imaging of neurogenesis could provide a tool for monitoring the effects of new therapeutic strategies, which are emerging in the field of regenerative medicine. This work has been partially supported by a grant from Fondazione Italiana Sclerosi Multipla (FISM2012/R/8).

KEYWORDS: Hippocampus, MR Imaging, Multiple Sclerosis
E Shapiro¹, S Mukherji¹
¹Michigan State University, East Lansing, MI

Purpose

The use of magnetic resonance imaging (MRI) to detect specific cell populations in intact organisms has been supporting major developments in stem cell therapies, immunotherapies and cellular diagnostics. The basic tenet behind MRI-based cell tracking is to incorporate an MRI contrast agent inside cells and then to use imaging to detect their presence against a biological background. Our group has been pioneering the development of novel imaging agents, MRI detection schemes and postprocessing data analysis algorithms for ultrasensitive detection of cells, down to single cell sensitivity. In this work, we describe advances in iron oxide nanoparticles that will facilitate clinical translation of MRI-based cell tracking to humans. Further, we demonstrate the capabilities to use MRI to detect single cells in vivo in rodent brain. Next, we introduce an image processing framework for quantifying cell tracking. Lastly, we describe a way forward for accomplishing in vivo detection of single cells in humans.

Materials and Methods

Clinically viable iron oxide nanoparticles (NPs) for MRI-based cell tracking were fabricated by oil-in-water emulsion using an FDA approved polymer, PLGA, and 10 nm iron oxide nanocrystals. Multiple stem cell differentiation and immune cell functional assays were performed on magnetically labeled cells. Nanoparticle biodegradation was assayed as well. A model of single, dispersed cells in the rat brain was created by intracardiac injection of either magnetically labeled, CFSE labeled mesenchymal stem cells (MSCs) or nonmagnetic cells. Adult rats were anesthetized and 200,000 magnetically labeled MSCs or unlabeled MSCs were injected into the left cardiac ventricle. Animals were imaged at 11.7 T with high resolution gradient echo MRI, followed by pathology to identify green CFSE stained MSCs with red particles. Automated spot detection and quantification was accomplished using similar techniques used for automated vessel detection. However, instead of selecting for snake-like vessel structures, spheres were selected. Spots were quantified from the resulting binary images through cluster thresholds.

Results

Highly magnetic PLGA encapsulated iron oxide NPs can be fabricated, incorporating as much as 84 weight% magnetite. Total particle size is ~ 100 nm. An in vivo biodegradation study revealed that nanoparticles degraded 80% over the course of 12 weeks. Cells can be labeled in culture by simple incubation, with both dose and time dependent labeling kinetics. The capability of magnetically labeled MSCs or neural stem cells to differentiate down multiple lineages, or for magnetically labeled immune cells to release cytokines following stimulation, is uncompromised. Magnetically labeled MSCs appear as punctate, dark spots in high resolution gradient echo MRI in rodent brain following intracardiac delivery. Histology confirms that 70% of dark contrast spots are due to single cells, the remaining 30% are due to either two or three cells. Calculated numbers of cells in the brain were between 1,504 and 7,765, or between 0.8% to 3.9% of the total number of injected cells, depending on threshold.

Conclusions

In regenerative medicine, single cell detection enables a strategy on quantifying the cell transplants based on enumeration of contrast spots in the image. In immunotherapy, single cell detection opens up enormous possibilities for sensitivity, enabling the detection of the first infiltrative cell to enter a tumor and a way to monitor therapy. In cancer diagnostics, single cell
detection capabilities may allow one to image early inflammatory or neoplastic events as a way for early detection of disease. To achieve single cell MRI in humans will require an FDA-approved particle and high field MRI. The particle we describe here has a positive trajectory for potential FDA approval, while the proliferation of high field human MRI systems will enable the high resolution MRI we can achieve on animals, as shown here, to be performed on humans.

KEYWORDS: Molecular Imaging, MR Imaging, Stem Cell

Detection of magnetically labeled single cells in the rat. Purple circles show a single spot in all three orthogonal views, confirming the susceptibility effects induced by the label, spherical at this acquired resolution. Inset is a single MPIO, MPIOs in orange, nuclei in blue.

What Determines Workup of Incidental Thyroid Nodules Reported on CT and MRI? Review of Outcomes in 375 Patients

T Tanpitukpongse¹, A Grady², K Choudhury², J Sosa², J Hoang²
Purpose
Incidental thyroid nodules (ITN) commonly are reported on CT and MRI scans, but not all receive workup. The purpose of this study is to determine the proportion of reported ITNs on CT or MRI that receive workup and the factors that influence clinicians' deciding to evaluate them further. A secondary aim is to estimate how adoption of CT/MRI guidelines would affect the number of ITN reported.

Materials and Methods
This is a retrospective study of 401 patients with ITNs reported on CT or MRI studies between January and December 2011. Patients were identified by searching CT and MRI reports for the phrase "thyroid nodule". Patients were excluded if they had prior evaluation of their thyroid or history of thyroid cancer. Medical records and radiology reports were reviewed for 1) workup, 2) characteristics of the patient, ITN, and referring clinician, and 3) radiologists' reporting styles. Analyses were performed to identify factors associated with workup. For the secondary aim, a 3-tiered system was applied retrospectively to ITNs to estimate how application of these guidelines would change the number of nodules reported. The proposed 3-tiered system criteria are based on suspicious imaging features, patient age, and nodule size (1, 2); that is, indeterminate nodules <15 mm in patients <35 years do not meet criteria for reporting (3TS-).

Results
Three hundred seventy-five patients met inclusion criteria, and 30 received workup (Table 1). Twenty-four patients underwent an ultrasound, 21 FNA, and two surgery. There were two cases of thyroid malignancy: one anaplastic and one papillary cancer. One hundred thirty-eight (37%) ITNs were reported in the impression of the report, of which 19% received workup. The odds ratio (OR) for workup of a nodule in the impression section of the report was 14 (95%CI 5-40), which was higher than that of nodules recommended for ultrasound (OR 9, 95%CI 4-19). On multivariate analysis, the only two factors associated with workup were patient age and nodule size (p≤0.01, Table 1): younger patients and larger nodules were more likely to undergo additional workup. When the 3-tiered system was applied retrospectively, the result was that there would have been a reduction in ITNs reported in the impression section of the report: 57 reported were 3TS- and 25 mentioned only in the body were 3-tiered system positive.

Conclusions
Less than one in five ITNs reported in the impression section of CT/MRI radiology reports receive additional workup, which raises the question of whether the nodules reported by radiologists are of significance to clinicians. The factors associated with a greater likelihood of workup are younger patient age and larger nodule size. These are already criteria incorporated into a 3-tiered system. Such guidelines have the potential to improve consistency of radiology reports and reduce the number of nodules reported.

KEYWORDS: Thyroid

| Table 1. Characteristics of Incidental Thyroid Nodules That Receive Workup |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                | Ultrasound | FNA | Surgery | Any Workup | All Nodules | Univariate p-value | Multivariate p-value |
| N               | 24         | 21  | 2       | 30          | 375         |                  |                  |

1Duke University Medical Center, Chapel Hill, NC, 2Duke University Medical Center, Durham, NC
<table>
<thead>
<tr>
<th>Table 1. Characteristics of Incidental Thyroid Nodules That Receive Workup</th>
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<tr>
<td><strong>Ultrasound</strong></td>
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<tr>
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<td><strong>Nodule Characteristics</strong></td>
</tr>
<tr>
<td>Mean size in mm (SD)</td>
</tr>
<tr>
<td>Size (N)(%)&lt;b&gt;</td>
</tr>
<tr>
<td>&lt;10mm, subcentimeter</td>
</tr>
<tr>
<td>10-14 mm</td>
</tr>
<tr>
<td>15-19 mm</td>
</tr>
<tr>
<td>&gt; 20 mm</td>
</tr>
<tr>
<td><strong>Morphology (N)(%)</strong></td>
</tr>
<tr>
<td>Calcifications</td>
</tr>
<tr>
<td>Cystic</td>
</tr>
<tr>
<td>Hypervascular</td>
</tr>
<tr>
<td><strong>Study Indication (%)</strong></td>
</tr>
<tr>
<td>Malignancy</td>
</tr>
<tr>
<td>Vascular</td>
</tr>
<tr>
<td>Trauma</td>
</tr>
<tr>
<td>Infection / Inflammation</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td><strong>Radiology Division (%)</strong></td>
</tr>
<tr>
<td>Chest imaging</td>
</tr>
<tr>
<td>Neuroradiology</td>
</tr>
<tr>
<td>Body imaging</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td><strong>Reporting style (%)</strong></td>
</tr>
</tbody>
</table>
Table 1. Characteristics of Incidental Thyroid Nodules That Receive Workup

<table>
<thead>
<tr>
<th>Reported in impression (N)(%)</th>
<th>Ultrasound</th>
<th>FNA</th>
<th>Surgery</th>
<th>Any Workup</th>
<th>All Nodules</th>
<th>Univariat e p-value&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Multivariat e p-value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>US recommended (N)(%)</td>
<td>16 (67)</td>
<td>11 (52)</td>
<td>1 (50)</td>
<td>18 (60)</td>
<td>69 (19)</td>
<td>&lt;0.0001</td>
<td>0.09</td>
</tr>
<tr>
<td>Workup Results by Bethesda Cytopathology Categories (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I - Nondiagnostic / Unsatisfactory</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II - Benign</td>
<td>16 (77)</td>
<td>16 (77)</td>
<td>16 (77)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III - Atypia</td>
<td>2 (10)</td>
<td>2 (10)</td>
<td>2 (10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV - Follicular neoplasm</td>
<td>1 (5)</td>
<td>1 (5)</td>
<td>1 (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V - Suspicious for malignancy</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VI - Malignant</td>
<td>2 (10)</td>
<td>2 (10)</td>
<td>2 (10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> p-values for factors associated with any workup of ITN.

<sup>b</sup> Not all patients had sizes reported in the radiology report. The nodules were measured on the CT/MRI images for cases that had workup with missing nodule sizes in order to categorize nodules by the 3-tiered system.

O-929

Structural Brain Changes Following Long-term Bedrest

D Roberts<sup>1</sup>, T Brown<sup>1</sup>, K Garrett<sup>1</sup>, J Helpern<sup>1</sup>, A Tabesh<sup>1</sup>

<sup>1</sup>Medical University of South Carolina, Charleston, SC

Purpose

Following long term missions aboard the International Space Station, ophthalmic changes, including papilledema, and increased intracranial pressure (ICP) have been documented in
NASA astronauts (Mader et al., 2011). It has been hypothesized that these changes may result from the loss of gravitational hydrostatic pressure gradients and large cephalad fluid shifts. Altered gravitational pressure gradients also occur in chronically ill patients who are confined to long term bedrest. The consequences of fluid redistribution on the brain are poorly understood but may include alterations in brain structure, cerebral blood vessels, and brain function. In this study, we used long term bedrest as an analog for spaceflight to study any potential structural changes of the human brain.

Materials and Methods
Eight normal subjects underwent 60 days of bedrest at the NASA Flight Analogs Facility at the University of Texas Medical Branch. The subjects were positioned in 6º head down tilt and maintained on a strict diet. T1-weighted 3D SPGR MR images of the brain were acquired before undergoing bedrest (baseline) and on day 60 (d60) of bedrest. We applied voxel-based morphometry (VBM, VBM8 toolbox, available at http://dbm.neuro.uni-jena.de/vbm/) to the baseline and d60 MR image pairs to map longitudinal changes in local tissue volume. We assessed these changes in both gray and white matter. We also evaluated the global brain shift upwards and posteriorly following bedrest. This was accomplished by quantifying the brain shift along the direction perpendicular to the plane passing through the anterior commissure (AC) and interpeducular fossa(IPF) [Figure 1(a)].

Results
Group analysis showed a trend toward global brain tissue shift upwards and posteriorly following bedrest (p < 0.06) [Figure 1(a)]. Voxel-based morphometry indicated that compared to baseline, frontal lobe tissue expanded at d60 while the sulci along the vertex became more crowded. Figure 1(b, c) show the t-statistic map of the difference between the d60 and baseline tissue volume for all eight subjects, after mapping to a common MRI template and smoothing. There is a consistent contraction (red) of the cerebrospinal fluid (CSF) spaces along the vertex with expansion (blue) of brain tissue and surrounding sulcal CSF in the anterior frontal lobes.

Conclusions
Changes in body position, and resultant changes in gravitational gradients, have been found to impact brain physiology and function. Moving from an upright to supine position alters venous outflow, with collapse of the internal jugular veins and redirection of venous return through the vertebral venous plexuses. Clinically, altered venous outflow has been implicated in disease processes such as pseudotumor cerebri and multiple sclerosis. The consequences of long term maintenance of a supine or head-down body position is unknown, and therefore in this study, we investigated associated changes in brain structure. We use this model as an analog for spaceflight and hypothesize that our observed structural alterations may lead to changes in CSF flow dynamics and compression of the dural venous sinuses along the vertex. This in turn may contribute to venous outflow obstruction and the spectrum of intra-orbital and intracranial findings described in astronauts. We have planned future studies to include vascular imaging in the astronaut population. These findings may be applicable to long term bedridden patients as well.

KEYWORDS: Brain Volume, Volumetric Analysis, Voxel-Based Morphometry
Sex modulates the effects of substance-dependence on neuroanatomical volumes

M Regner¹, M Dalwani¹, J Sakai¹, J Honce¹, Y Dorothy¹, R Perry¹, J Tanabe¹
¹University of Colorado, Aurora, CO

Purpose
The natural history of substance-dependence is known to differ between men and women (4). While structural neuroimaging studies have demonstrated volumetric differences between healthy control subjects and substance-dependent individuals (SDI) in numerous brain regions, the effect of sex on these differences is poorly understood. Few studies that have investigated these interactions provide conclusions mitigated by small sample sizes, confounding population characteristics, or experimental design (1,2,5-7). We investigated the sex and group effects of substance-dependence on cortical gray matter volumes (GMV).

Materials and Methods
One hundred twenty-seven age- and sex-matched participants (28F/40M controls, 28F/31M SDI) were scanned on a 3 T MR system. Substance-dependent individuals met DSM-IV criteria for lifetime dependence on psychostimulants but were abstinent an average of 13.5 months. T1-weighted SPGR-IR images were acquired, segmented using SPM8 with the VBM8 toolbox, and registered using Diffeomorphic Anatomical Registration Through Exponentiated Lie Algebra (DARTEL). Main effects of group, sex, and group by sex interactions were analyzed over the whole brain using ANCOVA, adjusting for age and intracranial volume by modulation (SPM8). Family-wise cluster-based corrections voxel-wise (p<0.001) for multiple comparisons (p<0.05) were used. ANCOVA on parahippocampal gyrus (PHG), medial frontal gyrus (MedFG), anterior cingulate gyrus (ACG), insula, and orbitofrontal cortex (OFC) region of interest (ROI) volumes was performed based on a priori hypotheses.

Results
There were main effects of sex on GMV, with women showing significantly more GMV than
men in the bilateral frontal-temporal lobes, consistent with previous literature (3). Main effects of group on GMV were driven primarily by GMV differences observed between female controls and female SDI. Compared to female controls, female SDI had significantly less GMV in bilateral OFC, MedFG, insula, ACG, medial temporal lobe (including PHG), ventral striatum, cerebellar vermis, and superior temporal gyrus (Figure). There were no significant differences in GMV in male controls versus male SDI. A significant group by sex interaction was contained entirely within the effect of group within females. Whole brain results were corroborated by ROI analyses (box plots).

Conclusions
In this largest sample size to date investigating the effects of abstinent substance-dependence on neuroanatomical volumes, significant differences in frontal, limbic, and cerebellar regional volumes were found between controls versus SDI, female controls versus female SDI, and sex by group interactions. These findings may elucidate mechanisms underlying the differences in the natural history of substance dependence in men compared to women. Our results illustrate the need for sufficiently powered studies to control for sex effects in brain morphometry studies.

KEYWORDS: Psychiatry, Sex Differences, Voxel-Based Morphometry
Female Controls > Female SDI

**Insula**

$p = 0.001$

Voxels (10^3)

**PHG**

Voxels (10^3)
Purpose
Myelopathy of the cervical cord is a common complication related to degenerative disk disease. Cervical spondylotic myelopathy (CSM) is more likely to occur in patients with developmentally narrow spinal canal. Cord signal changes in patients with CSM are variable and can be associated with abnormal cord enhancement. The imaging changes on T2-weighted images can be focal or segmental (more than one vertebral level), with or without intramedullary contrast enhancement. Patients with segmental disease or cord enhancement typically have a worse prognosis. The purpose of this study is to evaluate the canal diameter and compression ratio in patients with enhancing versus nonenhancing cord signal changes as well as in patients with segmental versus focal disease.

Materials and Methods
We retrospectively reviewed 653 patients with CSM who had undergone magnetic resonance (MR) imaging between January 2008 and December 2012. Common indication for MR imaging included: pain, sensory changes and motor dysfunction. We identified 48 patients with cord signal changes. The imaging features on T1, T2, cord enhancement, canal diameter and compression ratio were evaluated. Independent samples t-test was performed for statistical analysis.

Results
Intramedullary enhancement was seen in 14 patients, whereas cord signal changes without enhancement was seen in 34 patients. Focal intramedullary signal changes were more common in patients with nonenhancing CSM (32 versus 7). Patients with intramedullary enhancement typically had segmental disease with involvement of more than one vertebral level (7 versus 2). The average anteroposterior (AP) cord diameter in patients with enhancing CSM was 5.3 mm with a compression ratio of 37% in comparison to patients with nonenhancing CSM whose AP cord diameter was 4.8 mm with similar compression ratio of 37% (p value 0.77). The compression ratio was minimally larger in patients with segmental disease in comparison to patients with focal disease (39% versus 37%; p value 0.77). The average canal diameter was similar between the two groups measuring 10 mm (segmental versus focal and enhancing versus nonenhancing; p value 0.93).

Conclusions
Canal diameter and compression ratio are not significantly different in CSM patients with cord enhancement and segmental disease in comparison to CSM patients with no intramedullary enhancement and focal disease. This indicates that other factors might be responsible for the development of cord enhancement and segmental cord changes in CSM patients.
The occipital emissary vein: part 1, a radio-anatomical study

A Piveteau\textsuperscript{1}, P Gailloud\textsuperscript{2}, D San Millan\textsuperscript{1}
\textsuperscript{1}Hôpital de Sion, Réseau Santé Valais, Sion, Switzerland, \textsuperscript{2}The Johns Hopkins Hospital, Baltimore, MD

Purpose
Emissary veins of the base of the skull and posterior fossa play an important role in directing cerebral venous blood towards the cervical venous outflow pathways. The occipital emissary vein (OEV) has received little attention in the past anatomical and clinical literature. It connects the torcular herophilii to the suboccipital veins of the external vertebral venous system. The purpose of the present study was to determine its prevalence and evaluate its potential functional and clinical implications.

Materials and Methods
1.5 T magnetic resonance imaging (MRI) studies including gadolinium-3DT1-SPGR from 100 patients (64\% females, average 56 years old) were analyzed retrospectively. Patients with venous thrombosis, intracranial arteriovenous shunts or posterior fossa surgery were excluded. The presence of an OEV was recorded. Maximum diameters of the OEV were measured within its osseous segment in the occipital squama and in front of its extracranial orifice. The presence of the osseous canal of the OEV was sought for on CT (64MDCT) when available.

Results
An OEV was found in 32\% of the patients. Two OEVs were found in two occasions and a triple OEV was encountered once. The average diameter of the OEV was 1.6 mm (range 0.5-3 mm) both in its osseous segment and extracranially. The exit point of the OEV always was located between the external occipital protuberance and the foramen magnum. Seventy-seven percent of patients also underwent CT. Five patients had an OEV canal on CT but not visible OEV on MRI.

Conclusions
An OEV was observed in 32\% of the cases, a much higher incidence than previously reported in the anatomical literature (up to 14\%). Because it is located proximally to the transverse and sigmoid sinuses it may provide an outflow pathway in case of stenosis or occlusion of the transverse/sigmoid sinuses (see The occipital emissary vein, part 2).

KEYWORDS: Venous Anatomy, Venous Drainage
Purpose
Parallel imaging techniques, such as generalized autocalibrating partially parallel acquisitions (GRAPPA), utilize spatial information inherent in phased array coils to shorten MRI acquisition times by under-sampling of k-space. These techniques are compatible with most pulse sequences, and commonly are used to accelerate imaging by a factor of 2 or more using 8 - 32 channel head coils. Acceleration factors (AF) above 2-3 are limited by decreasing signal-to-noise ratios (SNR). However, SNR losses can be partially offset with higher order coil arrays, high field strength systems, and advantageous pulse sequences, thereby maintaining image quality at higher AF. Our purpose was to develop an accelerated five-minute brain magnetic resonance imaging (MRI) protocol by optimizing routine clinical sequences for use with a 32-channel or 64-channel coil at 3 T, and to assess image quality in normal volunteers.

Materials and Methods
Our institutional review board approved this study. Brain MRIs of healthy volunteers were performed on a 3 T scanner using both a 32-channel head coil and a 64-channel head and neck coil. Existing routine clinical sequences for the 32-channel coil at 3 T were optimized and further accelerated using GRAPPA parallel imaging AF ranging from 3 to 4. Sequences performed included: Scout, T1 sagittal, FLAIR, T2, DWI and Susceptibility.

Results
Total image acquisition time for the rapid protocol was four minutes, 52 seconds, compared with nine minutes, 50 seconds for the standard clinical protocol. Individual sequence acquisition times for the rapid versus standard protocols were: Scout (14 versus 46 s), T1 Sag (53 versus 172 s), DWI (55 versus 58 s), FLAIR (100 versus 128 s), T2 (64 versus 70 s), and Susceptibility (6 versus 124 s). Image quality for the rapid protocol was comparable to the standard clinical protocol for both 32-channel and 64-channel coils.

Conclusions
An accelerated brain MRI protocol requiring less than 5 minutes is feasible using parallel imaging, advantageous pulse sequences, and either a 32- or 64-channel coil at 3 T.

KEYWORDS: MR Imaging Brain, Parallel Imaging, Phased-Array Head Coils
The occipital emissary vein: part 2, a marker for pseudotumor cerebri?

A Piveteau¹, P Gailloud², D San Millan¹

¹Hôpital de Sion, Réseau Santé Valais, Sion, Switzerland, ²The Johns Hopkins Hospital, Baltimore, MD
Purpose
Transverse sinus stenosis is increasingly recognized as a cause of pseudotumor cerebri. Transverse sinus stenosis may be primary (post-thrombosis or large arachnoid granulations) or secondary to increased intracranial CSF-pressure, but in both situations may induce increased venous pressure resulting in venous pseudotumor cerebri (VPTC). The occipital emissary vein (OEV) connects the torcular herophilii with the suboccipital veins of the external vertebral plexus and, therefore, represents a potential collateral pathway in VPTC.

Materials and Methods
The presence of an OEV was evaluated in 42 patients with documented VPTC underwent 320-multidectector subtracted venography (320MDCTV). Maximum diameters of the OEV were measured within its osseous segment in the occipital squama and in front of its extracranial orifice. 25 patients underwent transverse sinus stenting after documented significant transstenotic pressure gradient. Of these, 15 had follow-up 320MDCTV. Post-stenting OEV diameters were recorded in this subgroup of stented patients.

Results
An OEV was found in 60% of the patients. Average maximum diameters of the OEV were 2.4mm (range 1-7mm) at the osseous segment and 3.4mm (range 1.8-10mm) extracranially. In the15 patients undergoing stenting, average OEV intraosseous and extracranial diameters were 2.2 and 3.2 respectively prior to stenting and 1.8 and 2.6 after stenting.

Conclusions
An OEV is frequently encountered in patients with VPTC, with an incidence of 60% compared to 32% in the normal population*. Additionally, the diameter of the OEV in patients with VPTC is larger than in patients without VPTC*, further suggesting that the OEV is recruited as a collateral venous pathway in cases of significant transverse sinus stenosis. Venous stenting results in a diameter reduction the OEV in keeping with the normalization of the intracranial venous pressure by the stenting procedure. * OEV is present in 32% of normal patients and average maximum diameter is 1.6mm (range 0.5-3mm), see The occipital emissary vein, Part 1).

KEYWORDS: Venous Anatomy, Venous Sinus Stenting, Venous Stenosis

Thursday
3:00PM - 4:30PM
Palais des congres de Montreal, 517bc

93 - SNIS PROGRAMMING: ENDOVASCULAR MANAGEMENT OF ACUTE STROKE AND STROKE PROPHYLAXIS
O-935
3:00PM - 3:30PM

Carotid Angioplasty and Stenting: Where We Are and Where We Are Going?

Heck, D.
The Johns Hopkins Hospital
Baltimore, MD

Abstract/Presentation Summary
This presentation will cover the imaging evaluation of carotid artery disease and the data
supporting the use of carotid stenting for primary prevention and secondary prevention of stroke. Trials comparing carotid stenting and carotid endarterectomy will be summarized. Future areas of research will be discussed, and the rationale and design of the upcoming CREST 2 trial will be presented.

O-936

New Insights from the IMS Trials: Hints at Future Directions in Acute Stroke Revascularization Trials

Tomsick, T.
University Hospital/University of Cincinnati College of Medicine
Cincinnati, OH

O-937

The Angio Suite as the Stroke Resuscitation/Management Unit: Possible Future of Acute Stroke Management

Strother, C.
University of Wisconsin
Madison, WI

Abstract/Presentation Summary
Paralleling the rapid development of the tools and techniques used in endovascular therapy has been a simultaneous dramatic enhancement in the imaging capabilities of x-ray angiographic equipment. The 2D and 3D images of the intracranial and spinal vasculature now obtainable have spatial and temporal resolution that is superior to ones obtained with any other technique. The high resolution CT like images obtained with new flat detectors allow imaging of implantable devices, vasculature and brain parenchyma with image quality that is, in many instances, superior to that of multi-detector CT; this is achievable with radiation exposures significantly lower than that used with conventional CT. Measurement of physiologic parameters i.e. perfusion in the angiographic suite is now a reality. New developments in 4D DSA and Omni-plane fluoroscopy will further enhance the capabilities of the angiographic suite. The modern angiographic suite now offers an environment where it is feasible for some patients with acute ischemic and hemorrhagic strokes to go from arrival at the hospital to the angiographic suite for diagnosis, triage and, if appropriate, treatment. In this presentation I will discuss and illustrate these capabilities. A proposed workflow showing the feasibility of a "one stop shop" approach to the management of patients with acute strokes will be described and illustrated. In theory, such an approach, by saving time and improving patient selection, should result in improved outcomes.

Thursday
3:00PM - 4:30PM
Palais des congres de Montreal, 517a
**95 - ASSR PROGRAMMING: CONTROVERSIES IN SPINE PRECEDURES**

**95-1**

Vertebral Augmentation: Myths and Reality

Ortiz, A.
Winthrop University Hospital
Mineola, NY

**O-941**

Controversies in Spine Intervention

Barr, J.
California Center for Neurointerventional Surgery
La Jolla, CA

**O-942**

Epidural Injections: To Be or Not To Be

Brook, A.
Montefiore Medical Center
Bronx, NY

**O-943**

Augmentation for Malignant Spinal Lesions: Is there A Role for RF Ablation?

Georgy, B.
North County Radiology

Abstract/Presentation Summary
The role of vertebral augmentation for malignant compression fractures has been described extensively in the literature. Cement augmentation helps pain control and stabilization of the vertebral bodies. Recently, radio-frequency ablation of the tumor tissue has been described for tumor debulking before cement augmentation. This presentation outlines the evolving role of this technique and the potential benefits. Early clinical results and potential benefits in the treatment algorithm of malignant compression fractures will be also discussed.
**Discussion**

Thursday
3:00PM - 4:30PM
Palais des congres de Montreal, 520

**96 - GENERAL PROGRAMMING: FILM PANEL, STUMP THE STARS**

Thursday
3:00PM - 4:30PM
Palais des congres de Montreal, 524

**97 - PARALLEL PAPERS: Tumor - New Techniques and fMRI**

O-946 3:00PM - 3:07PM

**Simultaneous Measurement of ADC Probability Density Functions and Functional Connectivity in Brain Tumor Patients Using DREAM-MRI**

B Ellingson¹, T Cloughesy¹, W Pope¹

¹University of California Los Angeles, Los Angeles, CA

**Purpose**
Diffusion magnetic resonance imaging (MRI) is an important, yet controversial quantitative cancer imaging biomarker. The apparent diffusion coefficient (ADC), or magnitude of random water movement, within tumors can be used to estimate tumor cell density, allowing clinicians to monitor and predict treatment response. Apparent diffusion coefficient maps acquired clinically are only an estimate of ADC within the tissue, and therefore are prone to measurement and physiologic noise. Additionally, resting-state functional MRI (fMRI) information on patients with brain tumors typically is not acquired, mostly due to the additional scan time requirements of this sequence. The purpose of the current study was to develop and test a new MR sequence to simultaneously acquire estimates of the ADC probability density function (ADC PDF) as well as estimate functional connectivity in patients with primary brain tumors.

**Materials and Methods**
We have developed a new technique to quickly estimate ADC PDFs for each image voxel using a "diffusion reproducibility evaluation and measurement" (DREAM) MR sequence. Additionally, the nondiffusion-weighted (reference) images collected simultaneously can be used as resting-state fMRI data to measure functional connectivity, an unbiased parameter thought to reflect neurological integrity. We tested this sequence in a variety of phantoms, 20 healthy control participants, and 40 patients with primary gliomas.

**Results**
Phantom studies suggest an optimal b-value of 500 s/mm2 for minimal variance in ADC.
Apparent diffusion coefficient variability changed linearly with choice of repetition time, but not number of acquisitions, direction, or tissue T1. Test-retest reliability demonstrated good concordance between serial measurements in both phantoms and healthy tissues. We observed complex ADC PDF characteristics in biologically heterogeneous tumors, suggesting ADC PDFs may be a novel method of quantifying tumor heterogeneity. These complex ADC PDFs were independent of tissue perfusion and diffusion direction, but occurred most frequently in metabolically active tumor as measured using 18F-FDG PET. Apparent diffusion coefficient coefficient of variation (ADC CV) measurements of less than 5% appeared to isolate and label regions of nonenhancing tumor and predict future enhancement independent of FLAIR, T2, or average ADC maps. Functional diffusion mapping (fDMs) using voxel-wise changes in ADC PDFs could be used to spatially visualize and statistically quantify treatment response. Resting-state fMRI networks extracted from DREAM-MRI data in volunteers and patients were anatomically consistent with known functional networks, including in the default mode network. Conclusions DREAM-MRI is a potentially valuable technique for simultaneously characterizing brain tumor microstructure and neurological integrity by estimating the voxel-wise ADC PDF, exploring new image contrasts including ADC CV, statistically comparing diffusion measurements over time, and simultaneously estimating functional connectivity from resting-state fMRI signals.

KEYWORDS: Biomarkers, Brain Neoplasms, MR Diffusion
Diffusion Imaging Genomic Mapping Identifies Genomic Targets Involved in Invasion and Poor Prognosis

G Thomas¹, J Wang², Z Mahmood¹, M ElBanan¹, P Zinn¹, R Colen¹
¹MD Anderson Cancer Center, Houston, TX, ²The University of Texas MD Anderson Cancer Center, Houston, TX

Purpose
To create an imaging genomic map, linking MR imaging traits with gene and miRNA expression profiles, in GBM patients to determine genomic correlates of a MR diffusion radiophenotype to possibly find new genomic targets for GBM treatment. Decreases in diffusion in tumors, specifically GBM, is associated with increase in cellular density and higher nuclear to cytoplasm (N:C) ratio. Here, we present the first study examining in a quantitative way diffusion imaging genomics in GBM to determine novel and targetable genomic biomarkers in GBM.

Materials and Methods
We identified 60 treatment-naive GBM patients from The Cancer Genome Atlas (TCGA) who had both gene-and miRNA expression profiles and pretreatment MR-neuroimaging specifically ADC maps. Image segmentation analysis was done in Slicer 3.6 (slicer.org) using segmentation module, where regions of FLAIR hyperintensity, contrast enhancement, and necrosis were segmented to obtain accurate tumor volumetric data. Diffusion was analyzed and patients were grouped into those with restricted diffusion and facilitated diffusion (those with mixed diffusion were excluded). Biostatistical image-genomic analysis was performed for gene and miRNA sets in restricted versus facilitated diffusion group. Comparative Marker Selection (Broad Institute) identified preferentially up-regulated genomic events in the restricted versus facilitated groups. All the genomic data also were analyzed to determine the most upregulated mRNAs/miRNAs using ingenuity pathway analysis (IPA).

Results
IPA identified molecular networks, as well as canonical and functional pathways highly associated with cancer and invasion in those patients with low ADC values (areas of restricted diffusion).

Conclusions
The diffusion radiophenotype identified genes and miRNAs and corresponding molecular networks that were highly associated with tumor invasion. By these means we were able to identify possible key genes and miRNAs involved in the latter regulation. The uncovered genes and miRNAs represent new insight into tumors with restricted diffusion seen on MRI. The discovery of imaging biomarkers reflecting specific genomic compositions associated with presence of restricted diffusion are clinically relevant as they can determine tumor aggressiveness/growth. Differences in the genomic composition of GBMs with restricted versus facilitated diffusion provide insight into possible genomic- based therapeutics that target more aggressive tumors with restricted diffusion.

KEYWORDS: Diffusion MR Imaging, GBM, Genomic Mapping
Dynamic Susceptibility Weighted Perfusion MR Imaging Metrics are Predictive of Overall Survival in Patients with Recurrent Primary Central Nervous System Lymphoma

R. Barajas¹, S. Cha¹, M. Mabray¹, J. Rubenstein¹, F. Valles¹
¹University of California San Francisco, San Francisco, CA

Purpose
Primary central nervous system lymphoma (PCNSL), an aggressive primary brain neoplasm of immunocompetent patients is occurring with a rising incidence. Morphologic magnetic resonance imaging (MRI) characteristics have not proven to be clinically prognostic. We previously have demonstrated that baseline pretherapeutic dynamic susceptibility weighted (DSC) perfusion MR imaging metrics quantified at the time of initial diagnosis are prognostic of progression free and overall survival (OS). Given the variable response to therapy and clinical outcomes in patients with recurrent PCNSL, we investigated if DSC MR imaging-derived relative cerebral blood volume (rCBV), peak height (rPH), and percentage of signal intensity recovery (rPSR) were prognostic of clinical outcome.

Materials and Methods
Thirty-two patients treated at our institution between June 2001 and 2013 were included in this study on the basis of the following criteria: histopathologic diagnosis of B-cell PCNSL, negative HIV status, and absence of disease outside the central nervous system (CNS). All patients had a pathologic diagnosis of large B-cell CNS lymphoma and demonstrated full resolution of enhancing disease following high dose methotrexate-based chemotherapy treatment as described previously. All 32 patients developed clinical and imaging evidence of recurrent PCNSL. Of this cohort, 11 patients underwent DSC MRI prior to re-initiation of high dose methotrexate therapy for recurrence of disease. Standard of care morphologic MR images (T2, FLAIR, and T1 Postcontrast) were obtained in addition to DSC perfusion imaging (TR/TE 1250/54; Flip Angle 35°) on a 1.5 T clinical scanner. Imaging data were transferred to a GE advantage workstation for processing (GE Functool 4.4). Regions of interest (ROIs) were drawn about the enhancing lesion allowing for the calculation of mean, minimum, and maximum rCBV, rPH, rPSR values and enhancing disease volume as described previously. Dichotomous high and low DSC imaging metric groups were stratified based on receiver operating curve (ROC) analysis. Overall survival was defined from the imaging diagnosis of recurrent disease until death or loss to follow up. Survival analysis was performed by using log-rank test. A P-value <0.05 was considered to indicate statistical significance.

Results
The mean OS time for the entire cohort following development of recurrent disease was 17.7 ± 26.9 months. Patients were stratified into low and high DSC imaging groups for each perfusion metric (low group = CBVmean <1.0; CBVmin <0.6; CBVmax < 1.6; rPH <1.5, and rPSR <1.0). Karnofsky Performance Score and time to disease recurrence from initial diagnosis of PCNSL was not observed to be statistically different when stratified between groups (P> 0.05). Volume of recurrent disease burden also was not significantly different between the low and high groups (1312 m³ vs 857 m³; P= 0.29). Six patients stratified into the low CBVmean and CBVmax groups were found to have a significantly increased risk of death (Figure 1). Multivariate
analysis demonstrated enhancing disease volume did not influence overall survival (P> 0.05). rCBVmin, rPH, and rPSR values were not observed to significantly risk stratify patients for death at time of recurrent PCNSL diagnosis (Relative Risk< 2.97; P> 0.19).

Conclusions
This preliminary study suggests that DSC perfusion MR imaging obtained prior to chemotherapy for recurrent PCNSL may be used as a prognostic biomarker of survival. Specifically, mean and maximum CBV metrics may identify patients at risk for adverse prognosis. If the findings of this study are supported in a larger patient cohort then the use of DSC perfusion MR imaging as a possible means of risk stratification prior to initiation of high dose methotrexate-based chemotherapy for recurrent PCNSL would be prudent. The implementation of this prognostic noninvasive imaging biomarker could prove to alter the clinical treatment strategy. The validation of this preliminary finding is currently underway in a larger cohort of patients with recurrent PCNSL.

KEYWORDS: Dynamic Susceptibility Contrast-Enhanced, Lymphoma, Primary CNS Neoplasms

![Figure 1: Patient survival outcome as a function of CBV metric stratification into low and high groups. Kaplan Meier analysis of overall survival into the low rCBVmean group (red line; left, cutoff value= 1.0) and rCBVmax (right, cutoff value= 1.6) with mean survival of 17.6 months; and the high rCBV groups (green line) with a mean survival of 26.8 months was found to be significantly different (P= 0.037). rCBVmin did not demonstrate a statistically significant overall survival benefit.](TCT_O-949_Figure1use.jpg)

**O-950**

**A Comparative Study of DCE-derived Permeability Metrics Obtained Using Different Software Platforms in Intracranial Neoplasms**

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Purpose
The implementation of image-processing software to dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) data allows for acquisition of quantitative metrics that reflect
tissue microvascular physiology. Variability in data acquisition, post-processing, and analysis methods can limit the accuracy and reproducibility of these studies. It is known that differences in postprocessing software can influence measured values, however the actual magnitude of variability in brain tumors is unclear. We sought to investigate the effect of software platforms that utilize different postprocessing algorithms on the calculation of quantitative values in patients with intracranial neoplasms.

Materials and Methods
Twenty patients with intracranial neoplasms (12 glioblastoma multiforme and 8 intracranial metastases) who had received DCE-MRI imaging protocol were retrospectively selected. The same raw DCE-MRI brain tumor data were analyzed using two different software: CADvue, which utilizes the extended-Tofts pharmacokinetic model and TOPPCAT, which utilizes the Patlak model. In addition, CADvue uses an institutionally derived arterial-input function (AIF) to generate one set of DCE parametric maps, while TOPPCAT uses both the superior sagittal sinus (SSS) and an arterial source to generate two sets of parametric maps, one for each vascular input function (VIF). Regions of interest (ROIs) were placed manually over enhancing regions of tumor on traditional T1 postcontrast images and coregistered to DCE-MRI data. Lesion ROI's were used to extract permeability metrics on a voxel-wise basis. Statistical correlation analysis was performed voxel-by-voxel on the transfer coefficient (Ktrans) and fractional blood plasma volume (vp) values obtained from CADvue and TOPPCAT.

Results
There was no statistically significant correlation between CADvue and SSS VIF-derived TOPPCAT Ktrans values (r= 0.084, p=0.155). Weak correlation was found between CADvue and arterial VIF-derived TOPPCAT Ktrans (r= 0.155, p=0.0258). There was moderate correlation between the two software for vp, particularly between CADvue and arterial VIF-derived TOPPCAT vp (r=0.425, p<0.01) but also between CADvue and SSS VIF-derived TOPPCAT vp (r=0.326, p<0.01). The strongest correlation was found between the TOPPCAT SSS and arterial-derived VIF data sets for both Ktrans (r=0.57, p<0.01) and vp (r=0.689, p<0.01).

Conclusions
Using identical brain tumor source data, we found inconsistencies in quantitative DCE-MRI pharmacokinetic parameters between different software platforms and analysis methods. We found variable correlation of vp between TOPPCAT and CADvue platforms. Ktrans showed either weak or no statistically significant correlation, depending on the VIF selected for analysis. However within TOPPCAT, the use of SSS or arterial-derived VIF appeared to demonstrate good correlation. Our results indicate that the choice of software and post-processing methods can have significant implications for the quantification of brain tumor DCE metrics, particularly with regard to Ktrans. This should be kept in mind when performing a multi-vendor study or interpreting results across the literature.

KEYWORDS: Dynamic Contrast-Enhanced MR

O-951

3:35PM - 3:42PM

Comparison of Restriction Spectrum Imaging and FDG-PET for Prediction of Recurrent GBM
Purpose
Assessing treatment response in patients with glioblastoma multiforme (GBM) is a challenging issue. On these patients' posttreatment magnetic resonance (MR) scans, areas of new or increasing enhancement and/or edema frequently are detected. Determining whether these areas represent recurrent tumor versus radiation injury is often difficult with standard MR imaging. Therefore, many investigations have studied the ability of advanced imaging techniques such as diffusion-weighted imaging (DWI), MR spectroscopy, MR perfusion, and fluorodeoxyglucose-positron emission tomography (FDG-PET) to differentiate between recurrent tumor and radiation injury. Given its ability to depict tumor cellularity, DWI has shown particular promise in predicting recurrent tumor and differentiating it from radiation injury. High b-value DWI has been shown to be superior to standard DWI in this regard due to its greater sensitivity to restricted diffusion. Our group has developed a new advanced DWI technique, called Restriction Spectrum Imaging (RSI), that shows even greater sensitivity to restricted diffusion compared to both standard and high-b value DWI by utilizing multiple b-values and diffusion times to separate out the spherically restricted water compartment from the hindered water compartment. We previously have shown that RSI offers improved tumor conspicuity relative to high b-value DWI/ADC in patients with primary and metastatic brain tumor. In the current study, we aim to determine whether RSI can provide improved detection of pathologically proven recurrent GBM compared to FDG-PET.

Materials and Methods
Retrospective review of our brain tumor database between April 2011 and July 2013 revealed 16 patients with pathological proven recurrent GBM who had both RSI and FDG-PET data available within the six months prior to surgical resection. RSI and FDG-PET images were reviewed for each patient. The sensitivity of each of these techniques for predicting recurrent tumor then was calculated.

Results
RSI was positive (i.e., showed some area of restricted diffusion) in all 16 patients with recurrent GBM (100% sensitivity), whereas FDG-PET demonstrated FDG uptake in 13 of the 16 patients with recurrent GBM (81% sensitivity). In addition, three of the 13 cases which were positive on FDG-PET only showed mild FDG uptake with SUV values less than 4 (see Figure).

Conclusions
Due to RSI's greater sensitivity to restricted diffusion compared to both standard and high-b value DWI, it previously has been shown to offer improved tumor conspicuity in patients with primary and metastastic brain tumor. In the current study, we show that it also offers improved detection of pathologically proven recurrent GBM compared to FDG-PET.

KEYWORDS: Advanced MR Imaging, Glioma Recurrence, Restricted Diffusion
Semi-automated, Computer-assisted Quantification of Neuroimaging Characteristics of Glioblastoma: Correlation with Histopathologic Subtypes.

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Purpose
Glioblastoma (GBM) is a malignant and highly infiltrative tumor. Recent analysis of the Cancer Genome Atlas (TCGA) has revealed four subtypes (mesenchymal, classical, neural, and proneural) of GBM based on gene patterns. Disease course and treatment response varies according to genomic subtype. The development of reproducible, quantitative imaging
biomarkers that can be used to classify the subtypes of GBM preoperatively may provide a useful tool for treatment guidance and prognosis. Using semi-automated computer-assisted technique, the purpose of this study is to correlate the quantitative imaging features of glioblastoma from the TCGA data set with the four histopathologic subtypes of GBM.

Materials and Methods
This was a retrospective review using pathology results and images from the TCGA database and Cancer Imaging Archive, respectively. The Cancer Imaging Archive maintains images corresponding to TCGA patients. Only patients with presurgical MRI with T1 precontrast, T1 postcontrast, and FLAIR imaging were included. Patients without presurgical imaging or pathology were excluded. Magnetic resonance (MR) images were analyzed using a semi-automated algorithm that combines the region-based active contours and level set approach. The volume of peritumoral edema (Ed), contrast enhancing tumor (CE), noncontrast enhancing tumor (nCE), and necrosis (NE) was obtained for each patient. Additionally, the edema to contrast enhancing ratio (Ed:CE) and edema to noncontrast enhancing ratio (Ed:nCE) were calculated. Peritumoral heterogeneity was quantified objectively by measuring the skew in signal intensity within the peritumoral edema on FLAIR imaging. Statistical analysis with multiple regression was performed with SPSS for each variable. A p < 0.05 was considered statistically significant for this study.

Results
A total of 82 patients were available, of which 59 met inclusion criteria. Subtypes distribution was 32.2% (19/59) proneural, 18.6% (11/59) neural, 18.6% (11/59) classical, and 30.5% (18/59) mesenchymal class GBM tumors. We observed a significant relationship between nCE, Ed:nCE ratio, and peritumoral edema heterogeneity with the Verhaak classification (p<0.001 for each category). For example, the mesenchymal subtype displayed the lowest mean nCE (2.9%), whereas other tumor types had higher amounts. Additionally, mesenchymal subtypes displayed a higher Ed:nCE ratio and peritumoral heterogeneity compared to other GBM subtypes. With regard to other studied variables, CE, peritumoral edema, and NE did not display a significant difference among the subtypes. Ed:CE ratio also did not demonstrate a significant difference amongst tumor subtypes.

Conclusions
In summation, the use of semi-automated computer-assisted analysis of neuroimaging characteristics provides quantifiable and objective metrics in the evaluation of the four subtypes of GBM. The mesenchymal subtype of GBM demonstrates statistically significantly lower noncontrast enhancing tumor, higher edema to noncontrast enhancing tumor ratio, and higher peritumoral heterogeneity compared to the other subtypes.

KEYWORDS: Computer Modeling, Glioblastoma
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† Statistical analysis assessed with multiple regressions

**Abbreviations:**

%CE, proportion contrast enhancing; %Nec, proportion necrotic; %nCE, proportion non-contrast enhancing disease; %Ed, proportion edema.
Diffusion Restriction Precedes Contrast Enhancement in Glioblastoma Multiforme

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**Purpose**
Glioblastoma multiforme (GBM) are known to have highly variable responses to currently used therapies. The current imaging standard for detecting and assessing tumor progression in these patients depends on the presence of or changes in contrast-enhancing abnormality on brain MR imaging. Diffusion-weighted images (DWI) have become important in characterization of tumors. In tumors, restricted diffusion is seen in areas showing very high cellularity. We have observed that isolated foci of diffusion restriction precedes the enhancement in cases of GBM. The aim of our study was to assess the incidence of isolated diffusion restriction preceding corresponding enhancement and to determine whether diffusion restriction can predict the development of new enhancing mass lesions.

**Materials and Methods**
Magnetic resonance imaging (MRI) of brain, including diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) maps, of 102 consecutive patients with confirmed cases of glioblastoma were examined retrospectively. Images were assessed to determine whether there were nonconcordant areas of restricted diffusions (areas where low ADC lesions were present without corresponding postgadolinium enhancement). If found, these regions of interest (ROIs) for each patient were further followed for development of corresponding areas of tumor enhancement on follow-up MRI. Data were collected to assess where low ADC regions exist without enhancement, the normalized ADC (comparing tumor regions to normal regions), the length of time that enhancement takes to appear, and the overall survival of patients from the time of the appearance of corresponding enhancement.

**Results**
In 97 of 102 patients, restricted diffusion was detected at some point during treatment. The study cohort was formed by 41 patients (42.3%) who had low ADC lesions without an enhancement in a corresponding location on Post-Gad MR imaging. Ten (24.3%) patients developed enhancing tumor at the site of the low ADC lesion. In these ten patients, there were 12 instances where isolated diffusion restriction preceded the development of enhancing tumor. Enhancements appeared in follow-up imaging an average of 145 days after detection of corresponding low ADC lesions. In one case, detection of a nonconcordant low ADC lesion occurred 359 days before gadolinium enhancement appeared in MR imaging. Isolated low ADC lesions had an average apparent diffusion coefficient value of 721.4 GY (compared to 888.7 GY for the comparison group). Progress could not be tracked in 10 patients of the 41 (24.3%) who lacked follow-up imaging after detection of low ADC lesion. In nine (21.9%) more patients, potential development of enhancing tumor could not be accurately examined because of surgical changes, incomplete image sets, or a lack of timely follow up. The remaining 12 patients (29.2%) had low ADC lesions that did not precede the development of corresponding enhancement.

**Conclusions**
Isolated low ADC lesions indicating restricted diffusion preceded the development of enhancing tumor in approximately 1/5th of GBM patients. Further examination of this phenomena will be...
necessary, but we believe that these areas of restricted diffusion should be included in the
treatment planning of GBM both of surgery or radiotherapy. Inclusion of these potentially may
result in more predictive outcome in these patients.

KEYWORDS: Diffusion-Weighted Imaging, Glioblastoma, Restricted Diffusion

O-954

Image Optimizing in Retinoblastoma: RESOLVE Diffusion Technique for Evaluation of
Tumor Expansion and Activity in the Orbit.

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Purpose
Retinoblastoma is the most common orbital malignancy in childhood. Planning therapeutic
strategies information on tumor extension and activity is needed. The aim of this prospective
study (04/2013-12/2013) was to assess the value of RESOLVE (readout segmented diffusion
sequence) in MR diagnostic in currently 40 children with retinoblastoma.

Materials and Methods
This study was approved by the local hospital ethics committee. Magnetic resonance imaging
(MRI) was performed on a 1.5 T scanner (Magnetom Aera, Siemens, Erlangen, Germany) with
the use of two orbit surface coils. A standardized high resolution examination protocol with
additional RESOLVE sequence of the orbit was applied. Image analysis concerning image
quality, evaluation of orbital structures, tumor detection and artifacts was performed by two
neuroradiologists in consensus using a three point scale (1-poor to 3-very good). Additionally the
mean signal intensity of tumor and vitreous body was evaluated and detection of tumor in
RESOLVE, CISS (constructive interference in steady-state) sequence and T1 weighted images
with fat saturation and contrast agent were compared.

Results
RESOLVE imaging shows very good image quality (2.4±0.5) and a very good delineation of
tumor (b1000 2.8, b0 2.0, ADC 2.3). Some artifacts (b1000 2.1) are detectable however without
compromising tumor detection. In evaluation of tumor detection the RESOLVE was inferior to
the CISS sequence (1.6±0.3) but superior to the T1+CE (2.6±0.8). Inactive tumor lesions in
fundoscopy are not diffusion restricted in RESOLVE [hypointense {26.0±20.6, vitreous body
22.6±7.8}]; active tumors show diffusion restriction [hyperintense (117.5±38.2)], with drop in
the ADC maps. Even very small lesions can be assessed successfully concerning tumor activity.

Conclusions
The RESOLVE technique allows detection of retinoblastoma. First experiences demonstrate its
value in evaluation of tumor expansion and activity even in small lesions.

KEYWORDS: Diffusion MR Imaging, MR Imaging, Retinoblastoma
Optimization of conditional probabilities of a Bayesian Expert System for Neuroradiology differential diagnosis

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Purpose
Decision-support applications are being designed to help physicians analyze the growing amount of medical data, but have not been applied broadly within radiology. We have developed a Bayesian network expert system (BES) model for neuroradiology differential diagnosis (DDx). This network integrates reader-extracted data from brain magnetic resonance imagings (MRIs) using predefined conditional probabilities (CPs) to output posterior probability for eleven diseases and normal. An initial model (M1P1) based upon the opinion of one expert neuroradiologist was used to generate DDx from key features (KFs) extracted from cases by blinded readers. This model showed reasonable performance compared to the radiologists' DDx (Rad-DDx) (1). In this study, we test the hypothesis that models based upon consensus agreement of neuroradiologists or derived from data extracted from cases would show improved performance.

Materials and Methods
Three readers of varying experience (resident, fellow, attending) extracted KFs and generated Rad-DDx from 101 cases: six of each disease and 35 normals. Modified Delphi method was used for expert consensus CP modification (2). Conditional probabilities independently generated by three neuroradiologists were blinded, shared, and discussed. Independent CP changes then were permitted. After two rounds, the final CPs were averaged yielding model M1P2. For the data driven approach (M1P3), CPs were calculated from the KFs extracted by the case readers. Conditional probabilities were initially set to equivalence and then proportionally modified based upon reader extracted KFs. BES network structure was identical for all models. Reader extracted KFs were run through each BES model to generate DDx and evaluated by complete and partial receiver operating curve (ROC) analysis using Proproc curve fitting. Area under the curve (AUC) was compared between Model DDxs and Rad-DDx using ANOVA.

Results
The figure shows mean ROC curves. Rad-DDx and M1P3 had the highest AUC while M1P1 had the lowest. Compared to Rad-DDx, M1P1 showed significant difference (p <0.01) while M1P2 and M1P3 did not. Partial curve analysis showed significant difference between M1P3 and M1P1 (p=0.026) and a trend towards significance between M1P2 and M1P1 (p=0.09) while M1P2 and M1P3 did not differ. Complete ROC analysis did not show significant differences reflecting insufficient power.

Conclusions
Expert consensus, which can reduce personal and recall bias, and a data driven method, limited by the size and representativeness of the sample it was derived from, resulted in improved performance of a prototype differential diagnosis system for neuroradiology.

KEYWORDS: Differential Diagnosis, Informatics, Report Content
“Overshoot”-induced Variability in DSC-MR PWI rCBV Measurement of Intracranial Tumors among FDA-approved and Public Research Software programs

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Purpose
The first-pass effect in dynamic susceptibility contrast (DSC)-MR perfusion weighted imaging (PWI) leads to decrease of T2* signal intensity followed by recovery after the peak. In most of brain tumors, the T2* signal intensity could recover back close to the base line. The phenomenon that T2* signal intensity recovers higher than the base line is defined as "overshoot". The "overshoot" is less common in DSC MR PWI of intracranial tumors; in this study, we compared the relative blood volume (rCBV) value in the intracranial tumors with "overshoot", which was calculated by three FDA-approved and public research DSC MR PWI software programs.

Materials and Methods
We retrospectively reviewed 32 cases with pathology confirmed intracranial tumors, including 12 cerebral lymphomas, three brain metastases, three meningiomas, and 14 high grade gliomas. Three DSC MR PWI software programs were applied to generate rCBV maps, including GE BrainStat and nordicICE are FDA-approved products, LUPE (Lund University Perfusion Evaluation) is a public research software program. The rCBV image derived from GE BrainStat is without blood-brain barrier (BBB)-leakage correction. The nordicICE and LUPE calculate...
BBB-leakage corrected rCBV images. Two neuroradiologists measured the rCBV in the same localized ROIs of rCBV maps generated from these three software programs, and the difference among the three software programs was evaluated.

Results
The interoperator analysis between two neuroradiologists showed that the intraclass correlation coefficient (ICC) was 0.917. The mean rCBV value of "overshoot" intracranial tumors in GE BrainStat rCBV without BBB-leakage correction was 0.38±0.33, ranged from 0.21 to 1.36. The mean value of LUPE BBB-leakage corrected rCBV was 0.72±0.38, ranged from 0.47 to 1.79. The mean value of nordiICE BBB-leakage corrected rCBV was 2.97±2.15, ranged from 1.86 to 4.31.

Conclusions
There is significant difference of rCBV value in "overshoot" intracranial tumors among three FDA-approved and public research DSC MR PWI software programs. The "overshoot" can cause underestimation of rCBV in such intracranial tumors, even in BBB-leakage corrected rCBV maps. Therefore, interpretation of rCBV findings in "overshoot" intracranial tumors must be careful.

KEYWORDS: Cerebral Blood Volume, MR Perfusion-Weighted Imaging, Neoplasm

O-957

Value of Quantitative Apparent Diffusion Coefficients in Differentiating Low-grade Gliomas from Mixed Neuronal-glial Tumors

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Purpose
To retrospectively assess if diffusion-weighted MR imaging (DWI) and quantitative apparent-diffusion coefficient maps (ADC) could be used to differentiate between low grade gliomas and mixed neuronal-glial tumors (Dysembryoplastic Neuroepithelial Tumor or Ganglioglioma).

Materials and Methods
This institutional review board-approved, Health Insurance Portability and Accountability Act-compliant retrospective study involved 46 patients with histologically verified tumors: 24 with low grade gliomas (LGGs), 13 with dysembryoplastic neuroepithelial tumor (DNETs) and nine with ganglioglioma. All these patients had conventional MRI and diffusion-weighted imaging done within one month prior to surgery. Apparent diffusion coefficient (ADC) values of tumor (enhancing regions or the solid portion of tumor) and ADC ratios (ADC of tumor to ADC of contralateral white matter) were compared with the histologic diagnosis. Apparent diffusion coefficient values and ratios of low-grade gliomas and mixed neuronal tumors were compared by using the t-test. Optimal thresholds of ADC values and ADC ratios for distinguishing low grade gliomas from mixed neuronal-glial tumors were determined by receiver operating characteristic (ROC) curve analysis.

Results
Statistically significant differences were found for minimum and mean of ADC tumor and ADC
tumor ratio values between low grade gliomas and mixed neuronal tumors when including only one factor at a time (Figure 1). Including a combination of in total four parameters (mean ADC tumor, and minimum, maximum and mean ADC tumor ratio) resulted in sensitivity, specificity, positive (PPV), and negative predictive values (NPV) of 88.9, 78.6, 91.5, and 77.1% respectively. In the receiver operating characteristic (ROC) curve analysis, the area under the curve of the combined four parameters was the largest (0.86), indicating a good test.

Conclusions
The ADC value, minimal ADC value, and ADC ratios of solid tumoral or enhancing region appeared to be useful for differentiating low grade tumors from mixed neuronal tumors.

KEYWORDS: DNET, Ganglioglioma, Glioma
Purpose

There is a continuous process of cerebrospinal fluid (CSF) production and resorption in the central nervous system (CNS) which is crucial to normal function (1). Abnormalities in CSF equilibrium have been implicated in a number of CNS conditions from the straightforward mechanical situations including communicating and noncommunicating hydrocephalus, to less well understood phenomena relating to neurodegenerative disorders such as multiple sclerosis and Alzheimer disease. It also has been hypothesized that disequilibrium in CSF dynamics may contribute to morbidity and mortality in the setting of high grade glioma (HGG) (2). The choroid plexus (CP) is a key vascular structure in the production and regulation of CSF, but to date, only very limited assessment has been made in vivo using noninvasive techniques such as imaging (3). Since CP is known to have leaky endothelium, and large intravascular and extravascular, extracellular spaces, we proposed the use of dynamic contrast-enhanced MRI (DCE-MRI) to assess the perfusion and permeability characteristics of CP in both healthy volunteers in a test-retest setting, and in HGG to assess any variability in normal function detectible by MR, and investigate any possible link with HGG tumor size and degree of perifocal FLAIR abnormality.

Materials and Methods

Fifteen healthy volunteers underwent DCE-MRI at 3 T using an optimized whole brain protocol with baseline variable flip angle T1 relaxometry, and pharmacokinetic analysis based on the Tofts model (4). Time of day and potential modifiers of CSF production such as alcohol, caffeine and prescription medications were controlled for, and the volunteers were scanned on two separate occasions. Brain volumes were segmented using FSL FAST, with manual segmentation of the CP in the lateral ventricles. Twenty-eight patients with histology proven HGG underwent preoperative imagine with the same DCE-MRI protocol. Tumor regions and lateral CP were segmented manually, with FAST segmentation of the remaining brain. Median values of Ktrans, ve, vp, and bolus arrival delay were calculated for each segmented region and in each individual and compared. The image shows the tumor, brain, and choroid plexus segmentation results for an example patient.

Results

There was no difference between left and right lateral CP ve, vp, and bolus arrival delay in healthy volunteers, or between visits. Ktrans was the only parameter to vary between visits in the healthy volunteers. In tumor patients, values for all parameters were comparable to healthy volunteers, and there was no difference between the choroid plexus parameters between ipsilateral and contralateral hemispheres to tumor. There also was no significant relationship between tumor size, enhancing volume, necrotic volume, nor FLAIR abnormal volume and any of the CP DCE-MRI parameters.

Conclusions

Assessment of choroid plexus perfusion and permeability characteristics is feasible at 3 T in healthy individuals and in disease. There is no intervisit variability in vascular or extravascular, extracellular volume in CP in healthy volunteers, although Ktrans does change. This may indicate that variance in permeability is the main baseline contributor to variability in CSF production in healthy individuals. In tumors, there is no significant variance in CP characteristics when compared to healthy volunteers, and there also is no difference between ipsilateral and contralateral vascular characteristics, even when taking into account the size of the lesions and
significant differences in local and global mass effect, indicating that CP may maintain its functional characteristics even in the setting of significant lesion burden. Further work is required to assess the pathological significance, although the technique can now be utilized to assess a number of neurological disorders of differing etiologies.

KEYWORDS: Cerebral Neoplasm, Cerebrospinal Fluid, Choroid Plexus

O-959

Rapid Development of Diffusion Restricting Lesions Following Bevacizumab Initiation in High-grade Gliomas is Associated with Male Sex, Older Age, and high MIB-1 proliferation.

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Purpose
To identify characteristics of high grade gliomas associated with rapid development of diffusion restricting lesions (DRLs) following initiation of bevacizumab.

Materials and Methods
Diffusion-weighted imaging (DWI) before and after initiation of bevacizumab was reviewed for 34 patients with high grade gliomas either resected or biopsied during 2012. Patient age ranged from 22 – 77 years (17 M/ 17 F). All patients underwent initial resection or biopsy and chemoradiation, and were started on bevacizumab as salvage therapy following evidence of progression of disease. Histologic and molecular data evaluated included: MIB-1% (a marker of proliferation), IDH-1 mutation analysis, p53 expression, EGFR expression, 1p19q FISH, p16 (CDKN2A) FISH and loss of heterozygosity in 9p. Magnetic resonance images (MRIs) obtained...
before (0-24 days) and after (1-2 months) bevacizumab initiation were reviewed for new DRLs in the absence of other evidence of interval disease progression. Demographics, histologic and molecular pathology were compared to the DWI findings by chi squared and Student T-tests, with a p-value of <0.05 deemed significant. The study was IRB approved.

Results
Sixteen of 34 patients rapidly developed new DRLs after bevacizumab initiation. There was no significant difference in the average age between men or women or between those that developed DRLs and those that did not. Men were more likely to develop DRLs (11/17) than women (5/17) of any age (p=0.0393). For those over 70 years, 5/5 men developed DRLs, while 0/3 women did (p<0.00001). There was no significant difference in average percent tumor MIB-1 expression between those that developed DRLs and those that did not; however, patients with tumors demonstrating MIB-1 > 20% were more likely to develop DRLs (p=0.0019). Diffusion restricting lesions were associated with 15/28 glioblastomas, but only 1/6 anaplastic astrocytomas (NS, p=0.10). Tumors with loss of heterozygosity in 9p were more likely to develop DRLs (p=0.011). Homozygous loss of p16 and a greater percentage of polysomy 19q trended toward a greater number of DRLs, but did not reach significance in either case. No association was seen with IDH-1 mutations, p53 or EGFR expression or 1p19q FISH.

Conclusions
In this study, a subset of patients started on bevacizumab as salvage therapy rapidly developed DRLs in the absence of other signs of disease progression. Development of DRLs following bevacizumab is not well understood, though these lesions have been reported as atypical necrosis. Delayed onset of diffusion restriction often precedes progression of disease. The rapidly developing DRLs were associated significantly with patient age, sex and aggressive tumor pathology such as an elevated proliferation marker (MIB-1 > 20%) and loss of heterozygosity in p9, a chromosomal region rich in tumor suppression genes such as p16. These preliminary studies suggest that tumors with these aggressive pathologic and demographic features are characterized by rapid development of DRLs following bevacizumab initiation. Future studies will include multivariate analysis and evaluate the relationship of DRLs with overall and progression free survival, as well as characterizing location of recurrence relative to location of the DRLs.

KEYWORDS: Anaplastic Astrocytoma, DWI, Glioblastoma

Thursday
3:00PM - 4:30PM
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CSI: MONTREAL PROGRAMMING: MAKING A SCIENTIFIC PRESENTATION