Acute Bithalamic Infarction Manifesting as Sleep Like Coma – Diagnostic and Therapeutic Challenge

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Purpose
The presentation of bithalamic infarct (BTI) as a sleep-like coma (SLC) with few or no localizing signs poses a diagnostic challenge in the Emergency Room (ER) that may result in delayed treatment. Diffusion-weighted MRI (DW MRI), which is key for BTI diagnosis, should be performed urgently. After the initial diagnosis is established, CT angiography (CTA), CT venography (CTV), and additional imaging tests may be required to characterize stroke etiology and determine the optimal intervention. We review cases of BTI with different etiologies and emphasize the critical role of timely imaging in diagnosis and management.

Materials and Methods
We retrospectively reviewed the diagnostic work up, imaging data, and management for patients presenting to the ER from 2010–2014 with clinical presentation of SLC and DW MRI-based diagnosis of BTI. The hospital's Institutional Review Board waived the requirement for informed consent.

Results
Six patients (3 females, 3 males, mean age 70 years, range 55–88 years) with a similar initial clinical presentation of SLC and acute BTI on DW MRI were included. On further work up with CTA, CTV, and in some cases digital subtraction angiography (DSA), four different etiologies for BTI were identified: embolic occlusion of the artery of Percheron with patent posterior cerebral artery (PCA) in one patient and with occluded PCA in one; small vessel disease involving the artery of Percheron in two patients; unilateral lacunar thalamic infarct following contralateral thalamic infarct 8 weeks earlier; and deep sinus vein thrombosis secondary to dural arteriovenous fistula. Emergent treatments included successful IV tPA administration to the embolic arterial occlusion and successful neuroendovascular management in the patient with venous infarct, both resulting in a good outcome. The four remaining patients were left with significant neurological sequelae. In two of four, diagnosis and treatment were delayed due to late arrival at the ER because the patients were mistakenly thought by family members to be asleep, and in two of four, a standard work up for unconscious patients including toxic-metabolic panel, lumbar puncture, and EEG were performed prior to DW MRI, leaving these patients beyond therapeutic window.

Conclusions
Optimal patient management in cases of SLC includes urgent DWI MRI to establish/rule out BTI. In cases of BTI, further imaging work up with noninvasive or invasive vascular imaging is
indicated to provide a comprehensive and timely assessment of the source of the infarct. Early diagnosis and prompt, targeted intervention are crucial.

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**EP-09**

6:00AM - 3:00PM

Adult onset aqueductal stenosis and increasing resistance of CSF flow in the extracellular space.
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Purpose
Aqueductal stenosis may occur as a result of compression from a mass lesion or intrinsic pathology. It is known that aqueductal stenosis is a dynamic process and can present in adulthood. To determine whether increasing resistance to cerebrospinal fluid (CSF) flow through the extracellular space (ECS) of the brain contributes to the development of adult onset aqueductal stenosis.

Materials and Methods
Retrospective review of our database searching for the keywords of aqueductal stenosis from August 2009-August 2014, yielded 10 cases of adult onset aqueductal stenosis. The apparent diffusion coefficient (ADC) in four regions in the centrum semi ovale were measured as a surrogate of the amount of water in the ECS in patients with adult onset aqueductal stenosis and in age-matched controls with the same amount of deep white matter ischemia (DWMI).

Results
Apparent diffusion coefficient measurements performed in the centrum semiovale are significantly higher in patients with aqueductal stenosis than in age-matched controls (P 0.009), controlling for the same degree of DWMI indicating increased fluid in the ECS of the brain.

Conclusions
Increasing resistance to CSF flow through the ECS in the brain may contribute to the development of adult onset aqueductal stenosis.

Algorithmic selection of emboli protection device during the procedure of carotid artery stenting

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Purpose
Tailored-CAS algorithm has been advocated to decrease complication rate of carotid artery stenting (CAS) (1). Three different types of emboli protection devices (EPDs) are available in the Japanese market. Because each type of EPD has theoretical advantages and limitations, we made an algorithm in the selection of EPD. The purpose of this study is to verify the validity of our algorithm.

Materials and Methods
Since 2011, CAS with EPDs was performed in 31 patients in our hospital. Twenty-five patients were male, and six were female, and the median age is 72 years (64-89 years). There were eight symptomatic lesions and 23 asymptomatic lesions. Nineteen patients (61%) were at high risk for carotid endarterectomy. The algorithm was based on the presence of neurological symptom, T1-weighted image of the carotid plaque, the collateral arterial supply, and the lesion length (Figure). Accordingly, filter-type EPDs were used in 13 procedures, and balloon-type EPDs were
used in 11 procedures. In six cases, proximal endovascular blockage of blood flow was performed only during predilatation or throughout the procedures.

Results
No patient had an ischemic event during the procedure, and one patient had a transient ischemic attack after 24 hours of the procedure. Symptomatic myocardial infarction was observed in a patient, and exacerbation of chronic kidney disease was observed in a patient. High signal on diffusion-weighted MRI was observed in 15 patients (48%). Neither procedure-related morbidity nor mortality was observed at 30 days of the procedure.

Conclusions
The present study showed that our algorithm in the selection of EPD could be a useful tool in the prevention of cerebral emboli during CAS.
Purpose
The pathophysiologic patterns attributed to developmental venous anomalies (DVA) have been reflected in recent reports discussing perfusion abnormalities such as increased MTT, CBF and CBV. The purpose is to present two cases with peculiar hemodynamic patterns, aiming to address natural history and possible pathogeneses of DVA without and with associated cavernous malformation (CM).

Materials and Methods
We analyzed the drainage patterns of 205 patients with DVA (62.4% associated with CM) identified by retrospective and prospective studies and confirmed by MR and catheter angiography. Especially the venous patterns and angiographic circulation time were addressed. The inclusion criterion was an intensive early opacity of medullary veins without shunts associated with normal mean transit time of catheter angiography.

Results
The imaging studies of the first patient showed frontal DVA without parenchymal signal abnormalities, with early visualized radially oriented medullary veins without AV shunts. The mean transit time of angiographic circulation was identical with the other brain areas. The second patient presented with imaging of cerebellar stroke; the catheter angiography showed cerebellar DVA with early visualized medullary veins. The follow-up studies showed complete disappearance of the DVM and no signal abnormalities.

Conclusions
Considering previous reports analyzing the hemodynamic alteration of DVAs the explanation of the natural history may be related to both the unique impact of genuine developmental factors on the venous angioarchitecture as well the simultaneous induced developmental disorder of arterial morphology. The increased CBV may trigger a change of pressure gradient at the capillary bed level (like as developmental or autoregulation disorder), which may explain the increased CBF with early vein visualization (case 1). An acquired venous obstruction may promote creation of hemorrhage or CM (62.4% in our database); in association with still enough accommodation reserves the spontaneous occlusion of DVA may be possible (case 2).

**EP-80**

6:00AM - 3:00PM

**An Automatic Segmentation Pipeline for Chronic Stroke Lesions Employing Mean-Shift and Symmetry of the Human Brain**

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Purpose
Currently, investigations of chronic stroke are utilizing multimodal neuroimaging to identify biomarkers to predict recovery or response to therapy. An important step in this process requires the identification of the stroke lesion and the peri-lesional region. Previously this was either generated by hand tracing or semi-automated methods. The purpose of this study is to provide a
fully automated pipeline to identify the chronic stroke lesion and the subsequent peri-lesional space.

Materials and Methods
Five chronic stroke participants underwent imaging that included a 3D MPRAGE 1x1x1mm and a FLAIR (1x1x5 mm). The pipeline has three main steps (Figure 1): (1) T1 image is skull-stripped (Figure 1b) and clustered using Mean Shift (Figure 1c); (2) significant differences between lesioned (Figure 1e) and nonlesioned (Figure 1d) hemisphere are identified as total abnormality (Figure 1f), which is further separated into the ventricular expansion (Figure 1g) and the T1 lesion (Figure 1h); (3) we employ FLAIR to locate additional lesion tissue (Figure 1j). The lesion masks were dilated to get the perilesional region after subtracting the original lesion (Figures 1k, 1l). The Dice similarity index was calculated to compare the automated results with the hand drawn lesion mask.

Results
The performance evaluation of our method is shown in Figure 2 and Table 1. Most errors come from smaller lesions as the quasi-symmetry property of brain does not hold as well at the finely grained level.

Conclusions
A novel fully automated pipeline is developed to identify chronic stroke lesions and the peri-lesional space. The pipeline successfully employs mean shift clustering and the quasi-symmetry of human brain at the cluster level. When comparing the pipeline to the hand tracing, the Dice similarity index demonstrates good agreement. Future work will extend this pipeline to 3D and make it more robust to smaller size lesion.
The first row shows the segmentation results for subject 1 with each slice's Dice index tagged in gold; the second row shows the results for subject 5. Note that the identification accuracy decreases when the lesion size is small. We select these two subjects simply for illustration purpose.
Analysis of Brain T1/T2 Ratio Histogram in the Patients with Sickle Cell Disease Comparing with the Normal Controls

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Purpose
To investigate the manifestations of brain abnormalities in adult patients with sickle cell disease (SCD) using quantitative MRI (qMRI) parameters, specifically T1 and T2 relaxation times, and T1/T2 ratio.

Materials and Methods
Following IRB approval, 14 SCD subjects (5 males and 9 females, mean age: 29.3 years, range: 19.8-43 years) and 12 control subjects (4 males and 8 females, mean age: 36.6 years, range: 17-48.6 years) were included in this study. All subjects were imaged on a 1.5T MR scanner including the qMRI sequence, mixed turbo spin echo pulse sequence. For each subject, the whole intracranial volume was segmented and histograms of T1 and T2 relaxation times, and T1/T2 ratio were generated. Peak histogram values were obtained and compared between SCD subjects and normal controls.

Results
Of 14 SCD subjects, seven subjects had abnormal MR findings within brain parenchyma, including multiple old infarcts, non-specific T2 hyperintense foci, and mild atrophy. The remaining seven subjects demonstrated no abnormality within brain parenchyma. There are no between-group differences in age (p=0.06). T1 histograms were bimodal, representing gray matter (GM) and white matter (WM) compartments, while T2 histograms were primarily monomodal, resulting in bimodal T1/T2 ratio histograms. In the analysis of T1 and T2 histograms, there were no significant differences between SCD and control group in the values of GM peaks of the T1 histograms (p=0.83), T1 WM peaks (p=0.47), or T2 histogram peaks (p=0.09). In contrast, the T1/T2 ratio histograms demonstrated significant between-group differences; the GM peak values of SCD subjects were lower than those of controls (p<0.0001), with age-associated decreases in GM peak values in SCD and slight increases in controls. There were small, but statistically significant differences in the WM peak values of the T1/T2 ratio histograms (p=0.046).

Conclusions
This study shows the significant differences between SCD and control group in GM peak values of the T1/T2 ratio histogram, while the analysis of T1 and T2 histograms did not show statistically significant differences between SCD patients and controls. Hence, the T1/T2 ratio of the brain may be more sensitive and useful for the quantitative assessment of the pathological conditions including SCD.
Angiographic demonstration of occlusion of Percheron’s artery with bithalamic infarction

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Purpose
To present a clinical case with bithalamic infarction and angiographic demonstration of occlusion of Percheron's artery occlusion.

Materials and Methods
We present the case of a 53-year-old male, with a temporo occipital arteriovenous malformation previously embolized with onyx and glue and then surgically resected who was admitted to our service for an angiographic control. During the exam the patient evolved with impaired consciousness. The review of angiography as well as previous patient images showed occlusion of the artery of Percheron. Diffusion-weighted imaging showed bithalamic diffusion restriction, without involvement of the midbrain.
Results
The patient evolved with affected conjugated vision and severe impairment of awareness. Nowadays the patient is admitted to a rehabilitation program.

Conclusions
The artery of Percheron is an infrequent anatomical variant of a single thalamoperforating artery irrigating both thalami and variably the midbrain. Four patterns of infarction have been reported, bilateral paramedian thalamic and anterior/paramedian thalamic both of them with or without midbrain involvement.

(Filename: TCT_EP-67_PERCHERON001.jpg)

EP-39

Arterial Spin Labeled Brain Perfusion in Patients with Disorders of Intracranial Pressure: A Prospective Study of Changes Related to Measured Cerebrospinal Fluid Pressure
Purpose
The physiologic intracranial changes that accompany abnormal intracranial pressure (ICP) states of idiopathic intracranial hypotension (IIH) and spontaneous intracranial hypotension (SIH) are poorly understood. This study evaluates arterial spin labeled (ASL) MR perfusion derived cerebral blood flow (CBF) in patients presenting with known or suspected IIH or SIH related to measured cerebrospinal fluid (CSF) pressure.

Materials and Methods
Five women with known medically treated IIH (n=2), suspected IIH (n=2), or SIH (n=1) were enrolled prospectively. Each patient underwent 3.0T MRI followed immediately by lumbar puncture with opening pressure (OP) measurement. Patients with known or suspected IIH had CSF withdrawn and closing pressure (CP) measured. The patient with suspected SIH had OP measured and then underwent CT-guided epidural blood patch. Within 15 minutes following CP or 2 hours following blood patch, the MRI protocol was repeated. Volumetric anatomical sequences and 3D GRASE ASL (n=4) or multi-TI ASL (n=1) were acquired at both time points.
Mean whole brain CBF was calculated and assessed in relation to the clinical and imaging diagnosis, OP and CP, and changes related to CSF removal or blood patching. Anatomical images were assessed for findings including venous distension suggesting SIH, and transverse sinus stenosis (TSS) suggesting IIH.

Results
The SIH patient demonstrated distended dural venous sinuses and OP=14.5 cm water. Cerebral blood flow increased from 34.2 ml/100g/min to 43.9 ml/100g/min (28%) following blood patch with resolution of the patient's positional headaches. All four patients with known or suspected IIH had TSS. Two of these patients had elevated OP (35 and 26 cm water) reduced to 20 and 12 cm water CP following CSF removal, respectively. Cerebral blood flow did not change substantially (47.4 to 47.7 ml/100g/min and 29.1 to 31.1 ml/100g/min). The two patients with known medically treated IIH had normal OP (13 and 16 cm water, reduced to 12 and 11 cm water CP, respectively). Both patients also did not demonstrate substantial changes in CBF (35.6 to 33.6 ml/100g/min and 46.3 to 43.6 ml/100g/min) following CSF removal.

Conclusions
Therapeutic blood patch for SIH was associated with substantial increase in CBF. Cerebrospinal fluid removal in patients with known treated or suspected IIH did not result in substantial changes in CBF, suggesting a complex interaction between arterial perfusion and venous outflow obstruction in this condition.
Assessing Biological Response to Bevacizumab Using 18F-fluoromisonidazole (18F-FMISO) PET/MR Imaging in High Grade Gliomas

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Purpose
One of the pathologic hallmarks of high grade glioma recurrence is the presence of hypoxia-induced angiogenesis. To this end, angiogenesis inhibitor therapy currently is administered to patients who have developed glioma recurrence; however, a paucity of literature describing the effects of bevacizumab on tumor hypoxia currently exists. The specific aim of this study was to utilize FMISO PET/MR imaging to quantify the biological effects induced by bevacizumab therapy in patients with recurrent high grade glioma (1-4).
Materials and Methods
In this institutional review board approved study, two patients with recurrent WHO grade III anaplastic astrocytoma underwent FMSIO PET/MR imaging 1 week prior to and following the fourth dose of bevacizumab therapy (879 mg, every 2 weeks). Simultaneous imaging was performed on a GE 3T PET/MRI scanner 90 minutes following intravenous administration of seven mCi FMISO. MR sequences included diffusion-weighted imaging (1,000 sec/mm² B-value) and dynamic susceptibility perfusion imaging (DSC, 35º flip angle). GE advantage workstation running PET/MR review v1.0 and Functool software v4.4 was used to produce tumor wide FMISO activity, cerebral blood volume (CBV), cerebral blood flow (CBF), and apparent diffusion coefficient (ADC) physiologic maps. Relative imaging metrics were generated by comparing lesion wide values with those of normal appearing white matter. Differences between imaging time points were assessed utilizing Student's t-test. P value < 0.05 was considered statistically significant.

Results
Pre-bevacizumab FMISO PET/MR imaging demonstrated contrast enhancing recurrent disease associated with elevated rCBV (mean 1.84) and rCBF (mean 1.23). FMISO uptake within the contrast enhancing lesion also was elevated (rFMISO, mean 2.11, max 2.18) without associated reduced diffusion (ADCmin 935, ADCmean 1500, rADCmin 1.50, rADCmean 1.86) (Figure 1A). FMISO PET/MR imaging following the fourth dose of bevacizumab therapy demonstrated a nonenhancing T2/FLAIR hyperintense mass that had developed reduced diffusion (ADCmin 534, ADCmean 707; rADCmin 0.77, rADCmean 0.81) and decreased FMISO uptake (rFMISO, mean 0.71, max 1.65) (Figure 1B). The nonenhancing reduced diffusion lesion maintained rCBV (mean 0.99) and rCBF (mean 1.18). All values were found to be decreased significantly following the initiation of bevacizumab therapy (P< 0.02).

Conclusions
In these two index patients, bevacizumab therapy resulted in the development of nonenhancing tumor characterized by reduced diffusion and markedly decreased FMISO uptake in the setting of maintained CBF and CBV. These preliminary observations suggest that the dynamic biological interplay between tissue hypoxia and vascular normalization occurring within bevacizumab treated recurrent high grade glioma can be captured utilizing FMISO PET/MR imaging. Continued patient enrollment currently is underway.
Assessment of acetazolamide-enhanced arterial spin labeling MR-perfusion for cerebral steno-occlusive diseases

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Purpose
Arterial spin labeling (ASL) MR perfusion before and after acetazolamide (ACZ) administration was performed in patients with major cerebral artery steno-occlusive disease. Validity of ACZ-enhanced ASL MR perfusion was assessed with comparison of ACZ-enhanced SPECT with I-123 iodoamphetamine (IMP SPECT).

Materials and Methods
The study was performed in 16 patients with stenosis of the unilateral internal carotid artery (n = 6), bilateral occlusion of the internal carotid artery (n = 1), stenosis of the unilateral middle cerebral artery (n = 1), cerebrovascular moyamoya disease (n = 4), occlusion of the unilateral middle cerebral arterial trunk (n = 1), and others (n = 3). MR imaging was performed with a 3T MRI unit. Fast spoiled gradient-recalled acquisitions in the steady state (FSPGR) images were obtained before ASL sequences. Pulsed continuous ASL MRI were acquired before and 5, 10
and 15 min after administration of ACZ with the following parameters: repetition time = 5216 ms, echo time = 9.8 ms, points × arms = 512 × 8, post-labeling delay = 2525 ms, acquisition time = 3 min 39 s. Four-phase M0 images before, 5 min., 10 min., and 15 min. after ACZ administration were registered to their averaged image using NiftyReg application (http://sourceforge.net/projects/niftyreg/). The averaged M0 image was aligned to the 3D FSPGR image. The FSPGR image was aligned to the SRI24 SPGR template (https://www.nitrc.org/projects/sri24/) The 4-phase ASL CBF maps were computed and warped to the SRI24 template space. ACZ-enhanced IMP SPECT was performed using the quantitative SPECT dual-table autoradiographic method. IMP SPECT CBF images before and after ACZ administration were aligned to their averaged image by NiftyReg. The averaged image was registered to the SPM8 SPECT template. IMP SPECT CBF images before and after ACZ administration were warped to the SRI24 template space. On both ASL MR perfusion and IMP SPECT, ACZ-enhanced CBF 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 relation of %CBF between the two techniques was evaluated using simple linear regression.

Results
The %CBF of ACZ SPECT was 30.2 ±15.4% (mean±SD). The %CBF of ACZ ASL was 25.8 ±9.7% at 5 min after ACZ administration, 26.4 ±22.9% at 10 min after ACZ administration, and 26.3 ± 22.3% at 15 min after ACZ administration. The %CBF of ACZ SPECT correlated with %CBF of ACZ ASL at 5 min after ACZ administration (r = 0.59, p < 0.001), but not with %CBF of ACZ ASL at 10 (p = 0.71) or 15 (p = 0.37) min after ACZ administration.

Conclusions
ASL MR perfusion 5 min after ACZ administration can be used to evaluate cerebrovascular reserve in patients with cerebrovascular disease. ACZ-enhanced ASL MR perfusion is an alternative to ACZ-enhanced SPECT.

![%CBF using ASL MR-perfusion 5 min. after ACZ administration](Filename: TCT_EP-70_1.jpg)

![%CBF using ACZ-enhanced IMP-SPECT](Filename: TCT_EP-70_1.jpg)
Assessment of Dynamic Contrast-Enhanced T1-weighted MRI Perfusion and Diffusion-Weighted Imaging in Glioma Grading

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Purpose
Accurate glioma grading is crucial for treatment planning and predicting prognosis. We performed a quantitative volumetric analysis to assess the diagnostic accuracy of histogram analysis of diffusion-weighted imaging (DWI) and dynamic contrast-enhanced (DCE) T1-weighted perfusion imaging in the pre-operative evaluation of gliomas.

Materials and Methods
Sixty-three consecutive patients with pathologically confirmed gliomas who underwent baseline DWI and DCE MRI were enrolled. The patients were classified by histopathology according to tumor grade: 21 low grade gliomas (grade II) and 42 high grade gliomas (grades III and IV). Maps for plasma volume (Vp) and permeability constant (Ktrans), derived from the pharmacokinetic two-compartment model, and apparent diffusion coefficient (ADC) maps were generated, and the corresponding volume-of-interest values were calculated. Comparisons between high grade and low grade gliomas, and between grades II, III and IV, were performed. A Mann-Whitney U test at a significance level of corrected p≤0.01 was used to assess differences.

Results
All perfusion parameters could differentiate between high grade and low grade gliomas (p<0.001) and between grades II and IV, grades II and III and grades III and IV. Significant differences in minimum ADC also were found (p<0.01). Mean ADC only differed significantly between high and low grades and grades II and IV (p<0.01). There were no differences between grades II and III (p=0.1) and grades III and IV (p=0.71).

Conclusions
When derived from whole tumor histogram analysis, DCE MRI perfusion parameters performed better than ADC in noninvasively discriminating low from high grade gliomas. However, ADC and perfusion parameters Vp and Ktrans all appear to be useful indicators of tumor grade.
Purpose
Patients with meningiomas can have complicated clinical courses with poor outcomes. Many of these patients undergo debilitating cranial surgeries with extensive recoveries, and on many occasions, the meningiomas recur. Hence, physicians have been looking toward alternative medical therapies. Some meningiomas, may express somatostatin receptors. Nuclear medicine indium-111 pentetreotide scans (octreoscans) can identify meningiomas that express somatostatin receptors. Treatment in the form of somatostatin receptor blockers may represent an alternative or adjunctive treatment to the complex and often grueling course of multiple surgical procedures.

Materials and Methods
We retrospectively reviewed seven patients who had octreoscans with meningiomas positive for somatostatin receptors. The relevant medical records and radiologic imaging were reviewed to categorize the patients' symptomatology, surgical history, pathology results, imaging findings, and treatment plans.

Results
Twenty-nine percent of the patients identified had pathology results consistent with meningiomas without atypical features. Fifty-seven percent of the patients had pathology results consistent with meningiomas with atypical features (WHO Grade II). Fourteen percent of the patients had pathology results consistent with anaplastic meningioma (WHO Grade III). In all seven of the cases, the octreoscans were performed after there was MRI evidence of residual or recurrent disease following surgical resection. Fourteen percent of the patients had residual or recurrent disease in close proximity to cranial nerves, which limited further surgical resection. In 71% of the cases, medical therapy with a somatostatin receptor blocker was initiated. In 43% of these patients, there was no evidence of recurrence or progression of disease after initiation of treatment.

Conclusions
Somatostatin receptor blocker therapy may act as an amenable alternative to complicated and possibly debilitating surgical resections in patients with meningiomas expressing somatostatin receptors as it has been shown to lead to a period of progression-free survival. Radiologists can play a role in guiding treatment of these meningiomas through octreoscans which can aid in identifying the subset of patients that may benefit from this therapy. This can be particularly helpful in patients who have undergone multiple surgical resections or in cases where the meningiomas demonstrate aggressive features which preclude surgery.

EP-58
6:00AM - 3:00PM

Beyond FLAIR: Expanding the Role of Inversion Recovery in MR Imaging of the Brain

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Purpose
Inversion recovery (IR) sequences improve diagnostic accuracy by increasing the contrast to noise ratio of pathologic lesions. They accomplish this by minimizing signal from a chosen background tissue. Other than fluid-attenuated inversion recovery (FLAIR) and T2-weighted
double inversion recovery (DIR), the role of inversion recovery imaging in the brain has remained limited. The objective of this study was to develop two separate T1-weighted inversion recovery sequences that would null signal from white matter (WM) and gray matter (GM), allowing for improved diagnosis of lesions that lie in these two tissues and at the gray white junction.

Materials and Methods
A Siemens Avanto 1.5T MRI system with a standard circular polarized head coil was used on a healthy adult volunteer. The following variables were held constant: echo time (TE) of 11 seconds, receiver bandwidth of 16 kHz, slice thickness of 3 mm, 40 sections, 256 x 256 matrix size and a single excitation. The white matter inversion recovery sequence (WMIR) was obtained with a TR of 1700 milliseconds, and a TI of 350 milliseconds (acquisition time of 6 minutes and 11 seconds). The gray matter inversion recovery (GMIR) sequence was obtained with a TR of 2500 milliseconds, a TI of 630 milliseconds (acquisition time of 6 minutes and 24 seconds).

Results
Significant WM nulling was achieved on the WMIR and significant GM nulling was achieved on GMIR. On the WMIR, signal intensity for WM was 20 compared with 180 for GM and 245 for cerebrospinal fluid (CSF). On the GMIR, signal intensity for GM was 60 compared with 220 for WM and 205 for CSF. The sequences had intermediate T1 and T2 weighting, with the nulled tissue having almost zero signal and the non-nulled tissue having a similar signal intensity to CSF. While no pathology was tested in this study, the significant decrease in WM and GM signal potentially could allow subtle or small pathology to be more readily visible in gray matter, white matter, or at the gray white junction. As the CSF is slightly higher in signal than a standard spin echo T1 sequence, the WMIR and GMIR will likely be somewhat less sensitive to lesions that are immediately adjacent to CSF.

Conclusions
Inversion recovery is a powerful tool that can be used to minimize signal from background gray matter and/or white matter. Such partially T1-weighted WMIR and GMIR sequences have the potential to improve diagnostic sensitivity for a myriad of pathologies both before and after gadolinium administration. Further research is necessary to test these sequences and their ability to detect small or subtle lesions such as early metastases, small vascular malformations or small/subtle primary neoplasms.
Figure 1 shows axial slices at similar levels through the lateral ventricles and basal normal adult brain using A) white matter inversion recovery (WMIR) and B) gray matter recovery (GMIR) algorithms. The WMIR was obtained with a TR of 1700 ms and TI of 600 ms. The GMIR had a TR of 2500 ms and TI of 600 ms.

(Episode: TCT_EP-58_ASNRGM_and_WM_inversion_recoveryversion2.jpg)

EP-26

Brain Metabolites in Patients with Asymptomatic Versus Symptomatic HIV-associated neurocognitive disorder: A 7 Tesla MR Spectroscopy Study

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Purpose
HIV has been studied extensively using magnetic resonance spectroscopy (MRS) at field strengths of 1.5, 3.0 and 4.0T (1, 2). The current study was undertaken to investigate the utility of 7.0T MRS in five brain regions for evaluating differences in brain metabolites' concentrations in HIV+ patients with asymptomatic neurocognitive impairment (ANI) versus symptomatic HIV associated neurocognitive disorder (HAND) [mild neurocognitive disorder (MND) and HIV associated dementia (HAD)].

Materials and Methods
Ten HIV+ individuals with ANI, 12 with symptomatic HAND and six HIV- controls (mean age of 62.3 ± 7.53, 59.8± 5.4 and 68.3 ± 7.8 respectively) were included in this study. Using a 7.0T Philips Achieva scanner and 32-channel head coil, single voxel STEAM spectra (TR/TE=3000/14 msec) were acquired from the left frontal white matter (FWM), basal ganglia (BG), precuneus (PC), posterior cingulate cortex (PCC) and hippocampus (Hippo) with and without water suppression. The voxel sizes ranged from 8 to 15 cc (Figure 1). Spectra were analyzed using LCModel and quantified in millimolar (mM) concentrations, i.u. relative to the unsuppressed water signal. Metabolite concentrations and ratios relative to creatine (Cr) were calculated. The data normally were not distributed; therefore, comparisons of the groups' medians and interquartile (IQR) ranges were evaluated for significant differences using nonparametric median test.

Results
There was a significant increase in BG total choline (tCho = GPC+PCh) between HIV+ and seronegative controls [median (IQR) = 1.71 (1.15-12.0) and 1.6 (1.48- 1.6) mM respectively], P= 0.03. There were no significant differences in other brain regions metabolites in regards to serostatus. In regards to cognitive impairment, there were significant differences in the FWM and PC NAA/Cr ratio which was lower in the symptomatic HAND [(median (IQR) =1.19 (1.17 - 1.24) for FWM NAA/Cr and 1.11 (1.05-1.21) mM for PC NAA/Cr] versus ANI [median (IQR) =1.29 (1.16- 1.35) for FWM NAA/Cr and 1.24 (1.22-1.3) mM for PC NAA/Cr], P= 0.025 and 0.017 respectively. Furthermore, Glu/Cr was significantly lower in the FWM and PCC in the symptomatic HAND [median (IQR) =1.08 (0.98 -1.13) for FWM Glu/Cr and 1.07 (1.03- 1.2) mM for PCC Glu/Cr] versus the ANI [median (IQR) = 1.15 (1.12-1.24) for FWM Glu/Cr and 1.24 (1.23-1.26) mM for PCC Glu/Cr], P= 0.025 and 0.005 respectively. The Hippo and BG showed no significant differences in metabolites between ANI and symptomatic HAND.

Conclusions
The current study confirms some of the previous 3T findings namely reduced FWM NAA/Cr and Glu/Cr (3, 4) and it adds new findings in other brain regions namely reduced PC NAA/Cr and decreased PCC Glu/Cr reflecting neuronal impairment in association with symptomatic HAND. This study also showed increased BG tCho in HIV+ versus HIV- reflecting glial cell proliferation with change in serostatus. In conclusion, 7T MRS metabolites measurement of Glu/Cr and NAA/Cr can be reliable biomarkers for assessment of symptomatic HAND in patients with HIV.
**Figure 1:** showing the 5 brain regions and their corresponding spectra from an HIV+ subject.
Cerebral Phaeohyphomycosis Caused by Cladophialophora bantiana in an Immune Competent Patient

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Purpose
Cerebral phaeohyphomycosis is a rare disease caused by dematiaceous fungi (1, 2). Cladophialophora bantiana is the most frequently isolated species of central nervous system phaeohyphomycosis. We present phaeohyphomycosis caused by C. batiana in a immune competent patient.

Materials and Methods
A twenty-eight-year old male with no contributory history. He was admitted to our institution with difficulty speaking and hemiparesis of the right side of the body. There was no immunosuppressive condition.

Results
Because of progressive neurologic deficit it was decided to follow the patient at the department of neurology. Brain MRI findings showed a suspicious mass and massive edema as a neoplasia in the left cerebral hemisphere. Histological examination of the surgical brain specimens showed the presence of a dematiaceous fungi identified as C. bantiana. Patient was discharged with aggressive surgical and systemic and intrathecal antifungal treatment after twelve months.

Conclusions
Cerebral phaeohyphomycosis is an uncommon and frequently fatal disease caused by dematiaceous fungi that contain melanin pigment in their cell walls. Melanin plays an important role in the pathogenesis of this fungi. The diagnosis of phaeohyphomycosis is difficult and based on brain imaging and histopathological examination of the cerebral lesions. C. bantiana is the most frequent agent causing cerebral phaeohyphomycosis more commonly in immune competent than in immune compromised patients (3). Portal of entry of this fungus usually occur as inhalation of spores, direct extension from paranasal sinuses, and penetrating skin trauma (4, 5). Even in immune competent patients, C. bantiana spreads hematogenously to the brain and presents as multiple brain abscesses and rarely presents as meningitis without other organ involvement. In a review of culture proven cases of CNS phaeohyphomycosis by Revankar et al. (5) all cases of C. bantiana presented as brain abscess. Without aggressive surgical and medical treatment cerebral phaeohyphomycosis often recurs. MR imaging is the most substantial diagnostic method before surgery and during period of treatment. The differential diagnosis should include neoplasia and other granulomatous diseases. Brain abscess caused by C. bantiana is not distinguish from brain tumors with conventional MRI. Edema and contrast enhancement of abscess is similar with tumor. Perfusion MRI is a useful method in this situation. Abscess shows hypoperfusion differentiated from tumor at the pMRI. When cerebral phaeohyphomycosis is
suspected, pMRI should be added to conventional MRI, to improve prognosis with adequate treatment in the early stage of the disease.

**EP-05**

**Changes in the brain after liver transplantation: An analysis on T1-weighted MR imaging**

H Ishimaru, M Enokizono, R Ideguchi, M Morikawa, M Uetani

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Purpose

In cirrhotic patients, even in a nonencephalopathic state, MRI may show an increased signal in the globus pallidus (GP) on T1WI; however, signal changes in other areas are not well understood. The purpose of this study was to elucidate T1WI abnormalities of cirrhosis by comparing before and after liver transplantation, and to investigate the relationship between the abnormalities and clinical consequences.

Materials and Methods

We obtained T1WI before and after successful liver transplantation from 58 cirrhotic patients [14 with clinical hepatic encephalopathy (HE)]. For semiquantitative analysis, we calculated the signal intensity ratio (SIR) of the white matter (WM), putamen, GP, and thalamus relative to the frontal cortex and evaluated the changes after successful liver transplantation. We also evaluated the correlation to HE, serum bilirubin, albumin, prothrombin time, and NH3.

Results

SIR of the WM, putamen, and GP significantly decreased after liver transplantation (paired t-test <0.01), although that of the thalamus showed no significant change. SIR of the WM, putamen, and GP before liver transplantation showed no correlation to clinical HE. Serum bilirubin, albumin, prothrombin time, and NH3 showed no correlation to these SIR.

Conclusions

SIR of the WM, putamen, and GP significantly decreased after successful liver transplantation, and the signal increases of the WM, putamen, and GP were considered to indicate abnormalities associated with cirrhosis. However, the signal increases in these areas did not correlate to any clinical consequences.

**EP-22**

**Characterizing stroke motor recovery by structural and functional MRI**

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*Washington University School of Medicine, Saint Louis, MO*

Purpose

We measured longitudinal changes in the fractional anisotropy (FA) of the cortico-spinal tract (CST) with diffusion tractography imaging (DTI), and interhemispheric motor functional connectivity (FC) with resting-state functional magnetic resonance imaging (R-fMRI), in patients with stroke and motor deficits. We used these metrics to characterize stroke recovery.
Materials and Methods
First-time stroke patients (N=31) were studied at 1-2 weeks, 3 months, and 12 months postinjury with an extensive motor battery and R-fMRI. Diffusion tractography imaging was carried out at 3 and 12 months. Motor performance was summarized with a principal component analysis. Fractional anisotropy values averaged over the extent of the CST were measured ipsilesionally and contralesionally. Interhemispheric FC was measured between a set of previously defined motor regions. ANOVAs were used to test for changes in FA, DTI, and motor behavior scores over time and a multiple regression analysis related motor outcome to clinical and neuroimaging variables.

Results
Motor performance of the hemiparetic arm was highly correlated with the motor NIHSS scores (A), and improved over time. Fractional anisotropy of the ipsilesional CST improved significantly from 3 to 12 months (B) and was correlated strongly with motor performance at both time points. Interhemispheric FC also improved over time (C), but did not correlate with motor performance at 12 months. Clinical variables (acute motor score, education level, and age) predicted 80.4% of the variation of motor outcome, and FA increased the predictability to 84.6% while decreasing the significance of education level in the model (D).

Conclusions
Fractional anisotropy values improved from 3 to 12 months post stroke, beyond the traditional 3 month window of recovery. From the regression analysis, FA can objectively quantify baseline patient characteristics previously measured using proxy variables such as education level and be used in addition to acute motor scores to predict motor outcomes.
Comparison of 3D T1-TSE BB MRI and iMSDE prepared 3D T1-TSE BB MRI in patients with cervical carotid stenosis confirmed by DSA

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¹Mie University School of Medicine, Tsu, Japan, ²Mie University, Tsu, Japan

Purpose
For accurate morphology assessments of vessel wall diseases, efficiently flowing blood signal suppression is important. Nevertheless, because of the complicated flow patterns of cervical...
carotid artery bifurcation, current black-blood (BB) imaging techniques frequently are degraded by plaque-mimicking artifacts. For this study, an improved motion-sensitization driven equilibrium (iMSDE) sequence that is expected to improve blood suppression of the cervical carotid artery was used. The purpose of this study is to compare the clinical significance of iMSDE prepared 3D T1-TSE BB MRI with that of 3D T1-TSE BB MRI in patients with cervical carotid stenosis confirmed by digital subtraction angiography (DSA).

Materials and Methods
This study examined 45 patients with cervical carotid artery stenosis (NASCET mean 64.2%) confirmed by DSA. 3D T1-TSE BB MRI sequences with and without iMSDE were performed using 3T MRI (Achieva, Quasar Dual; Philips) with a 16-channel NV array coil. Visual assessment of the two sequence images was done independently by two neuroradiologists. The border between the vessel wall and blood lumen was rated for stenotic vessels using four-point scoring to differentiate between the lumen and wall because of the flow artifact or other artifacts: 4 = no artifact (clear), 3 = partial or mild artifact (obscure), 2 = substantial artifact (obscure), and 1 = impossible. For quantitative analyses, signal ratios of the plaque and adjacent lumen were obtained, as were signal ratios of the plaque to the sternocleidomastoid muscle. Wilcoxon signed-rank tests were used for statistical analysis.

Results
Visual assessment revealed that assigned scores were significantly higher for 3D T1-TSE BB MRI than those for iMSDE (3.7±0.4 versus 3.3±0.4, p<0.01). The iMSDE occasionally showed a blurred appearance of wall images, leading to lower scores compared with 3D T1-TSE BB MRI. However, the iMSDE was particularly effective for blood signal suppression in the two cases. For the quantitative analyses of lumen and plaque, the values of the two sequences were not significantly different (0.75±0.12 versus 0.72±0.13, p=0.72). Regarding the signal ratio of the plaque to the muscle, the values of the two sequences were not significantly different (1.65±0.52 versus 1.65±0.58, p=0.64).

Conclusions
These preliminary results suggest that the iMSDE prepared 3D T1-TSE BB MRI is not as good as the 3D T1-TSE BB MRI for the assessment of plaque morphology for patients with cervical carotid arteries. Apparently, the iMSDE tends to show blurring of wall images in clinical cases, possibly because of the susceptibility to the physiological pulsation of vessels or subtle motion of patients. This blurring might be disadvantageous when the method is used for diseased cervical vessels in a clinical setting. However, the iMSDE demonstrated dramatic blood suppression in a few cases with complicated flow patterns in diseased vessels, suggesting its potential as a useful method. Further investigation must be undertaken to evaluate the appropriate application of this method in a clinical setting.

EP-44
6:00AM - 3:00PM

Comparison of the Perfusion MRI Findings with Intraoperative Stiffness and Pathological Findings of Meningiomas.

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Purpose
Purpose of this study is obtaining information about stiffness and vascularity of meningiomas using neuroradiological assessments. By this acquired information, contributions to techniques of surgical approach and surgical planning were aimed.

Materials and Methods
Surgical reports and subjective opinions of surgical teams about stiffness and vascularity of 34 meningioma cases were incorporated into observation based scoring system. Neuroradiologically, MR perfusion studies were conducted. Analysis of tissue collagen and CD34 levels of tumors are performed histopathologically. All of the results are correlated and analyzed.

Results
In skull base group, CD34 levels, which shows microvascular density, is found higher compared to other groups and results were statistically significant (p=0.004). When comparing CD34 levels between transitional and fibroblastic subtypes of meningiomas, CD34 levels were statistically significantly (p=0.032) higher in transitional subtype of meningiomas. There is no statistically significant correlation between tumor grade and rCBV values (p=0.604). Intraoperative observation based stiffness scores are compared to histopathologically acquired EVG collagen scales. In contradiction to aforementioned observation based surgical vascularity score, comparing these subjective and objective data, there is statistically modest but significant correlation between intra-operative stiffness and EVG collagen scores (rs=0.400).

Conclusions
Significant data were found as a result of our study. But assessing stiffness and vascularity of meningioma cases preoperatively using MRI was thought ambiguous. It was concluded that, by emergence of statistically significant results, increasing sample sizes and acquiring different MRI sequences will allow obtaining more information. In our study, it was concluded that, like many other studies, one of the most important limiting factor was tumor stiffness and vascularity were assessed observationally by surgical team.

Figure Legends: Figure 1. The contrast in the axial T1-weighted MRI frontobasal seated meningioma. Figure 2. Perfusion MRI CBV measurement in patients with a diagnosis of meningioma. Figure 3. Demonstration CD 34 400x magnification. Figure 4. Show the EVG amount of collagen Van Gieson's stain.
Concurrent Demonstration of Cerebral Infarction and the Involved Pyramidal Tract by 3D-FLAIR Imaging Using a Variable Refocusing Flip Angle
K Tsuchiya, M Yamashita, N Shimatani, M Yorimitsu, M Kokan, T Suzuki, S Ichisaka

Tokyo Teishin Hospital, Tokyo, Japan

Purpose
We have found that FLAIR imaging using a VISTA (Volume Isotropic TSE Acquisition) sequence can highlight some nerve tracts by changing a refocusing flip angle (RFA) from that (60°) recommended for conventional FLAIR contrast. We assessed the feasibility of the FLAIR VISTA sequence in demonstrating cerebral infarction and the involved pyramidal tract (PT) on one image.

Materials and Methods
We first obtained FLAIR VISTA images with variable RFAs (30°, 60°, 90°, 110°, 120°, and 150°) from five normal volunteers and assessed the contrast-to-noise ratio (CNR) of the PT with the normal white matter. Based on the assessment as well as comparison with conventional tractography, we chose 110° for imaging clinical cases. We then obtained FLAIR VISTA images from consecutive 15 cases of acute/subacute infarction that developed adjacent to the PT at 1.5T with following parameters: TR/TE/TI, 6000/312/2000 ms; FOV, 250 mm; matrix, 208 x 208; slice thickness, 0.6 mm; SENSE factor, 2.8 (phase) x 2 (slice); flip angle, 90°; turbo factor, 140; and imaging time, 6 min 18 sec. Scan was performed in the sagittal plane followed by reconstruction of coronal images. We visually assessed images regarding the visualization of the PT and the lesion using a three-point grading scale (3 = good, 2 = fair, 1 = poor).

Results
In all of the 15 cases, the PT was depicted on both sides. FLAIR VISTA images also showed the PT and the adjacent infarct that caused motor paresis of a variable degree. The average grading score was 2.5.

Conclusions
Probably reflecting histological characteristics of anisotropic fibers, the FLAIR VISTA technique can readily visualize the relationship between the PT and cerebral infarct involving it.
Correlation between Carotid Plaque Signal on Magnetic Resonance Imaging and Cerebral Infarction Lesions in Non-diabetic Patients

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¹Chang Gung Memorial Hospital, Keelung & Linkou, Taiwan

Purpose
We perform this prospective study to evaluate the correlation between carotid artery plaque MR imaging and cerebral infarction.

Materials and Methods
Patients with cervical carotid artery stenosis in the Neurology clinics are enrolled in this prospective study. Their demographic information, past history of associated disease and serum laboratory studies are collected. Carotid plaque imaging, including T1-weighted images, T2-weighted images and time-of-flight images, is performed in a 3T MR scanner with routine head
and neck coil. Acute embolic infarctions in the ipsilateral MCA territory are evaluated on the diffusion-weighted images (DWI). Chronic cerebral embolic infarction lesions in the ipsilateral MCA territory are evaluated on 3D T1-weighted gradient-echo images (MPRAGE). Correlation between carotid plaque signal on MRI and cerebral infarction lesions is analyzed using multivariate analysis.

Results
Thirty-nine patients with mean age of 65.6 years are enrolled in this study. Thirty-one patients have unilateral stenosis and eight patients have bilateral carotid stenosis. Totally 47 carotid plaques with mean stenosis ratios 77.3 (NASCET) are used for subsequent analysis. Type 2 diabetes was diagnosed in 12 of these 39 patients. In patients with acute embolic infarction detected on DWI, mean T1 value of the carotid plaque (337.8) is significantly higher than that of patients without acute infarction (275.2, p=0.019). Subgroup analysis shows that the difference of mean T1 value between patients with or without acute infarctions is more significant in nondiabetic patients (p=0.009). Multiple regression analysis shows significant correlation between T1 value of the carotid plaque and number of old cerebral infarction lesions (p=0.007, R-squared= 0.150). Subgroup analysis of nondiabetic patients reveal more significant correlation (p = 0.001, R-squared= 0.316). However, similar results cannot be found in the subgroup of diabetic patients.

Conclusions
In our study, T1 signal of MR carotid plaque imaging is correlated significantly with the status of acute cerebral embolic infarction and the number of old cerebral infarction lesions in the subgroup of nondiabetic patients. The results suggest MR plaque imaging using a 3T MR scanner with routine head and neck coil is effective in detecting vulnerable carotid plaque.

EP-47
6:00AM - 3:00PM

Correlation of Leptomeningeal Disease on MRI Between the Brain and Spine in Patients Presenting to a Tertiary Referral Center

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¹University of Texas Health Sciences Center- Houston, Houston, TX, ²University of Texas MD Anderson Cancer Center, Houston, TX, ³MD Anderson Cancer Center, Houston, TX, ⁴Baylor College of Medicine, Houston, TX, ⁵UT MD Anderson Cancer Center, Houston, TX, ⁶M.D. Anderson Cancer Center, Houston, TX, ⁷University of Texas M. D. Anderson Cancer Center, Houston, TX

Purpose
Current methods of diagnosing leptomeningeal disease (LMD) are insensitive. While cytological evaluation remains the gold standard for diagnosis, MRI often is used in the assessment of patients with suspected LMD involving the brain and spine. The purpose of this study was to determine if there is a correlation between MR findings in the brain and spinal canal in patients with LMD.

Materials and Methods
The presence of enhancement and T2/FLAIR signal hyperintensity in the cerebellar folia and sulci of the supratentorial compartment, and enhancement involving the cranial nerves, the basal cisterns, pituitary stalk and ependymal lining of the lateral ventricles was reviewed.
retrospectively. MR of the spine was assessed for the presence of leptomeningeal enhancement. The chi square test or the Fisher exact test was used to compare categorical variables, as appropriate. The association between MRI findings in the brain and the spine were analyzed using a univariate and multivariate logistic regression analysis that compared the aforementioned categories in the brain and the presence of leptomeningeal enhancement in the spine. Odds ratios and their 95% confidence intervals were obtained. A p value <0.05 was considered significant.

Results
The study included 157 patients, 88 women and 69 men, age 9-82 years (median 51 years). Supratentorial leptomeningeal enhancement was present in 89 patients, and FLAIR signal hyperintensity was present in 96 patients. Enhancement of the cranial nerves, basal cisterns, and pituitary stalk was present in 56 patients, and ependymal enhancement was present in 28 patients. No significant difference was noted in regards to gender (p=0.85) or tumor type (p=0.9). Accounting for all lobes, there was no significant association between leptomeningeal enhancement (p=0.68) or FLAIR signal hyperintensity in the sulci (p=0.36) with spinal LMD. Enhancement of the occipital lobes approached significance (right, p=0.24, and left p=0.11). A significant association with T2/FLAIR signal in the left parietal lobe (p=0.02) was noted, and the occipital lobes (p=0.06) closely approached significance. Overall, an association between cranial nerve, basal cistern and pituitary stalk involvement and spinal LMD, closely approached significance (p=0.08), with CNV and CNVII/VIII (p=0.01) reaching a significant association. No relation was found between ependymal enhancement (p=0.78) and spinal LMD.

Conclusions
Leptomeningeal disease can affect the brain in many locations. Involvement of the parietal and occipital lobes as well as CNV and CN VII/VIII are associated significantly, or closely associated, with LMD in the spinal canal. Patients with the suggestion of disease in these areas should undergo imaging of the spine to assess for LMD. Alternatively, in patients with LMD of spine, the occipital and parietal lobes, as well as CNV and CN VII/VIII should be closely scrutinized.

EP-07
6:00AM - 3:00PM
Cortical microinfarcts: imaging signature at initial evaluation and 3-4 month follow-up

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Purpose
To assess the imaging signature of cortical microinfarcts in the acute and chronic phase. Cortical microinfarcts (CMI), potential contributors to cognitive decline, may be detected on high resolution T1- and T2-weighted sequences at 3T and especially 7T with false negative assessment as major drawback (1, 2, 3).

Materials and Methods
Initial diffusion-weighted (DWI), 2D-FLAIR and 3D-T1 images and 2D-T2 and 3D-T1 images from a 3- or 4-month follow up were collected in two patients. Twenty acute ischemic lesions, mean size 6.8 mm located in the cortex with extension into the subcortical white matter (n=7) identified on DWI, were assessed visually. On follow up CMI were defined as hyperintense on
FLAIR and hypointense on T1, major location cortical, distinct from perivascular spaces, size ≤ 5 mm.

Results
In the acute phase, lesions were somewhat smaller on 3D-T1 (5.3 mm) than DWI (6.8 mm). On follow-up 3D-T1 in patient one, four lesions (mean size 6.3 mm on initial DWI) out of 10 were not identified while one lesion (3 mm on initial DWI) now was visualized; remaining lesions had decreased to 2.8 mm. On the follow-up 3D-T1 in patient two, one 8 mm large lesion on DWI was not identified; remaining lesions had decreased in size to 2.3 mm. Follow-up 2D-T2 showed fewer lesions than 3D-T1.

Conclusions
The fate of acute cortical microinfarcts differs as these may resolve or cavitate with a substantial decrease in size at 3-4 month follow up. This suggests that lesions identified 3-4 months after ischemia on 3D-T1 would underestimate the initial total lesion burden.

Fig 1. Five cortical infarcts in patient 1 on initial DWI

(Filename: TCT_EP-07_Fig1_initial.png)
Dehydration Status leads to Poor Posterior Cerebral Artery Laterality in Acute Middle Cerebral Artery Occlusion

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Purpose
Recent large series studies demonstrated that dehydration is common among stroke subjects and is associated with poor outcome (1, 2). Dehydration can be detected with biomarkers of reduced blood water, most commonly using the nitrogen to creatinine (BUN/Cr) ratio. A serum BUN/Cr ratio more than 15 represents dehydration status (2). However, the effects of hydration status on the development of collaterals have never been discussed in the literature. In this study, we tested the hypothesis that hydration status is an important factor for developing collaterals after acute middle cerebral artery (MCA) infarction.

Materials and Methods
This retrospective study enrolled 48 patients with acute MCA territory infarction due to occlusion of MCA. Clinical and laboratory data, as well as CT scans were obtained when patients visited emergent department and were collected from a standardized data registration form. Patients with fibrinolytic therapy were excluded. MR imaging scans were performed within 2 days after stroke. Two collateral markers, posterior cerebral artery (PCA) laterality (3) (Figure A) and fluid attenuated inversion recovery vascular hyperintensity (4). FVHS were recorded from MRI (Figure B). Calcification of major cerebral arteries and presence of dense MCA sign were detected by CT (Figure C).

Results
The demographic and clinical data of the patients are shown in the table. Thirty-two of 48 patients (66.7%) are defined as dehydrated (BUN/Cr > 15). Among all of the clinical and imaging variables except BUN and Cr, only PCA laterality shows significant difference between dehydrated and euhydrated patients (p < 0.001). The euhydrated patients tend to have more FVHS but do not reach statistical significance (p = 0.064). Serum BUN level, BUN/Cr ratio, diastolic blood pressure and modified Rankin Scale at 1 month are associated significantly with developing of PCA laterality (p= 0.012, 0.008, 0.035 and 0.033 respectively).

Conclusions
Hydration status is associated with PCA laterality which represents developing of collateral flow. This preliminary study provides the first imaging clue that how dehydration leads to early neurological deterioration and worse outcome in acute stroke patient.
Table. Demographic and clinical characteristics of patients with and without dehydration

<table>
<thead>
<tr>
<th></th>
<th>Overall (n=48)</th>
<th>Dehydration (n=32)</th>
<th>Euhydation (n=16)</th>
<th>p</th>
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<tbody>
<tr>
<td><strong>n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, years</td>
<td>75.0 (12.2)</td>
<td>74.3 (13.9)</td>
<td>76.4 (8.1)</td>
<td>0.587</td>
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<tr>
<td>Sex, male</td>
<td>31 (64.6)</td>
<td>19 (59.4)</td>
<td>12 (75.0)</td>
<td>0.286</td>
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<tr>
<td><strong>Risk factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>28 (58.3)</td>
<td>17 (53.1)</td>
<td>11 (68.8)</td>
<td>0.301</td>
</tr>
<tr>
<td>Diabetes</td>
<td>11 (22.9)</td>
<td>7 (21.9)</td>
<td>4 (25.0)</td>
<td>0.808</td>
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<tr>
<td>Atrial fibrillation</td>
<td>16 (33.1)</td>
<td>9 (28.1)</td>
<td>7 (43.8)</td>
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<td><strong>Medication</strong></td>
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<tr>
<td>Anti-hypertensive</td>
<td>17 (35.4)</td>
<td>12 (37.5)</td>
<td>5 (31.3)</td>
<td>0.670</td>
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<tr>
<td>Antiplatelet</td>
<td>12 (25.0)</td>
<td>7 (21.9)</td>
<td>5 (31.3)</td>
<td>0.480</td>
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<td><strong>Laboratory studies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood urea nitrogen (mg/dl)</td>
<td>18.1 (6.1)</td>
<td>19.9 (6.1)</td>
<td>14.5 (4.4)</td>
<td>0.003*</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>1.1 (0.3)</td>
<td>1.0 (0.3)</td>
<td>1.2 (0.3)</td>
<td>0.035*</td>
</tr>
<tr>
<td>BUN/Cr ratio</td>
<td>17.6 (5.7)</td>
<td>20.4 (4.7)</td>
<td>12.1 (2.4)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Haemoglobin (g/dl)</td>
<td>13.6 (1.8)</td>
<td>13.4 (1.9)</td>
<td>14.0 (1.6)</td>
<td>0.273</td>
</tr>
<tr>
<td>Platelet count (1000/μl)</td>
<td>201.2 (60.9)</td>
<td>196.7 (57.4)</td>
<td>210.2 (68.5)</td>
<td>0.474</td>
</tr>
<tr>
<td>White blood cell count (1000/μl)</td>
<td>8.4 (2.9)</td>
<td>8.4 (2.7)</td>
<td>8.6 (3.5)</td>
<td>0.864</td>
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<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>158.1 (31.5)</td>
<td>159.6 (32.8)</td>
<td>155.0 (29.6)</td>
<td>0.637</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>88.9 (19.7)</td>
<td>90.3 (20.2)</td>
<td>86.2 (19.0)</td>
<td>0.503</td>
</tr>
<tr>
<td>Initial NIHSS score</td>
<td>12.6 (8.1)</td>
<td>13.2 (8.1)</td>
<td>11.5 (8.2)</td>
<td>0.508</td>
</tr>
<tr>
<td>MRS at one month</td>
<td>4.0 (1.1)</td>
<td>4.1 (1.0)</td>
<td>3.6 (1.2)</td>
<td>0.097</td>
</tr>
<tr>
<td>Dense MCA on CT</td>
<td>18 (37.5)</td>
<td>14 (43.8)</td>
<td>4 (25.0)</td>
<td>0.206</td>
</tr>
<tr>
<td><strong>Vascular calcifications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal carotid artery</td>
<td>44 (91.7)</td>
<td>29 (90.6)</td>
<td>15 (93.8)</td>
<td>0.712</td>
</tr>
<tr>
<td>Middle cerebral artery</td>
<td>13 (27.1)</td>
<td>7 (21.9)</td>
<td>6 (37.5)</td>
<td>0.251</td>
</tr>
<tr>
<td>Vertebralbasilar artery</td>
<td>16 (33.3)</td>
<td>12 (37.5)</td>
<td>4 (25.0)</td>
<td>0.386</td>
</tr>
<tr>
<td><strong>Collaterals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCA laterality</td>
<td>24 (50)</td>
<td>10 (32.3)</td>
<td>14 (87.5)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>FVHS</td>
<td>4.6 (2.2)</td>
<td>4.2 (2.1)</td>
<td>5.4 (2.1)</td>
<td>0.064</td>
</tr>
</tbody>
</table>

Continuous variables were expressed as mean (standard deviation) and were compared by performing Student’s t test. Categorical variables were expressed as number (%) and were compared using the chi-square test or Fisher’s exact test.
Diffusion Tensor Imaging and Hyposmia as a Biomarker for Parkinson's Disease in REM Sleep Behavior Disorder

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Purpose
Parkinson disease (PD) is characterized by a progressive neurodegenerative process that begins many years prior to the onset of specific signs and symptoms that are used to make the diagnosis. By the time a diagnosis is rendered, it is often too late to effectively intervene with a neuroprotective or neurorestorative treatment. The purpose of this study was to evaluate the effectiveness of fractional anisotropic (FA) analysis and the University of Pennsylvania Smell Identification Test (UPSIT) in detecting early PD in nonsymptomatic patients with REM sleep behavior disorder (RBD).

Materials and Methods
REM sleep behavior disorder subjects were recruited from community physicians, PD subjects were recruited from the OHSU clinic, and control subjects were recruited from the community. REM sleep behavior disorder subjects had polysomnography to confirm their diagnosis using the International Classification of Sleep Disorders (ICSD) and were administered the UPSIT. All subjects were classified using the Unified Parkinson's Disease Rating Scale (UPDRS). A midbrain DTI sequence was performed on all subjects with a 3T MRI (TR=9500 ms; TE=95 ms; slice thickness 2.0 mm; number of slices=72; 20 directions; FOV 240 mm; phase partial Fourier=6/8; b-value=1,000s/mm\textsuperscript{2}). Three regions of interest (ROIs) were created by dividing the SNc into thirds at the level just below the red nucleus by two blinded neuroradiologists (ROI1=medial third; ROI2=middle third; ROI3=lateral third). Fractional anisotropy (FA) mapping and analysis was performed by a blinded research assistant. A total of three PD subjects, three RBD subjects, and three controls were enrolled. The average PD subject symptom onset was 9 – 26 months (tUPDRS=22, range 12-34; mUPDRS=12, range 6-19). REM sleep behavior disorder subjects were without evidence of parkinsonism at the time of enrollment (tUPDRS scores ranging 1-3 and mUPDRS scores ranging 0-1).

Results
The "ROI 2" (mid-portion of SNc) in PD subjects was significantly lower when compared to controls, as previously has been reported (1). REM sleep behavior disorder subjects' mean changes in ROIs were not significant when compared to controls. However, one RBD subject had significantly lower FA in all ROIs and significantly lower UPSIT (=11) versus controls. This subject developed signs and symptoms of PD at the 2-year follow up (tUPDRS = 25, mUPDRS = 13).

Conclusions
This pilot study demonstrated changes in the mid-portion of the SNc in patients with early PD compared to age-matched controls based on fractional anisotropic analysis of diffusion tensor magnetic resonance imaging. This may be consistent with degenerative changes in Nigrosome 1, the cabindin-poor region of the SNc situated in this same region where maximal cell loss has
been reported in PD (2), and thus may be a potentially useful tool as an early imaging biomarker for PD. Further, although mean changes in RBD subjects did not differ from controls, the one RBD subject with hyposmia and significantly reduced FA values on DTI phenoconverted to PD at a 2-year follow up, thus demonstrating the potential utility of using these techniques for screening at-risk individuals for pre-motor Parkinson disease.
Discordance of CTA and Digital Subtraction Angiography in Diagnosing Vasospasm Following Aneurysmal Subarachnoid Hemorrhage

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Purpose
Vasospasm is a leading cause of morbidity and mortality in patients surviving aneurysmal subarachnoid hemorrhage (aSAH) with a prevalence approaching 70% in the first 2 weeks. Digital subtraction angiography (DSA) is the gold standard for the diagnosis of vasospasm. However, CT angiography (CTA) is an attractive alternative, given its speed and widespread availability. The purpose of this study is to analyze the degree of concordance between CTA and DSA in the diagnosis of vasospasm in patients with aSAH.

Materials and Methods
Two neuroradiologists reviewed CTAs of 15 patients for which there was clinical concern for vasospasm following aSAH. The bilateral supraclinoid internal carotid arteries, A1 and M1 segments of the anterior and middle cerebral arteries (ACA and MCA), and the basilar artery were scored for vasospasm on a four point scale (0 = none, 1 = mild, 2 = moderate, 3 = severe). Similarly, the more distal branches of the bilateral ACAs and MCAs, as well as the posterior cerebral arteries were scored on the same scale. Additionally, the vasospasm score in each case was assigned a degree of confidence in the diagnosis, either low or high. Subsequently, a neurointerventionalist independently analyzed the DSAs using on this same set of patients, utilizing the same scoring system and confidence ratings. Statistical analysis of the concordance between the interpretations of the CT and conventional angiograms then was calculated.

Results
There was agreement in the score of vasospasm on CTA and DSA in 45% (88 of 195) of the vessels scored. The scores on the CTA and DSA were discordant by one point in an additional 27% (53 of 195) of cases and by two or more points in 28% (54 of 195) of cases. On DSA, 99% of scores were given high confidence, compared to 75% on CTA, with the distal MCA branches, PCA, and A1 segments more likely to have a lower confidence on CTA. No trend towards overestimation or underestimation of vasospasm on CTA was identified. The figure below shows DSA and CTA images of a patient following aSAH. Vasospasm in the basilar artery was scored as mild on the DSA, while it was scored as severe on the CTA. Both scores were given a high degree of confidence.

Conclusions
Despite a reported sensitivity of 93% in detecting cerebral aneurysms, CTA has a much lower concordance with DSA in the evaluation of vasospasm. This is believed to be secondary to multiple patient and modality-specific factors. For example, poor contrast bolus, patient motion/compliance, venous contamination, artifact from coil material, and adjacent blood products can confound interpretation of CTA for vasospasm, while these factors are controlled more easily with DSA.
Distribution of subarachnoid hemorrhage with respect to the foramen magnum in relation to ruptured intracranial aneurysms

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Purpose
A subarachnoid hemorrhage (SAH) due to ruptured intracranial aneurysm is a devastating clinical event with a high mortality rate and a substantial risk for rebleeding. It is important that the radiologist not miss a potential aneurysm given suggestive imaging findings. To date there have been no studies, to our knowledge, that have compared the distribution of SAH of ruptured intracranial aneurysms with respect to the foramen magnum and we hypothesize that a foramen magnum hemorrhage can be an important clue to the diagnosis of an aneurysmal rupture.

Materials and Methods
A retrospective review of all cases of ruptured aneurysms with SAH at our institution was performed. Exclusion criteria included patients with multiple intracranial aneurysms, prior coiling of a known aneurysm, noncontrast CT scan of the brain after 4 days of the development of symptoms, imaging performed after intervention, and patients for whom no imaging was
available. The noncontrast CTs of these patients were reviewed to determine the distribution of SAH with attention paid to the foramen magnum.

Results
PICA, basilar, and vertebral artery aneurysms had high correlation with hemorrhage in the foramen magnum, particularly in hemorrhages without disproportionate supratentorial hemorrhages. Disproportionate supratentorial hemorrhage was evidenced by widening of basilar cisterns, Sylvan fissures, supratentorial sulci, or by presence of supratentorial intraparenchymal hemorrhage. In our study, 14/17 (93%) PICA aneurysm ruptures, 6/7 (86%) vertebral artery aneurysm ruptures, and 13/15 basilar artery aneurysm ruptures (87%) contained foramen magnum hemorrhage. Of other aneurysms, 19/69 (28%) Acomm, 10/29 (34%) Pcomm, and 12/36 (33%) MCA aneurysm ruptures contained foramen magnum hemorrhage. However, if excluding foramen magnum hemorrhages with disproportionate supratentorial hemorrhage, these decreased to 3/69 (4%), 2/29 (7%), and 2/36 (6%), respectively.

Conclusions
Hemorrhage within the foramen magnum is a reliable indicator of a ruptured PICA, basilar artery, or vertebral artery aneurysm rupture, particularly if there is no disproportionate supratentorial hemorrhage. Hemorrhage within the foramen magnum can be a clue to a lower posterior fossa aneurysm and search should be initiated with such a finding. Additionally, protocols for noncontrast CTs and CT angiography should fully include the foramen magnum and the posterior fossa circulation including the PICA to elucidate such findings.
Dural Venous Stenting for Idiopathic Intracranial Hypertension– Our experiences and literature review.

S Saipriya\textsuperscript{1}, C Miranda\textsuperscript{2}, S Chettri\textsuperscript{2}, H Sonwalker\textsuperscript{2}, S Wuppalapatti\textsuperscript{2}

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Purpose
Idiopathic intracranial hypertension (IIH) is a rare condition arising classically in overweight women aged between 20-44 years. If untreated, it can lead to visual loss due to chronic papilloedema and secondary optic atrophy. Current treatment options include medical treatment, and surgical intervention such as optic nerve sheath fenestration or CSF diversion via ventriculoperitoneal or lumboperitoneal shunts. A new treatment option is venous sinus stenting, which reduces the pressure gradient across the stenosis and results in a significant clinical improvement in a majority of the patients. This report outlines our experience with venous sinus stenting in a cohort of patients chosen via a strict selection criteria.

Materials and Methods
Patients were selected using a patient selection pathway based on current evidence as of January 2012, after peer review at a departmental level. The following criteria had to be met. Progressive headache as defined by the International Headache Society (version 1); Papilloedema/visual defect/6th nerve palsy; Raised intracranial pressure (ICP); Normal cerebrospinal fluid (CSF) chemistry; No intracranial disease; Temporal relation of headache to raised ICP; Improvement of symptoms following therapeutic lumbar puncture. Patients meeting the criteria underwent angiography. If a significant focal venous stenosis was identified, a stent was placed across a focal venous sinus stenosis and were followed up at 3 and 12 month intervals.

Results
A total of 28 patients were referred to our hospital with IIH, of which 27 were female, with an average age of 42.5 years and an average BMI of 28.8. Nineteen of these patients proceeded to having venous sinus stenting. Of these, focal venous sinus stenoses were identified in 18 patients, 17 of which were unilateral transverse sinus stenosis, and one patient with bilateral stenoses. The procedure was successful in all patients except one patient who had a postprocedural complication (major hemorrhagic stroke) within 24 hours. Twelve (66.67%) patients had continued symptomatic relief at 12 months.

Conclusions
In our case series, dural sinus stenting was utilized safely with an excellent success rate and clinical outcomes (74% improvement at 6 months). When compared to a similar case series carried out by Fields et al (67% symptomatic improvement), these results are marginally improved. We believe this may be a result of more stringent patient selection criteria. Our results along with those of similar studies demonstrate that venous stenting is a viable and safe alternative to surgical intervention in patients who are eligible. The rates of symptomatic improvement poststenting once again consolidates the hypothesis that dural venous sinus stenosis is a cause of IIH in some of the patients.

EP-19 6:00AM - 3:00PM

Effect of Chemotherapy on Brain Structure and Cognition in Older Women with Breast Cancer: a Brain MRI Study

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1City of Hope Medical Center, Duarte, CA, 2Magnetic Resonance Innovations, Inc., Detroit, MI, 3Wayne State University, Detroit, MI
Purpose
Some patients with breast cancer suffer from subjective and objective cognitive deficits during and after chemotherapy, colloquially termed "chemobrain" (1, 2). Brain structural changes including cerebral microbleeds (CMB) are associated with cognitive dysfunction (3, 4). The purpose of this study is to evaluate the effect of chemotherapy on brain structure and cognition in older women with breast cancer receiving adjuvant chemotherapy.

Materials and Methods
This is an on-going prospective longitudinal study of women age ≥ 60 with stage I-III breast cancers receiving adjuvant chemotherapy. Patients underwent neuropsychological testing with the NIH Toolbox5 and brain MRI prior to chemotherapy, time point 1 (TP1), and again 1 month after completion, time point 2 (TP2). Age -matched healthy controls underwent the same assessments. The MRI scan protocol includes T1WI, T2 FLAIR and susceptibility-weighted imaging (SWI). SPIN software (Detroit, MI) was used for postprocess.

Results
Eight patients (age 66.4+/−5 years) and 9 age-matched healthy controls (aged 66.2+/−6 years) have completed two assessments. Two (25%) patients had 1 CMB each in both pre and postimaging while no healthy control had CMB. Parenchymal brain volumes were consistent between scans for both controls (TP1=1086+/−75cm3, TP2=1080+/−78cm3) and patients (TP1=1091+/−61cm3, TP2=1097+/−67cm3) with the removal of one patient TP2 scan due to data quality. White matter hyper-intensity (WMH) was more prevalent in the control group (TP1=3.0+/−4cm3, TP2=2.7+/−3cm3) compared to the patients (TP1=2.7+/−3cm3, TP2=1.3+/−1cm3), however three of the four subjects with greater than 3cm3 of WMH were older than 71 years (2 controls and 1 patient). Analyses of the association of MRI imaging findings with neuropsychological data are in process.

Conclusions
The patient group shows a higher incidence of CMB than the control group; however total brain and WMH volumes do not differ between the two groups. SWI shows potential to evaluate brain structural changes in older cancer patients receiving chemotherapy. This study is funded by NIH/NIA grants: R03 AG045090-02 (CHEN) and R01 AG037037-01A1 (Hurria).

ClinicalTrials.gov (NCT01992432)

EP-64

Effectiveness and Complication of Intravenous Thrombolysis in an Asian Sample of Patients with Acute Large Arterial Infarction: Focus on Presence of Hyperdense Artery Sign

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1Far Eastern Memorial Hospital, New Taipei city, Taiwan, 2Far Eastern Memorial Hospital, New Taipei city, Taiwan, 3Taipei Veterans General Hospital and National Yang-Ming University, Taipei, Taiwan

Purpose
Based on CT imaging and histopathological correlation study of large arterial infarctions, thrombi with hyperdense artery sign (HAS (+)) were considered to be RBC predominant whereas those without hyperdense artery sign (HAS (-)) were probably fibrin predominant (1, 2). Given
the distinct nature of thrombi, presence of HAS was considered to correlate with outcomes of intravenous thrombolysis (iv-tPA) but findings were inconclusive (3-5). The current study aims to examine whether and how presence of HAS could influence outcomes of iv-tPA in a sample of Asian patients.

Materials and Methods
We enrolled 75 patients who received iv-tPA following acute stroke with large arterial obstructions between March 2012 and November 2014. All patients had initial CT and post-treatment 24 hour follow-up CTA/CTP/MRI. We categorized the subjects into "HAS (+)" and "HAS (-)" groups by correlating the initial CT and follow-up image to identify the presence of HAS. The impacts of HAS (+) on outcomes (24 hour NIHSS, and hemorrhage) were examined. Results
Thirty-eight HAS (+) patients and 37 HAS (-) patients were included. HAS (+) patients were more likely to have cardiogenic thrombi whereas those HAS (-) tended to have history of smoking and hyperlipidemia, which were both risk factors for atherosclerosis. Overall, 64% of patients improved after iv-tPA. In multivariate logistic regressions, presence of HAS did not differ in the odds of improvements and bleeding complications. On the other hand, initial lower NIHSS and presence of atrial fibrillation significantly correlated with improvement; old age and history of cerebrovascular accidents were related to bleeding complication.

Conclusions
Regardless of thrombi types based on presence of HAS, we found an over 60% improvement rate after iv-tPA based on an Asian sample. Other factors such as presence of risk factors (hyperlipidemia and smoking) and the underlying etiology (atrial fibrillation and atherosclerosis) may contribute to iv-tPA outcomes which warrants further investigation.

EP-16
6:00AM - 3:00PM

Effectiveness of Verb Generation by Noun and Picture naming of Thai Language Paradigm for Functional MRI for Lateralization and Localization of Language functional areas in Normal Thai Native speakers

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Purpose
To evaluate the cerebral cortical activity in verb generation by noun (VG) and naming picture (NP) paradigms and localize language function area by using Thai version of language paradigm (SiTP1).

Materials and Methods
Functional MRI was performed on 10 healthy volunteers (5 male, 5 female, and age 22-37 years), right handedness Thai native speakers by using Thai language paradigm test in verb generation by noun and naming picture. The blood oxygen level-dependent (BOLD) signal was recorded by 3T MRI. Cerebral lateralization was calculated in lateralized index by using SPM 8
running on MATLAB. Language functional areas were localized by signal-anatomical matching and localize classic Broca's and Wernicke's areas by coordinate.

Results
The BOLD signal activities on the left hemisphere were greater than the right hemisphere. Both VG and NP paradigms could activated signal at left occipito-temporal region, left perisylvian areas and left inferior frontal gyrus, represented reading process areas. Broca's area was found mainly at left pars opercularis. Wernicke's area was identified at the perisylvian areas, left superior temporal, left middle temporal, left angular gyrus, left supramarginal and left posterior parietal region. Primary visual cortex was demonstrated during both paradigms. Poor correlation between the lateralization index from VG and NP.

Conclusions
Thai language paradigm on verb generation by noun and naming picture were effective and useful for language lateralization. Language associated areas, primary visual cortex and classical Broca's and Wernicke's areas also were demonstrated in this study.

Summary of classical language coordinate on VG and NP paradigms.
Favorable biomarkers in hyperacute stroke: quantitative susceptibility measurement of thalamostriate veins shows strong inverse correlation with presenting NIH stroke scale score

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Purpose
To assess the relationship between quantitative susceptibility measurement (QSM) in superficial versus deep cerebral veins and baseline NIHSS score in hyperacute stroke patients selected for endovascular intervention by advanced imaging.

Materials and Methods
A retrospective analysis of patients presenting with hyperacute stroke from 2011-14 was performed. Inclusion criteria: age > 18 years, acute anterior circulation stroke, 3T SWI, and endovascular intervention. Exclusion criteria: posterior circulation stroke or poor quality SWI. Susceptibility-weighted imaging maps were created with SPIN software (MR Institute, Detroit). Quantitative susceptibility measurements of the bilateral thalamostriate (TS) and greatest anterior circulation cortical veins were obtained by placing a region of interest along the long axis of the veins and recording the mean value in parts per billion (ppb). Pairwise comparisons of QSM were made between each group using the Wilcoxon Signed Rank test. Correlations of QSM with presenting NIHSS score were made for each group using Spearman's rho.

Results
In this cohort of 25 patients, 10 male, the mean age was 66 years. Twenty-one patients had occlusion of the middle cerebral artery occlusion and four of the internal carotid artery. Mean
QSM (95%CI) were as follows: ipsilateral cortical 174 (139, 209); contralateral cortical 107 (92,120); ipsilateral TS 129 (104, 155); contralateral TS 107 (92,123). In pairwise comparisons, the cortical veins ipsilateral to the stroke showed statistically significant elevation in QSM versus all other vein groups (p = 0.001 v contra cortical, 0.001 v contra TS, 0.04 v ipsi TS). Comparisons between other groups did not reach adjusted statistical significance, although ipsi v contra TS was near. Both ipsilateral and contralateral TS veins showed strong inverse correlation with the presenting NIHSS score (r = -0.626, p = 0.001, and r = -0.458, p= 0.021, respectively) (Figures 1 and 2).

Conclusions
Quantitative susceptibility measurements are elevated in the cortical and thalamostriate veins on the side of ischemia in adult hyperacute stroke patients selected for endovascular intervention by advanced imaging. Additionally, thalamostriate vein QSM, especially ipsilaterally, is strongly inversely correlated with presenting NIHSS score.

(Filename: TCT_EP-76_ipsilateral.jpg)
Global brain physiology does not impact regional BOLD activations

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Purpose
Blood-oxygenation level dependent (BOLD) fMRI is a complex interplay between multiple physiological processes including blood flow, blood volume, oxygen consumption and neural activity. In this study, we use recently introduced techniques that query global brain physiology to investigate the relationship between BOLD activation and global brain physiology.

Materials and Methods
Data were acquired in nine healthy controls (4 females, 36 ± 9 years old) on a 3T TIM Trio
(Siemens, Erlangen, Germany) with a 32-channel receive-only head coil. High resolution (1mm isotropic) T1-weighted images were acquired using MPRAGE (1) for coregistration. A synonym language task (2) was presented visually during 8 minutes of fMRI data collection using gradient-echo-EPI with the following parameters: 36x3mm slices, 1.7 mm2 in-plane resolution, TR/TE=2s/20ms. Global cerebral blood flow (CBF), venous oxygenation in the sagittal sinus (Yv) and cerebral metabolic rate of oxygen (CMRO2) were measured using TRUST (3). All images were processed and analyzed using SPM8. A region-of-interest created from the most activated cluster, located in the left inferior frontal gyrus (see image) in relation to the task was used to extract percent BOLD signal changes (%ΔBOLD) for correlation with the global measurements.

Results
Scatterplots of the %ΔBOLD with various global measurements are shown in the Figure. None of the global measurements (CBF, CMRO2 and Yv) was significantly correlated with %ΔBOLD.

Conclusions
Our results demonstrate no significant correlations between task-related BOLD activation and global physiological measurements. It is possible that global brain physiology is maintained well by autoregulation in this cohort of young healthy adults and does not impact regional metabolic changes in response to brain function. Future work is needed to determine if the same relationship holds across age groups and pathology.
Hormone replacement therapy-related changes in the early postmenopausal period (critical window): an in vivo brain proton magnetic resonance spectroscopy study

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Purpose
Findings from clinical studies in postmenopausal women with late initiation of hormone replacement therapy (HRT) that test whether HRT protects cognitive functions in women are inconsistent. The aim of this study was to investigate the effects of HRT on brain metabolite ratios when initiated in the early postmenopausal period (critical window).

Materials and Methods
Proton magnetic resonance spectrometry (¹H MRS) was performed in four brain regions of 47 healthy postmenopausal women (21 received HRT, 26 did not). The subjects were aged between 45 and 65 years. The duration of HRT ranged from 1 to 12 years (mean: 6.3 years). The duration of menopause was 2–12 years (mean: 6.1 years) for HRT users and 1–20 years (mean: 7.8 years) for non-HRT users. Metabolite ratios [N-acetyl aspartate/choline (NAA/Cho), NAA/creatine (Cr), and Cho/Cr] were evaluated.

Results
Cho/Cr ratios were increased significantly and NAA/Cho ratios significantly decreased in all four regions in the HRT user group compared to the other group after elimination of the effects of age and menopause duration. Regression analysis revealed an association only between NAA/Cho and duration of menopause.

Conclusions
HRT-related changes in metabolite ratios are found in all brain regions. Decreased NAA/Cho and increased Cho/Cr levels do not support the neuroprotective role of HRT in the critical window.

Imaging Features to Distinguish Subacute Infarction from Other Non-Ischemic Disease Mimics: A Retrospective Study

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Purpose
Subacute infarction, especially when associated with enhancement, can mimic other disease conditions including tumor and demyelinating conditions. Identification of subacute infarction is important to avoid unnecessary surgical intervention. The purpose of our study was to identify
conventional MRI findings, in particular, the enhancing and FLAIR signal characteristics to
distinguish subacute infarction from tumor and other nonischemic disease conditions.

Materials and Methods
We retrospectively reviewed 11 cases of subacute infarction in which tumor or a demyelinating
condition was a consideration at the time of initial interpretation of the imaging studies. These
studies were evaluated in terms of diffusion restriction, FLAIR signal abnormality, intrinsic
hemorrhage, presence of surrounding edema, and mass effect. Five known cases of tumor (2
glioblastoma, 1 low grade glioma, 1 metastasis, and 1 primary CNS lymphoma), two cases of
parenchymal infection (abscesses), and three known cases of demyelination were used for
comparison.

Results
Of the 11 cases of subacute infarction, eight were lobar in distribution, two involved the thalami
and one involved the cerebellum. None of the cases demonstrated diffusion restriction, all
demonstrated well defined sharply margined FLAIR signal abnormality, only minimal
petechial hemorrhage was seen in two of our patients, diffuse but shaggy enhancement
corresponding exactly to the FLAIR signal abnormality was seen in all the cases, no surrounding
vasogenic edema was seen, and there was only minimal mass effect seen for the size of the
lesion. There was no incomplete or complete ring of enhancement, or nodular enhancement seen.
These imaging features were distinctly different from the other nonischemic conditions used for
comparison.

Conclusions
Diffuse, shaggy enhancement of an intraparenchymal lesion corresponding exactly to the FLAIR
signal abnormality, with no surrounding vasogenic edema, with minimal to no mass effect are
features suggestive of subacute infarction. Identification of these imaging features is imperative
to avoid unnecessary neurosurgical intervention.

EP-68
6:00AM - 3:00PM

In Vivo Assessment of Collateral Blood Flow with 4D MR Imaging at 3T in Acute Stroke
Patients

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1Department of Neurosciences, Germans Trias i Pujol University Hospital, Badalona, Spain,
2Biomedical Research Institute of Girona (IDIBGI), Hospital Dr Josep Trueta, Girona, Girona,
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Germans Trias i Pujol, Badalona, Barcelona, Barcelona, 5Hospital Universitari Germans Trias i Pujol,
Badalona, Barcelona, 6Institut de Diagnostic per la Imatge (IDI), Hospital Germans Trias i
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Purpose
Four-dimensional MR angiography (4D MRA) is a time-resolved sequence that enables the
hemodynamic study of cerebral blood vessels. We aimed to evaluate the ability of 4D MRA to
determine the site of occlusion and assess collateral blood flow in patients with acute ischemic
stroke.
Materials and Methods
We studied consecutive patients undergoing 3T MR within 12 hours of arterial occlusion in the anterior circulation. We recorded clinical and demographic variables. Two independent readers evaluated 4D MRA images to assess the site and grade of occlusion [modified Treatment In Cerebral Ischemia (mTICI) scale] and collateral circulation status (Arterial Collateral Grade (ACG) scale). Then we dichotomized collateral status into complete or incomplete filling of the affected vascular bed. We recorded diffusion-weighted imaging (DWI) lesion volume and volume of hypoperfused tissue (Tmax>6s) on perfusion-weighted imaging (PWI). We calculated the collateral circulation deficit, a PWI-based measure of collaterality as: Tmax>2s volume x (TMax>6s volume/volume of tissue with Tmax>2s and Tmax <6s).

Results
We studied 21 patients (mean age, 63; 57.1% women; mean NIHSS, 17). Inter-reader agreement was excellent for both mTICI and ACG (k=1 and k=0.93, respectively). Site of occlusion: 14 (66.7%) patients had M1 occlusion, four (19%) tandem occlusion, and three (14.3%) extracranial ICA occlusion. Grade of occlusion: mTICI was 0 in 10 (47.6%) patients, one in five (23.8%), 2a in two (9.5%), and 2b in three (14.3%). Collateral circulation status: ACG was one in nine (42.9%) patients, three in nine (42.9%) patients, and four in three (14.3%) patients; therefore, on dichotomization, collateral filling was classified as incomplete in nine (42.9%) patients and complete in 12 (57.2%) patients. Complete collateral filling was associated with smaller DWI lesion volume (p=0.012), smaller hypoperfused brain volume (p=0.028), and less collateral circulation deficit (p=0.009).

Conclusions
Four-dimensional MRA at 3T is a fast, direct, feasible, noninvasive, reliable way to assess collateral circulation. This technique provides profound insights into hemodynamic alterations in acute stroke patients. Four dimensional MRA is potentially useful for the evaluation of vascular occlusion and secondary effects throughout the vascular system; future studies should explore this role.

EP-72

Incidental findings in CT angiography performed in acute stroke patients and change of management: single center observation

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Purpose
In the diagnosis of acute stroke in most centers computed tomography (CT) is established as a combination of unenhanced cranial CT, plus CT angiography and CT-based perfusion measurements. Aim of this retrospective evaluation was to evaluate incidental findings during this CTA scans, and to evaluate change in therapy based on these observations.

Materials and Methods
From a PACS database 100 consecutive patients were selected (within 3 month), which were investigated with cranial CT and CT angiography, optional with CT perfusion (mean age 74 years, range 31- 95 years; 52 male, 48 female). CTA scan range was from the aortic arch to scull
in all cases at an injection of 80 - 130 cc contrast. All CTA data were reconstructed in axial, frontal and sagittal plane and were evaluated in consensus by two readers according to a predefined score (e.g., in category 1 for pulmonary lesions)= dissection, bronchial carcinoma, pulmonary embolism). From the hospital's KIS database a possible change of patient management was evaluated retrospectively.

Results
We found incidental findings in the chest in 20% (such as bronchial carcinoma, pulmonary embolism); in vessels in 44% (such as dissections), as well as incidental intracranial findings in 19%, incidental findings in the musculoskeletal region and the cervical spine in 11% and finally in the head and neck in 5%. In analysis of altered pathways we found alternated handling of patients in 14% based on these findings (such as intensive care unit in the case of dominant pulmonary embolism, bronchial carcinoma as a contraindication for iv thrombolysis).

Conclusions
A high number of examinations in acute stroke patients yielded incidental findings within the examined region. In our single center analysis, in 14% patients had an alternative treatment strategy based on CT findings, especially chest findings.

EP-25

Inflammatory Cerebral Amyloid Angiopathy: A Series of 3 Cases with Multiple Areas of Diffusion Restriction in One Case.

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2DEPT OF NEUROPATHOLOGY, ROYAL VICTORIA HOSPITAL, Belfast, Antrim, UK,
3CLINICAL RADIOLOGY, ULSTER GENERAL HOSPITAL, Belfast, Antrim, UK

Purpose
To discuss the spectrum of imaging findings of acute cerebral inflammatory amyloid angiopathy (AA) in a series of three patients along with a short discussion of the clinical histories. One patient showed diffusion restriction on MR, a previously unreported finding associated with this disease entity.

Materials and Methods
We describe the imaging findings in a series of three adult patients, referred to as Patient 1, 2 and 3, who were admitted with headache and acute cognitive problems to our Neuroscience Center, and were diagnosed with, and treated for inflammatory cerebral amyloid angiopathy. We also briefly describe their clinical course and eventual clinical outcomes. We also discuss the histopathological findings of the two patients who were diagnosed by brain biopsy, and propose a possible hypotheses correlating the presence of diffusion restriction seen in a single patient to pathology findings.

Results
Initial scans in all three patients showed white matter abnormalities in the supratentorial brain. Later scans showed microhemorrhages in Patients 2 (67-year-old female) and 3 (62-year-old male) with punctate foci of diffusion restriction in Patient 2. Patient 3 (77-year-old male) showed significant progression in the white matter signal abnormalities in the supratentorial brain with mass effect in the left temporal lobe. Patients 1 and 2 underwent brain biopsy; histopathology in
Patient 1 showed a severe variant of AA with focal angiitis; in Patient 2, who showed DWI restriction, the HP confirmed a severe rare type of congophilic AA inducing an inflammatory/vasculitic/granulomatous response. Patient 3 was treated on basis of radiological findings. All patients were treated aggressively with immunosuppressants (prednisolone, mycophenolate and cyclophosphamide). All the patients recovered well clinically.

Conclusions
Acute inflammatory cerebral amyloid angiopathy is perhaps a relatively underdiagnosed but severe and acute inflammatory disease of the brain characterized by the presence of amyloid in brain tissue with varying degrees of inflammatory response, including vasculitis. In our series of three patients, each demonstrated distinct imaging findings. In addition to the more commonly associated findings of white matter abnormalities and microhemorrhages, we noted the presence of diffusion restriction in one patient, a previously unreported imaging trait. We hypothesize that the severe inflammatory/vasculitic and granulomatous response seen on the histopathology analysis of this patient would correlate with the ischemic rather than the hemorrhagic complications normally seen with this disease. Often definitive diagnosis only can be made with brain biopsy, although some authors have noted subacute cognitive decline being the predominant clinical symptom in the patients suffering from the inflammatory variant, as was in our series. However, increasing knowledge of the varied imaging findings, including unusual ones such as DWI findings, may enable clinicians in future, to treat on the basis of radiological findings, negating the need for invasive procedures.

(Filename: TCT_EP-25_ACIAA.jpg)

EP-65
6:00AM - 3:00PM
Intra-observer Variability of Ischemic Core and Penumbra in CT Perfusion in Acute Ischemic Stroke

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Purpose
After more than a decade of its availability, CT perfusion (CTP) still lacks robustness for use in
acute ischemic stroke. Our objective was to 1) assess the intra-observer variability for quantifying ischemic core and penumbra using automated, semi-automated or manual postprocessing techniques and 2) assess the variability for different deconvolution algorithms using a commercially available perfusion package.

Materials and Methods
CT perfusion analysis was performed on 30 acute ischemic stroke patients from the Interventional Management of Stroke III trial data set. Ischemic core (dual threshold of relative CBF <30% and Tmax >6) and penumbra volumes (Tmax >6) in each patient were quantified using three different postprocessing techniques available in the software package: manual (manual selection of arterial and venous input), automated (automatic selection of arterial and venous input) and semi-automated (user allowed to adjust arterial and venous input, when deemed appropriate). Ischemic core and penumbra volumes also were calculated using different deconvolution algorithms available in the software package: sSVD (standard singular value decomposition), cSVD (block circulant matrix SVD), oSVD (oscillation index based SVD) and Bayesian estimation. Five patients were excluded due to technical limitations including truncated time curves and motion artifacts. The variability was quantified with Bland-Altman analysis using repeatability coefficient and coefficient of variation.

Results
Very high variability was observed in ischemic core quantification when comparing manual, automated and semi-automated postprocessing techniques (coefficient of variability 125-163%) as shown on Table 1. Penumbral volumes show low variation between automated and semi-automated processing (10%). The penumbral variation was higher (36%) in manual versus automated and manual versus semi-automated techniques. Very high variability in relation to the mean core volumes (100-197%) also was observed with different deconvolution algorithms. Again, lower variability is seen when comparing penumbral calculations (Table 2). The variability persisted among the delay insensitive algorithms (oSVD versus cSVD) and between delay sensitive (sSVD) versus delay insensitive algorithms (oSVD and cSVD). It is to be noted that 20% of the data contributed to a majority of the variability.

Conclusions
There is very high variability in CTP parameters, particularly ischemic core measurements among various postprocessing techniques and deconvolution algorithms. These results highlight the challenges for using CTP as a decision-making tool in acute ischemic stroke and emphasize a critical need for standardization of CTP analysis before it can be integrated in clinical practice.
**TABLE 1: Intra-observer variability of CTP quantification with different post processing techniques**

<table>
<thead>
<tr>
<th></th>
<th>Sample Mean</th>
<th>Standard Deviation</th>
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<th>Variability</th>
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<td><strong>Core</strong></td>
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<td>Automated vs Manual</td>
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<td><strong>Penumbra</strong></td>
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</table>
Intracerebral Amyloidoma: A Unique Intracranial Space Occupying Lesion

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Purpose
Intracerebral amyloidoma (IA) is a rare tumefactive form of isolated monoclonal amyloid light chain deposition. Clinical presentation varies according to location. Diagnosis usually is confirmed by biopsy. Nevertheless distinctive neuroimaging features have been described on CT and MRI. Our aim is to illustrate the common and uncommon imaging findings of IA in order to improve the radiologists' diagnostic accuracy.

Materials and Methods
We describe the clinical presentation, CT and MRI features and histopathological findings for five patients with IA who were diagnosed and treated at our institutions between January 2008 – December 2014. The hospitals Institutional Review Boards waived the requirement for informed consent.

Results
Five patients (M:F=3:2, mean age 52.8 years) were identified retrospectively. Clinical presentation was progressive unilateral hemiparesis in 2/5 and episodes of seizures in 2/5. One patient presented with right face numbness and diplopia. Neuroimaging demonstrated intraaxial mass lesions in four patients (mean diameter 32mm, range 25–40) and a 22 mm mass in right Meckel's cave extending into the right cavernous sinus. Four lesions were supratentorial with medial extension to the lateral ventricular ependyma. Lesions were solitary and unilateral in 4/5 (80%), bilateral in 1/5 (20%). Little or no mass effect was noted; only 1/5 showed perilesional vasogenic edema. On unenhanced CT, amyloid material was hyperattenuating in 4/5 with striated radial calcifications in 3/5. On MRI, all five cases showed heterogeneous hypointensity on T2-weighted images, intrinsic susceptibility effects on susceptibility-weighted imaging (SWI), and enhancement on gadolinium-enhanced T1-weighted images. On precontrast T1-weighted images, lesions were hyperintense in 2/5 and hypointense in 3/5. Histopathology following stereotactic biopsy demonstrated brain tissue replaced by aggregates of Congo red positive amorphous eosinophilic material, consistent with cerebral amyloid tumor and immunohistochemical staining showed plasma cells monotypic for lambda light chains. There was no evidence of systemic amyloidosis on further laboratory work up. Focused radiation was performed in 3/5, and subtotal resection in 1/5. At a mean follow up of 3 years (range 2-6), all five patients showed a benign clinical course with stable imaging findings.

Conclusions
Intracerebral amyloidoma is a unique intraaxial lesion both histologically and clinically. Characterization of CT and MR imaging findings may improve the pre-operative diagnosis and increase awareness to this rare clinical entity.
Intracranial AVMs: Comparison of volumes generated from orthogonal measurements and integrated 3D volumetric analysis

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Purpose
Estimation of brain AVM volumes is important for guiding appropriate therapeutic options and also monitoring treated lesions. While volume estimation based on orthogonal measurements commonly is used, there has been recent literature that this technique may not be accurate. Hence, the purpose of this study was to compare the volumes of brain AVMs calculated using two different methods: 1. calculating volume of an ellipsoid from three orthogonal measurements and 2. 3D integrated volumetric analysis from ROI placement on each individual slice demonstrating the AVM.

Materials and Methods
After IRB clearance, imaging studies from 11 patients with known brain AVMs were reviewed. All studies were analyzed by one board certified neuroradiologist (reader 1) and a second year neuroradiology fellow (reader 2) on custom software developed at the University of Michigan. For each patient, the AVM volume was calculated by two methods: 1. 3D integrated volume was calculated by tracing the boundaries of the AVM nidus on each axial slice on a cross-sectional study and 2. AVM nidus volume was calculated by the formula ABC/2 where A, B, and C are the maximal orthogonal measurements of the AVM nidus. Correlation between the two methods was performed using the Pearson's correlation coefficient for both readers.

Results
The average brain AVM volumes in our study using the two techniques were 6.2 ml and 6.9 ml using the 3D integrated technique and 4.2 ml and 7.6 ml using the orthogonal technique by reader 1 and 2 respectively. Our results demonstrated high correlation between the integrated 3D volumes and the orthogonal measurement technique based volumes for both readers (R=0.99 and 0.98). Correlation between the two readers for the orthogonal and integrated 3D volumes was 0.88 and 0.87 respectively.

Conclusions
Arteriovenous malformation nidus volumes derived from hand drawn 3D shapes were highly correlated with ellipsoid volume calculated from three maximal dimensions of the AVM nidus on a cross-sectional study, suggesting that the orthogonal technique may be sufficient for volume estimation.
Figure 1. Scatter plots for (A) Rad1, (B) Rad2, and correlation (C and D)
Is structural magnetic resonance imaging able to demonstrate motor and extra-motor impairment in amyotrophic lateral sclerosis?

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Purpose
The amyotrophic lateral sclerosis (ALS) is not always an isolated disease of the motor system, but often a multisystem disorder with many phenotypes. The extra-motor involvement may lead to clinical and imaging features identical to frontotemporal degeneration (FTD). A symmetric pattern of frontotemporal atrophy and anteromedial subcortical signal abnormality in the temporal lobes have been suggested to be a typical late finding of ALS and associated dementia. We aim to describe the clinical and structural magnetic resonance imaging (MRI) in a series of patients with ALS, emphasizing the ALS FTD findings.

Materials and Methods
Institutional imaging files and medical records from a single institution from January 2000 until December 2014 were reviewed retrospectively including only definite ALS patients in order to analyze the prevalence of imaging findings related to both ALS and ALS FTD, on T2-weighted imaging (T2WI), Proton density-weighted imaging, FLAIR and T1 magnetization transfer contrast (T1 MTC) imaging. These findings were compared with the predominant clinical features and also a control group of 50 asymptomatic subjects.

Results
One hundred twenty-six ALS patients were studied and all of them demonstrated a selective bilateral corticospinal tract hyperintensity on T1 MTC. The diagnosis of ALS FTD was confirmed in 11 patients (8.7%) in which the presence of atrophy and subcortical gliosis was better demonstrated on FLAIR and T2WI in the temporal lobe as a discriminatory finding. None of these findings were observed in the control group.

Conclusions
Our results confirmed the uncommon association between ALS and FTD and also demonstrated the applicability of structural MRI to depict the involvement of the frontal and temporal lobes and also to distinguish ASL FTD phenotypes among ALS patients. An appropriate protocol is recommended as a reliable demonstration of earlier motor abnormalities on T1 MTC, while extra-motor changes in ALS FTD patients were better demonstrated on FLAIR and T2WI.
Isolated cerebellar leptomeningeal involvement as an atypical radiological presentation of Herpes simplex virus infection

B Zeydan¹, E Ure², M Asik³, A Elmali¹, S Saip¹, Z Hasiloglu²

Fig. 1 – 84-year-old lady presenting with upper and lower motor neuron compromise year. Additionally, she presented progressive aphasia started three months later, consisting of amyotrophic lateral sclerosis and frontotemporal degeneration. A) Axial selective hyperintensity throughout the corticospinal tracts (arrows). B) Axial FLAIR cortical and subcortical hyperintensities (star) in the left temporal lobe.
Purpose
We aimed to present a case with a subacute neurological disease and atypical radiological features consisting of isolated cerebellar leptomeningeal involvement where herpes simplex virus-1 (HSV1) was detected as the etiological agent.

Materials and Methods
A 29-year-old female patient was admitted due to speech and walking difficulties. She had a history of balance problems and progressive speech deterioration. She was awake and oriented, could carry out complex cognitive tasks, but was agitated. Meningeal irritation signs were not present. Her muscle strength was normal, deep tendon reflexes were brisk and Babinski's sign was positive on the left side. She had bilateral dysmetria, ataxia and dysarthria, which supported cerebellar involvement.

Results
Cranial computed tomography and diffusion-weighted magnetic resonance imaging (DWI MRI) were normal. Cranial gadolinium MRI revealed global leptomeningeal contrast enhancement of cerebellar folia, but the cerebral neural parenchyma, especially lateral and inferior temporal lobes characteristic for HSV-1 encephalitis (HSV1-E) were spared (Figure 1 a-b). All parameters of cerebrospinal fluid (CSF) were normal with one exception, positivity for HSV1-PCR. Her condition started to improve within days with acyclovir treatment. Neuroimaging showed marked regression of cerebellar leptomeningeal contrast enhancement (Figure 1 c-d). HSV1-PCR became negative and HSV1-IgG was positive in recurrent CSF examination.

Conclusions
Clinical features of HSV1-E involve fever, headache, behavioral abnormalities, seizures and neurologic deficits. The characteristic localization of HSV1-E is temporal lobe and insula. Fluid attenuated inversion recovery (FLAIR), DWI and T2-weighted images of MRI mostly reveal hyperintense lesions in temporal lobes. Although temporal lobe involvement is suggestive of herpes encephalitis in a patient with encephalitis signs and periodic lateralized epileptiform discharges on electroencephalogram, characteristics of the disease were not detected in our case and especially the cranial MRI was atypical. But CSF HSV1-PCR positivity, and dramatic response to antiviral treatment supported our diagnosis. So, HSV1 may be a very rare, but possible etiologic agent in isolated cerebellar leptomeningeal involvement.
Mapping the Amydalofugal Tract of the Human Brain Limbic System.

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Purpose
The purpose of the current study is to demonstrate for the first time the feasibility of parcellation and tractography of fine limbic structures such as the amygdalofugal tract as part of the amygdalo-hypothalamic connections in relation to the gray matter nuclei (amygdala, hippocampus, and hypothalamus) in human brain using high spatial resolution DTI data on 3T.

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 the 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 fine limbic pathway of amygdalofugal tract using high spatial resolution DTI measurements on 3T. The fornix, anterior commissure and amygdalo-hypothalamic tracts are clearly distinguishable in relation to the amygdala, hypothalamus and hippocampus nuclei.

Conclusions
Using high spatial resolution specially reduced slice thickness (1mm) in this study reduced the partial volume effect as well as incoherency due to the fiber crossing within each voxel and we were able to reconstruct and show even the small limbic trajectories such as amygdalo-hypothalamic connections using deterministic tractography 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 amygdala and hypothalamic nuclei. In this report we demonstrate for the first time, in vivo 3D reconstruction of the amygdalofugal tract of the human brain limbic system using high spatial resolution diffusion tensor tractography on 3T.
Fig. 1  amygdalofugal tract (pink) and anterior commissure (red)
Fig. 2. amygdalofugal tract and relationship with the stria terminalis (black) and the uncinate fasciculus (green).
Masticator Blow-out Fracture, a Previously Unappreciated Fracture of the Lateral Maxillary Sinus

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Purpose
Segmental, depressed fractures of the lateral maxillary sinus may occur as a result of trauma to the masticator space, frequently in conjunction with other regional fractures. The authors hypothesize this fracture is due to a transient increase in pressure in the masticator space resulting in a blow-out fracture of the lateral aspect of the maxillary sinus. This fracture and its mechanism are thought to be analogous to orbital blowout fractures. Because the fracture frequently is seen in conjunction with other regional fractures this has been overlooked as a separate entity. This paper defines the fracture and estimates its incidence.

Materials and Methods
Masticator blow-out fracture is defined as a segmental fracture in the lateral aspect of the maxillary sinus with medial displacement of lateral maxillary bone fragments accompanied by herniation of a variable amount of masticator space fat and/or muscle into the maxillary sinus. Fractures were excluded if there were a rotational component or significant over-riding of fracture fragments. Injuries of the masticator space were identified retrospectively by searching the imaging data base for key words that would identify regional trauma. Consecutive imaging reports from January to November 2014 were searched for key words such as, but not limited to, "fracture" and "tripod", "ZMC", and "mandible". The retrospective search was HIPAA compliant and IRB approved. Two neuroradiologists reviewed the images and agreed by consensus on the presence or absence of a masticator space blow-out fracture.

Results
A total of 29 acute zygomaticomaxillary complex (ZMC) fractures and 97 acute mandibular fractures were identified. While all of the ZMC fractures had a maxillary component, five (17%) additional fractures met the criteria of a masticator blow-out fracture. Five (5.2%) of the mandibular fractures had an associated masticator space blow-out fracture. A typical masticator blow-out fracture is illustrated in Figure 1.

Conclusions
Masticator space blow-out fracture, defined as a segmental depressed fracture of the lateral maxillary sinus is relatively common. The authors hypothesize that it is due to a transient increase in pressure in the masticator space and is a separate entity from other fractures of the region that may occur concurrently.
EP-37

Methcathinone (Ephedron) abuse- Brain structural -haemodinamic changes

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Purpose
The aim of study was to assess the brain structural and hemodynamic findings in Methcathinone chronic users. This addictive psychoactive substance is derived via the oxidation of ephedrine with potassium permanganate.

Materials and Methods
Forty-one patients (35 male, 6 female; age 23-55 years) with chronic intravenous use of Methcathinone were investigated. All patients underwent transcranial sonography, brain MRI (1.5T, 3T), MR tractography, MR angiography and color Doppler of extra-intracranial vessels, neurologic and neuropsychological examinations. Cerebrovascular reactivity (CVR) by TCD test also was evaluated.

Results
In majority of abusers, 32 (78%) extrapiramidal disorders similar to Parkinson disease: bradikinesia, postural disturbance, ataxia, tremor, muscular distonia was noted. Pseudobulbar
syndrome or personal abnormalities were comparatively rare. Three cases of stroke was diagnosed. In one patient severe dissection and thrombosis of the ICA, one thrombosis of the MCA and one severe stenosis of MCA. MR images revealed T1 hyperintense lesions in 35 (85%) cases, predominantly in globus pallidum (30/74%), substantia nigra (28/68%), nuclei dentatus of cerebulum (23/55%), anterior pituitary lobe (16/40%) and the white matter (4/10%). T1 hyperintensity well correlated with substantia nigra hyperechogenicity on transcranial sonography. The development of brain changes were associated significantly with duration of abuse. At MRA moderate to severe vessel irregularity consistent with vasoconstriction and vasodilation was present in 28 (68%) case. TCD revealed reduced blood flow, increased pulsatility index (PI) values in MCA and ACA, also impaired CVR. No gender or side-to-side difference was observed for blood flow velocities or PI. The severity of TCD changes was associated significantly with duration of abuse longer than 3 years.

Conclusions
Our results suggests, that MRI demonstrate systematic brain structural deficits in Methcathinone abusers correlated with substantia nigra hyperechogenicity on transcranial sonography. Slowed cerebral blood flow velocity with increased pulsatility and impaired CRV in abusers indicate increased cerebrovascular resistance due to vasoconstriction of small cortical vessels.

EP-81

**Moderate and Severe Traumatic Brain Injury: Assessment of Diffuse Axonal Injury by Diffusion Tensor Imaging**

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**Purpose**
The clinical pathology underlying traumatic brain injury (TBI)-related impairment is diffuse axonal injury (DAI). Diffusion tensor imaging provides information about the directional coherence of water diffusion within tissue through the measurement of fractional anisotropy (FA), and complements the assessment of DAI obtained by conventional MRI. Our objective is to correlate FA values measured at white matter (WM) tracts with neurological outcome in patients with moderate and severe TBI.

**Materials and Methods**
Eighty patients with TBI (GCS<13) were admitted to our hospital (January 2008-December 2012). Diffusion tensor imaging was performed during the subacute phase of trauma, in a 1.5T scanner using 25 diffusion-encoding directions. To obtain FA values we placed ROIs in the corpus callosum, internal capsule (anterior and posterior limbs ALIC-PLIC), external capsule (EC), forceps major, forceps minor, cingulum, superior longitudinal fasciculus (SLF), inferior fronto-occipital fasciculus, inferior longitudinal fasciculus, corona radiate (anterior aCR, posterior and superior) and cerebral peduncles (CP). We calculated Pearson correlation coefficient between FA values and patient outcome at hospital discharge (Glasgow Outcome Score GOS) and after 6-month after trauma (extended GOS). We also evaluated which portion of the corpus callosum best discriminate patient outcome by means of the area under the ROC curve.
Results
We included 30 moderate and 50 severe head injuries (21 females and 59 males; mean age 35 years). Low FA values showed a significant correlation with poor outcome in all portions of the corpus callosum, right sCR, left SLF, left ALIC, both PLIC, both EC and CP. Pearson correlation coefficient showed a range of FA values between 0.283 and 0.514. The genu of the corpus callosum was the WM tract that best discriminated patient outcome.

Conclusions
Low FA values were associated in moderate and severe TBI with poor outcome at hospital discharge and 6 months postinjury. The genu of the corpus callosum showed the highest correlation with outcome.

EP-48
6:00AM - 3:00PM
MR Perfusion and MR Spectroscopy in Methotrexate induced Brain Parenchymal Necrosis relating to Indwelling Ventricular Catheter: A Valuable Tool in distinguishing from Recurrent Tumor.

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Purpose
1. To discuss the probable physiology and predisposing factors affecting development of methotrexate-induced brain parenchymal necrosis around indwelling ventricular catheters. 2. To illustrate MR imaging findings, MR perfusion and MR spectroscopy features, which help to differentiate chemotherapy-induced necrosis from tumor recurrence or progression.

Materials and Methods
Two patients were included in the study. The first patient, a 40-year-old woman with breast cancer and leptomeningeal metastasis had Ommaya reservoir placed for intrathecal methotrexate administration. Another woman with breast cancer and leptomeningeal metastasis had similar clinical course. In addition, she had a malfunctioning catheter. Both patients had received prior radiation therapy. After initial few cycles of chemotherapy their neurological conditions deteriorated and imaging was performed to assess disease progression. Brain MRI followed by dynamic susceptibility-weighted MR perfusion and multivoxel proton MR spectroscopy was performed.

Results
In both cases, brain MRI demonstrated new peripherally enhancing irregular lesion in the brain parenchyma, surrounding the catheter. Subsequent MR spectroscopy showed markedly decreased N-acetyl aspartate, Choline, Creatine peaks and elevated lipid. MR perfusion showed significant decreased regional cerebral blood volume and cerebral blood flow, compared to normal brain. Findings were not consistent with recurrent or second tumor. Taking into account the clinical history, risk factor of prior radiation, lesion location, the findings were felt secondary to chemotherapy-related necrosis.

Conclusions
Intraventricular catheters frequently are used to deliver chemotherapy such as methotrexate in cancer patients with leptomeningeal metastasis. However they can cause necrosis around the
catheter tract, the incidence of which increases with prior radiation. The appearance of necrosis on routine brain MRI may be confused with tumor recurrence. MR perfusion and MR spectroscopy can help solve the problem by demonstrating lack of increased blood volume, flow and decreased metabolites, features distinguishing it from tumor progression. To the best of our knowledge, there has been no prior report on MR perfusion and spectroscopy findings in methotrexate-induced brain parenchyma necrosis in the literature. Awareness of this complication in patients with indwelling catheters is critical, as it may be reversible, and it is important for the neuroradiologist to consider spectroscopy and perfusion for confirmation.

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**EP-03**

6:00AM - 3:00PM

**MR recognition of the differential diagnosis of corticospinal tracts lesions: a pictorial essay of amyotrophic lateral sclerosis and its “mimic syndromes”**.

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Purpose
Current diagnostic criteria of amyotrophic lateral sclerosis (ALS) is based on the upper motor neuron (UMN) and lower motor neuron (LMN) compromise in conjunction with the exclusion of "ALS mimic syndromes". The use of MRI has been justified only to rule out differential diagnosis. Despite that T1-magnetization transfer contrast imaging (T1-MTC) has emerged as a potential paraclinical tool for demonstrating a selective bilateral corticospinal tract (CST) hyperintensity in a particular phenotype of the disease with UMN compromise. However, many diseases involve encephalic motor pathways and a few of them may demonstrate a similar imaging pattern. Herein, we aimed, to confront imaging appearances between ALS and its "mimics syndromes".

Materials and Methods
Institutional imaging files from a single institution from January 2000 until December 2014 were reviewed retrospectively selecting patients with clinical suspicious of ALS and/or abnormal CST signal intensity on T1-MTC. The MR images were scrutinized by two experienced neuroradiologists in order to list all findings and to confront them with the final clinical diagnosis.

Results
We enrolled 295 subjects, including 126 ALS patients and a vast list of "mimic syndromes". Supratentorial selective bilateral CST hyperintensity sparing the bulbar pyramids on T1-MTC, as a solely MRI finding, was coincident with ALS diagnosis. All other included diseases presented additional MRI extra-motor findings, associated with variable imaging patterns. On the basis of these results, a flow chart was drafted to purpose an approach to differentiate the ALS and its mimic conditions based on the imaging features.

Conclusions
Appropriate MRI protocol should be done to recognize imaging patterns of ALS and its "mimic syndromes", particularly in patients with weakness and pyramidal signs. Our results reinforced that T1 MTC might be a highly specific imaging biomarker of UMN degeneration. However, radiologists must be aware that ALS is not the only cause of CST hyperintensity.
MRI Can Avoid Misdiagnosis in Seronegative Antiphospholipid Syndrome (SN-APS) of Central Nervous System (CNS) with Small Vessel Brain Lesions.

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Purpose
The main purpose is to define the usefulness of the MRI in the diagnosis of seronegative antiphospholipid syndrome (SNAPS) of central nervous system (CNS) with small vessel brain lesions, defined as the presence of clinical and MRI findings suggestive of antiphospholipid syndrome (APS) and persistent negative habitual antiphospholipid antibodies (APA). Recently, different antibodies directed against other molecules have been found in APS patients.

Materials and Methods
Series of 42 patients followed between 2011 and 2014. Control group: 13 patients with confirmed APS of CNS, small vessel brain lesions at MRI and presence of habitual APA. Study group: 29 patients with small vessel lesions at MRI and related CNS symptoms, with suspected APS and APA study persistent negative. These patients did not have cardiovascular risk factors and thrombophilia study was negative. We performed nonhabitual antiphospholipid antibodies (NH-APA) determinations in study group. Previously MRI studies already had been conducted including T1, T2, FLAIR and diffusion sequences (DWI). The lesions were classified according to the distribution, anatomical location, number and size. We used the Fazekas scale to determine the degree of white matter involvement.

Results
We found 18 (62%) patients from the study group with presence of NH-APA that allowed the SNAPS diagnosis. The most frequent NH-APA found was the phosphatidylserine/prothrombin complex (IgG isotype) in 66.6%. No differences were found when we compared MRI patterns between NH-APA study group and APS group. The MRI pattern with more than six supratentorial lesions and Fazekas scale ≥2 has been the most consistent finding, and also highly associated with NH-APA.

Conclusions
We have identified a MRI pattern defined by more than six supratentorial lesions and Fazekas scale ≥2 in patients with small vessel brain lesions associated to APS. In the absence of habitual APA, this pattern is associated highly with NH-APA, and a diagnosis of SN-APS should be suggested.

EP-82
Natural History of Subdural Hematoma and CT Imaging Density

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Purpose
The most valuable literature about the natural history of CT attenuation of subdural hematomas (SDH) is scant and several decades old (1). Particularly problematic is the use of nonspecific density terms without objective measurements. In particular, previous descriptions and case reports have led to the notion that hyperacute and acute SDH may be entirely hypodense (2). While heterogeneity and layering hematocrit effects may lead to hypodense acute areas, it is unclear based on the literature whether even small hyperdense components are completely absent in a purportedly "hypodense" acute hematoma (3). Case reports of homogenously hypodense
acute SDHs exist, and one possible explanation in the medical literature has been postulated as anemia (4, 5). The purpose of this study is to determine whether early acute SDHs always contain a hyperdense component (HU >40). In addition, we sought to determine the evolution of blood product density over time, with attention to the patient's hematocrit level.

Materials and Methods
A 6-month retrospective review of all patients undergoing two or more head CT studies in a 48-hour period was conducted yielding a screening database including 295 patients. Exclusion criteria included a prior surgical intervention, unclear onset of the event resulting in a SDH, absence of a SDH at the time of initial presentation, or the documented presence of a SDH prior to the event in question. Of the database, a total of 49 patients with SDHs present in their initial study were included in the study with all subsequent follow-up studies until surgical intervention, CT resolution, or loss to follow up included in the analysis. A total number of 200 studies at various time points were evaluated. The SDHs were divided by heterogeneity into either homogenous, simple layering, or heterogeneous. The HUs of the most dense portion of the SDH and the patient's hematocrit were recorded. We objectively measured and evaluated the densities of SDHs over time and correlated them with the patient's hematocrit levels.

Results
One hundred percent of the patients in our study had a hyperdense (>40 HU) component to their SDH in the acute phase (<7 days). One hundred percent of SDHs that were homogenous and <40 HU were subacute or chronic. All patients who had a hematocrit ≤33 (Range: 15.6 - 33) at the time of the initial scan had a hyperdense component to their SDH.

Conclusions
All SDHs in our study had a hyperdense component in the acute phase. Homogenously isodense to hypodense SDHs were not found to be acute. In our study, hyperdense SDHs were found even in anemic patients with hematocrits as low as 15.6 suggesting that anemia alone is not a sufficient explanation for acute isodense to hypodense SDHs in these patients.
Neuroradiological Aspects of Intracranial Dural Arteriovenous Fistula with Spinal Perimedullary Venous Drainage

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Purpose
Intracranial dural arteriovenous fistulas with spinal perimedullary venous drainage (Type V DAVF) are thought to be rare lesions with a progressive myelopathy and distinctive neuroradiologic aspects; however, there have been only a few reports of asymptomatic presentation. The purpose of this study was to correlate neuroradiologic findings of Type V DAVF with the presence or absence of myelopathy.

Materials and Methods
Eleven consecutive patients with Type V DAVF (9 men, 2 women; mean age, 61.1 years; range 41 to 75) were included. The diagnosis was confirmed by catheter angiography in all patients. Four patients had quadriplegia (symptomatic group). Seven patients did not suffer from myelopathy, but two of the seven developed subarachnoid hemorrhage (asymptomatic type). MR imaging and three dimensional time-of-flight MR angiography (TOF MRA) had been obtained before catheter angiography in all patients. The neuroradiologic findings were reviewed retrospectively on the basis of the consensus obtained by two experienced neuroradiologists.

Results
Of four symptomatic cases arteriovenous (AV) shunting was observed around tentorium in three and craniocervical junction in the remaining one, and drained into anterior medullary vein in all four. These four symptomatic cases had poor outflow vessels from anterior medullary vein, other than spinal veins and showed congestion of contrast media. In all four cases, the draining vein (anterior medullary vein) was not delineated on TOF MRA, and the swelling and T2 hyperintensity of medulla was observed. Seven asymptomatic cases showed AV shunting around craniocervical junction, draining into anterior medullary vein, and sufficient outflow vessels other than spinal vein, such as to petrosal veins and Galenic vein. These veins contributed to early washout of contrast media. In all asymptomatic cases the caudocranial flow of anterior medullary vein was delineated well on TOF MRA.

Conclusions
In symptomatic cases, the outflow congestion probably causes venous hypertension and myelopathy, and the loss of caudocranial flow of anterior medullary vein resulting in signal loss on TOF MRA. The correct diagnosis of type V DAVF by TOF MRA would be difficult in symptomatic cases; however, TOF MRA might be useful in differentiation between symptomatic and asymptomatic type V DAVF.
Newly Described Anatomic Signs Reliably Define Temporal Lobe Anatomy in Multiple Planes on MRI

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Purpose
When imaging the brain, precise anatomic localization in the temporal lobe is important since it contains closely positioned gyri with widely diverse functions. We defined and tested several anatomic imaging signs to allow rapid identification of specific temporal lobe gyri and sulci.

Materials and Methods
Volumetric MPRAGE (slice thickness = 1 mm) images were analyzed in 56 temporal lobes from 28 patients (females = 10, age range 1-79 years). Standardized axial, coronal, and sagittal planes were evaluated and cross-referenced. Two readers with a neuroradiology CAQ independently evaluated the following signs: 1) pointed superior temporal gyrus (identifies in the axial plane); 2) posterior insular corner (identifies Heschl's gyrus in the axial plane); 3) fork prong sign (identifies the collateral and occipitotemporal sulci anteriorly in the axial plane); 4) collateral sulcus (CS) bracket (identifies the mid CS in the axial plane); 5) CS arc (identifies in the sagittal plane); 6) occipitotemporal sulcus plateau (identifies in the sagittal plane); 7) the rabbit ear sign (identifies confluence of the rhinal sulcus and CS in the sagittal plane); and 8) parahippocampal 'Y' sign (identifies the confluence of the cingulate isthmus and lingual gyrus in the sagittal plane). Signs were considered present only with reader agreement.

Results
These signs were present in the following rates: 1) pointed superior temporal gyrus in 54/56
(96%); 2) posterior insular corner in 56/56 (100%); 3) fork prong sign in 44/56 (79%); 4) CS bracket in 55/56 (98%); 5) CS arc in 51/56 (91%); 6) occipitotemporal sulcus plateau in 55/56 (98%); 7) rabbit ear sign in 45/56 (80%); and 8) parahippocampal 'Y' sign in 56/56 (100%).

Conclusions
Temporal lobe gyri and sulci can be identified reliably in all three imaging planes using anatomical signs. The posterior insular corner sign to identify Heschl's gyrus and parahippocampal 'Y' sign were present in all cases.

EP-34
6:00AM - 3:00PM

Oncotic aneurysms with cerebral infarctions, chronic ischemia and development of synangiosis.

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Purpose
To present a clinical case with oncotic aneurysms with cerebral infarctions, chronic ischemia and development of synangiosis.

Materials and Methods
We present the case of a 53-year-old female, with history of auricular myxoma in 2000, subarachnoid hemorrhage in 2005 and multiple intracranial fusiforms aneurysms, probably oncotic, diagnosed by catheter angiogram in 2008. In 2009 she presented amaurosis fugax. Since then she had evolved asymptomatic. The patient was referred for a new angiography that showed eight stable intracranial fusiform aneurysms and synangiosis from both middle meningeal arteries; she was discharged next day after angiography.

Results
With angiography results we planned conservative management.

Conclusions
Previous reports had related myxomatous aneurysms and ischemia. Our case also presents extracranial-intracranial anastomosis ("synangiosis"). The probable explanation of synangiosis is the activation of inducible factors by chronic ischemia, like VEGF, platelet-derived GFβ and others.
Our Clinical and Radiological Experiences in Diagnosis of Acute Ischemic Stroke with Intra-arterial Thrombolytic Treatment

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Purpose
Stroke as a cause of death ranks third in our country as well as in the world. Furthermore, it
causes a loss of labor especially with middle-aged patients because it generates morbidity. We want to present data of 40 patients who had intra-arterial treatment in our clinic.

Materials and Methods
Between the years 2008-2013, we carried out intra-arterial treatment accompanied with digital subtraction angiography (DSA) to the patients who were admitted to the emergency department with stroke and had deficit but noncranial hemorrhage on computed tomography (CT) in the neurological examination.

Results
There were 27 (67.5%) male and 13 (32.5%) female patients and the average age was 63.5 years (23-78). The NIHSS scores were 7–29 (20.5) and the first initial neurological examination. In their cranial magnetic resonance imaging (MRI) and DSA, 23 patients had infarcts in the middle cerebral artery (MCA), 10 MCA total infarct, two anterior cerebral artery (ACA) and three in the basilar artery territory. We lost six patients because of intracranial hemorrhage in four patients and sepsis in two patients during the follow up. The tissue plasminogen activator (tPA) dose applied to the patients was 12 mg (6-20mg). The NIHSS scores after 24 hours were between 7–24 (6-20mg on average). Statistically improvement in the NIHSS scores after the intra-arterial treatment was observed.

Conclusions
Nowadays, intra-arterial therapy in acute ischemic stroke treatment, which is approved, is applied. In congestions of the internal carotid artery and proximal middle cerebral artery, intra-arterial treatment gained value because the thrombolytic agent can be introduced directly into the target (to clogged arteries) and thrombi. 30% Thirty percent of the patients who had thrombolytic therapy had complete recanalization, 48% partial recanalization and there was no change in 22% of the patients. But we observed that the clinical status of the patients who had complete recanalization and partial recanalization were better in their third month. With this study, we wanted to share our experience in intra-arterial thrombolytic therapy and emphasize the need of larger series of data in literature.

EP-27
6:00AM - 3:00PM

Postpartum Non-paraneoplastic Autoimmune Limbic Encephalitis

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Purpose
To describe a postpartum woman with symptoms of cognitive dysfunction and subsequent seizures due to postpartum autoimmune nonparaneoplastic limbic encephalitis (LE).

Materials and Methods
A 23-year-old woman 38 weeks pregnant admitted to our hospital with high temperature; giving birth by caesarean section. While she was under treatment for urosepsis in the hospital short-term memory deficit developed, dizziness and diplopia was added to her complaints. She was taken to the intensive care unit and was intubated after she had two generalized tonic-clonic seizures. Her lumbar puncture examination done to exclude the inflammatory causes was negative. Her EEG
result was normal. MR venography done to exclude thrombosis was negative. It is thought an immune-mediated encephalitis was the cause of the neurological and psychiatric disturbances. High titres of anti-VGKC-complex antibodies in the blood confirmed the diagnosis of VGKC-LE.

Results
T2-FLAIR images revealed high signal intensity changes in parahippocampal-hippocampal and mesiotemporal region extending to the mamillary bodies along cruse fornix. In addition, diffusion-weighted imaging (DWI) revealed restricted diffusion on above-mentioned areas. After steroid, intravenous immunoglobulin (IVIG) and plasmapheresis treatment, control MR imagings showed decrease in signal intensity in above-mentioned high signal regions.

Conclusions
The postpartum period is characterized by rapid shifts in the hormonal environment, leading psychiatric disorders rarely accompanied by seizures, also predisposition in autoimmune disorders due to excessive immune reaction in this period. In case of seizure, possible organic reasons should be exluded. MR imaging is helpful to differentiate encephalitis from postpartum psychosis. Limbic encephalitis which is seen mostly as a paraneoplastic condition, might be considered as a reason for neuropsychiatric disturbances due to excessive immune activity in the postpartum period.
Purpose
Functional MRI data requires multiple preprocessing steps which can be done by using various softwares with different algorithms. These varieties of solutions might result in some different functional localization for presurgical mapping. This study aims to establish a platform that can assess the accuracy of the localization and to test it on a widely used software.

Materials and Methods
The presurgical MRI exams of six right handed patients with different sizes of brain tumors at the fronto-parietal region were analyzed retrospectively. All scans were performed on a 3.0T GE MR scanner. It consisted of 3D T1, 2D T1 and a gradient-echo EPI functional scan. 2D T1 was acquired with the exact slice thickness and location of fMRI. The block-design motor task was analyzed using AFNI. The resultant correlation functional map was overlaid on both original EPI and 3D T1. An experienced neuroradiologist drew an ROI of the activation on 2D T1-weighted structural images, by referencing those overlaid on EPI volume (Figure 1). Then the manually drawn ROI was transferred to 3D T1, using the transformation matrix determined by registering 2D to 3D structural volumes using SPM8 software. The Euclidean distance between the manually drawn activation ROI and the software generated overlay were determined in the 3D structural image space. The size of the tumor/lesion and its distance to the activation blob was measured from the EPI volume.

Results
The tumor/lesion size ranged from 367 to 5088 mm³, with their centroid located 100-149 mm from the centroid of the activation foci. The distance between the centroid of software-localized activation and that of the anatomically based hand-drawn ROI ranged from 2.5 to 6.4 mm, with a mean of 4.6 mm and standard deviation of 1.8 mm. There was no statistically significant correlation between the size of the lesion or the lesion-activation distance with the distance between the software-localized activation and hand-drawn ROI.

Conclusions
We found that the overlay of the activation foci on high resolution T1 had errors of 4.6 +/- 1.8 mm in distance to the anatomically determined regions of activation. The localization error of functional blobs was not related to lesion size nor the distance between lesion and the activated area in motor cortex. The major contributors to this localization error may include patient motion between two scans and the distortion in echo-planar images. This platform will be applied to assess other available softwares and algorithms in the future.
Quantitative susceptibility mapping in detection of cerebral microbleeds in cerebral amyloid angiopathy

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Purpose
Cerebral microbleeds (CMB) associated with cerebral amyloid angiopathy (CAA) are common neuroimaging findings and often lead to detrimental clinical consequences in elderly subjects. Quantitative susceptibility mapping (QSM) is a novel technique that enables quantifying brain iron concentration in vivo. Purpose of the study is to evaluate the feasibility of routine clinical QSM which may have a potential diagnostic value as a complementary tool to conventional gradient-recalled echo (GRE) magnitude imaging and susceptibility-weighted imaging (SWI) in CAA.

Materials and Methods
Three patients (70–78 year-old, female) presented with intraparenchymal hemorrhage (IPH) were warranted for further evaluation on MRI after initial diagnosis of IPH on noncontrast head CT. All MRI scans were performed on 1.5T scanners using routine clinical protocol which included T1 and T2-weighted TSE, T2*-weighted 2D GRE and 3D fast low-angle shot (FLASH) SWI sequences. Cerebral amyloid angiopathy was confirmed by surgical pathology in two cases. Quantitative susceptibility mapping was reconstructed retrospectively from SWI data. Image processing steps for QSM included Fourier-domain phase unwrapping, background phase field removal using projection onto dipole fields (PDF) method, and solving ill-posed inverse field-to-source problem with morphology enabled dipole inversion (MEDI) method. Region of interest
(ROI) measures of QSM at amyloid plaques and site of IPH were performed using ImageJ software.

Results
Figure 1 demonstrates an example of in vivo QSM from one of our subjects. Quantitative susceptibility mapping allowed clear distinguish of paramagnetic CMB from diamagnetic mineral deposition and improved diagnostic accuracy with better marginal definition of the lesions by elimination of surrounding blooming effect. Areas of IPH manifested with high signal on T1 and large blooming effect showed higher value of QSM measure (mean=17051.38, SD=1897.12) than brain structures with physiologic iron distribution (i.e., caudate nucleus, putamen, globus pallidus, red nucleus, substantia nigra, and dentate nucleus). However QSM measures of CMB were highly variable (mean=7855.50, SD=5295.45).

Conclusions
We demonstrated feasibility of QSM in CAA with CBM from routine clinical MRI studies without additional special scans. Quantitative susceptibility mapping allowed improved diagnostic accuracy of CMB by taking advantage of paramagnetic specificity. This small pilot study was limited in that we were unable to quantify iron concentration of CMB in CAA distinctively from amyloid plaques. Further investigation on iron overload in CAA may provide valuable insight into prediction of hemorrhagic risk from the disease.
Quantitative validation of a threshold for distinguishing free-floating ICA thrombus from complex plaque

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Purpose
Filling defects identified at the ICA origin for the work-up of stroke/TIA may be due to an ulcerated plaque or free-floating thrombus (FFT). Accurate identification of FFT is of critical importance because of the potential for distal embolization. Prior research has suggested that the cranial-caudal extent of the filling defect seen at CT angiography (CTA) suggests a diagnosis of FFT rather than plaque. The purpose of our study was to validate a previously described quantitative measurement for distinguishing FFT from complex plaque in the ICA.

Materials and Methods
Our PACS archive between February 2013 and July 2014 was searched retrospectively for reports with the key words "free floating" thrombus in the ICA. Follow-up imaging reports were reviewed. Patients without follow-up imaging were excluded. The cranial-caudal length of the filling defect was measured by an experienced neuroradiologist. Filling defects which resolved completely or near completely on follow-up imaging were defined as FFT. Filling defects which remained static on follow-up imaging were classified as complex plaque. Patient demographics, imaging features and clinical data were collected and analyzed using univariate statistics. We evaluated the diagnostic performance of a 3.8 mm threshold for diagnosing FFT.

Results
There were 22 patients identified as possible FFT of which three were excluded for lack of imaging follow up leaving 19 patients for analysis. There were 16 males (84%) and three females (16%) with a mean age of 65 years. Median follow-up imaging was performed at 6 days. Mean length of filling defect was 9.3 versus 4.9 mm (p=0.43) in patients with FFT versus plaque. A threshold of 3.8 mm had the following diagnostic test characteristics: Sensitivity = 82.35% (CI: 56.55% - 95.99%), Specificity = 50.00% (CI: 8.17% to 91.83%), Positive Predictive Value = 93.33% (CI: 67.98% to 98.89%), Negative Predictive Value = 25.00% (CI: 4.12% to 79.66%).

Conclusions
Suspected cases of FFT seen at imaging with a threshold of 3.8 mm length had a high positive predictive value in this validation cohort. Filling defects shorter than 3.8 mm may still represent FFT; however, the clinical consequences of these smaller thrombi are unclear. A prospective study is warranted for further evaluation.
Radiological features of cerebellar glioblastoma in adults

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Purpose
Glioblastoma (GBM) is the most common malignant primary CNS tumor in adults; however the prevalence of GBM arises in cerebellum is extremely small. Cerebellar GBM, an even rarer histiotype, has been the subject of a number of reports. In cerebellar tumors in adults, a possible preoperative diagnosis can be based on the age of onset and imaging features. Malignant glioma rarely is considered in the pre-operative differential diagnosis. The possibility of glioma is mentioned, while primary consideration is given to metastatic brain tumor, hemangioblastoma, and primary central nervous system lymphoma. The purpose of this study is to demonstrate the radiological features of cerebellar GBMs including CT, MRI, FDG- and methionine (MET) - PET.
Materials and Methods
We retrospectively reviewed seven cerebellar GBM patients (six male, one female, 18-73 years, mean 56 years). We reviewed the medical records and radiological images including preoperative CT, MRI and PET. CT and MRI were performed in all patients. FDG- and MET-PET examinations were performed in three patients. All patients were treated with total or subtotal tumor resection. The pathological diagnoses were made in all patients.

Results
On CT, image findings of four patients were low density and one patient showed slightly high density compared with white matter. Hemorrhage was evident in one patient. CT could not detect the cerebellar tumor itself in one patient. On MRI, the tumors were predominantly high intensity on T2WI relative to the white matter in all cases. Contrast enhancements of the tumors were evident in six, and only a faint enhancement is observed in one case. Three cases showed irregular ring enhancement and one case showed nodular enhancement with necrosis. These four patients had common image findings with GBM and we could diagnose cerebellar GBM in four patients preoperatively. Two patients showed homogeneous patchy and nodular enhancement without necrosis on MRI resembled malignant lymphoma and metastasis. Positron emission tomography findings of these two patients were extent of MET uptake was larger than that of FDG uptake and contrast enhancement area on MRI. Tumor cells of astrocytic tumor and malignant lymphoma would infiltrate beyond the enhancing lesion, thus discrepancy between MET uptake and enhancing lesions on MRI suggest that the diagnosis would be GBM or malignant lymphoma. One case showed Lhermitte-Duclos disease like parallel linear striation ('tiger striped' appearance) was identified on left cerebellar hemisphere. Cerebellar GBM with Lhermitte-Duclos disease like 'tiger-striped' appearance is the first report in our knowledge. Although these three patients showed uncommon image findings with GBM, pathological diagnosis was confirmed with cerebellar GMB.

Conclusions
We reviewed the radiological features of seven cerebellar GBM cases including CT, MRI and PET. Some cases of our cerebellar GBMs showed uncommon radiological findings as GBM, therefore preoperative differential diagnosis is considerably difficult in such a case.
Purpose
The radiographic differentiation of brain tumor recurrence from post-treatment change is difficult and remains a challenge for radiologists and neurologists. The conventional MRI and different advanced MRI techniques offer the potential information that may help to distinguish between these two conditions. Aim of our study was to combine findings in both conventional MRI and advanced MRI and using multiparametric scoring system to determine recurrent disease in patients with treated gliomas.

Materials and Methods
Post-treatment 3T conventional and advanced MR imaging (perfusion MRI, DWI, and MR spectrography) were obtained in 28 patients (16 female, 12 male) who diagnosed glioma and previously were treated with surgery or combined surgery with chemoradiation. The findings on
conventional MRI were evaluated in terms of degree of precessional edema (mild <50%, moderated 50-75% and severe >75%), pattern of enhancement (thin linear, thick linear or nodular enhancement), hemorrhage and new enhancing lesion. Apparent diffusion coefficient (ADC) ratio, regional cerebral blood flow and blood volume (rCBF and rCBV), MRS Choline/Creatine ratio, Choline/N-acetyl-aspartate ratio within the lesions compared with contralateral normal white matter were evaluated and calculated for the optimum cut-off points based on thresholds derived from our own data. All data were correlated to final diagnoses established by histopathological and MR imaging follow up. Each finding was scored as positive (one point, exception for severe deem was rated as two points) and negative (zero point). The combined multiparametric scores (0-8) were analyzed and finding the optimal cut-off point to improve diagnostic accuracy for diagnosis of recurrent glioma.

Results
Moderate to severe perilesional edema, hemorrhage and new enhancing lesion are associated highly with recurrent glioma on conventional MRI (p = 0.046, 0.038 and 0.038, respectively). Thick linear and nodular enhancement occurred in eight of 10 (80%) recurrent glioma and two of 10 (20%) post-treatment cases (p=0.15). We found the optimum threshold for rCBV = 1 (sensitivity = 75%, specificity = 100%), rCBF = 0.8 (sensitivity = 75%, specificity = 66.7%), ADC ratio = 2 (sensitivity = 5%, specificity = 50%) but could not get the appropriate cut-off point for Cho/Cr and Cho/NAA in our study. Combined multiparametric score of conventional MRI and advanced MRI of two of eight, the sensitivity and specificity for detection of recurrent tumor was 83.3% and 100%, respectively. If we used the data from previous published study, the Cho/Cr or Cho/NAA ratio with diagnostic value greater than two on MRS will give high accuracy for diagnosis of recurrent tumor (sensitivity and specificity > 75%) as optimum value in our study, the multiparametric score threshold of three of nine yielding high diagnostic accuracy (sensitivity = 83.3%, specificity = 100%) for prediction of tumor recurrence or post-treatment change.

Conclusions
Combined findings from conventional and advanced MRI has potential to improve overall diagnostic accuracy in differentiating tumor progression from the post-treatment change.

EP-54

6:00AM - 3:00PM

Retrospective analysis for the 11C-methionine and 18F-FDG uptakes of the primary brain tumor

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Purpose
18F-FDG is the most widely used for tumor diagnosis, but there is a limit for evaluation of intracranial tumors such as gliomas because of strong uptake in normal brain tissue. 11C-methionine PET recently has been demonstrated to be effective for diagnosing various malignant brain tumors instead of 18F-FDG. Each of these radiotracers had respective intrinsic uptake mechanisms, and different information was acquired from those PET/CT images. The purpose of
this study is to investigate the diagnostic performance of uptakes on 11C-methionine PET/CT and 18F-FDG PET/CT in patients with primary brain tumors.

Materials and Methods
Forty patients (22-85 years old mean 54.9 years, 19 male and 21 female) with primary brain tumor were included, who have been proved pathologically after surgical resection or biopsy from January 2013 to October 2014. PET/CT examination using 11C-methionine and 18F-FDG was performed in all patients, and MRI also was performed. We retrospectively assessed the uptakes of each radiotracers for brain tumor on PET/CT scans, and calculated the scores including the maximum standardized uptake value (SUVmax), tumor-to-normal ratio (TNR), and metabolic tumor volume (MTV). MR images also were used as the reference of evaluation.

Results
Of the 40 patients, WHO grade I tumor was one case, WHO grade II tumor were seven cases, WHO grade III tumor were five cases, WHO grade IV tumor were 25 cases, and malignant lymphoma were two cases. The methionine uptake for brain tumor was depicted more clearly because of higher contrast. On the other hand, the FDG uptake was sometimes unclear because the uptake in surrounding normal brain tissue was strong as well as tumor, and accurate measurement of FDG uptake was difficult in some cases. The uptake of tumors with higher malignancy was stronger than that of benign tumors on both PET/CT scans. As the tumors with WHO grade I or II, the both uptakes were hardly shown. In the cases of malignant lymphoma, the uptake of both tracers, especially FDG, was stronger than the other tumors. The difference between WHO grading and the uptake pattern was not significant in this study.

Conclusions
It is suggested to be helpful for the proper preoperative diagnosis on primary brain tumors by evaluating properly in combination with the results of 11C-methionine and 18F-FDG uptakes, in addition to conventional CT and MR images.
Fig. 30M, glioblastoma. (a) plain CT, (b) MRI, (c) 11C-methionine PET, and (d) 18F-FDG PET. There was the round-shape tumor with Gd-DTPA enhancement in the Lt. temporal lobe (a) (b). Necrotic change could be detected inside the tumor. The solid part of the tumor uptake was on the 11C-methionine (c) and 18F-FDG PET (d). In this case, the methionine PET showed better contrast to the background brain tissue and was depicted more clearly compared to the 18F-FDG PET.
Purpose
Clinically mild encephalitis/encephalopathy with a reversible splenial lesion (MERS), otherwise known as a transient lesion of the splenium (TLS) has been described for many entities, including epilepsy, demyelination, posterior reversible encephalopathy, diffuse axonal injury, AIDS dementia complex, various viral and nonviral infections, and hypoglycemia. However, to date such splenial lesions have not been described in association with subarachnoid hemorrhage. We present two cases of isolated transient splenial lesions associated with subarachnoid hemorrhage.

Materials and Methods
We retrospectively reviewed the medical records and imaging findings in two patients who presented with SAH and subsequently were found to have splenial lesions with reduced diffusion between July and December 2014. Initial noncontrast MRI/MRA imaging following CT imaging for the purpose of localizing possible aneurysms and subsequent follow-up imaging studies were reviewed.

Results
Two male patients (ages 42 and 68 years) presented with acute onset headache and nausea. One had a history of untreated hypertension and the other did not. Both were found to have hypertension with systolic blood pressures varying between 140-170 at presentation. Noncontrast head CT revealed SAH. Subsequent MRI/MRA was obtained for evaluation of aneurysms. One patient was found to have a small aneurysm of the posterior communicating artery; the source of bleeding remained occult in the other. MRA was otherwise unremarkable. Both patients demonstrated small focal midline splenial lesions that were T2/FLAIR hyperintense with reduced diffusion on DWI, initially interpreted as acute ischemia. Follow-up scans approximately 1 month later demonstrated resolution of the splenial lesions in both patients.

Conclusions
Focal splenial lesions with reduced diffusion are recognized increasingly in various conditions and should not be mistaken for focal infarction. We report two cases of splenial lesions in patients who presented with acute subarachnoid hemorrhage.
Simple CBF grading based on MR perfusion to anticipate long-term clinical outcome in severe stroke patients due to the carotid artery occlusion

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Purpose
To investigate if CBF grading based on MR perfusion was useful for anticipating clinical outcome in stroke patients due to the carotid artery occlusion (CAO).

Materials and Methods
Patients 1) admitted within 24 hours between Jan 2005 and May 2014, 2) with CAO displayed by MRA, 3) treated without any reperfusion therapy. We evaluated CBF grades, any death within 120 days and clinical outcome at 90 days. Cerebral blood flow grade was based on time-intensity curves (TICs), which were generated 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 regarded the affected-sided PSa divided by TPa as CBFa and the contralateral-sided PSc divided by TPe as CBFc. Cerebral blood flow grade 1 was defined as CBFa divided by CBFc (CBF%) less than 0.2, grade 2 as CBF% of 0.2 or more and CBF% less than 0.6 and grade 3 as CBF% of 0.6 or more.

Results
Sixty-three patients were analyzed. In grades 1, 2 and 3, there were 25, 25 and 13, and survival rate (SR) of the Kaplan-Meier method at 120 days was 20%, 50.4% and 76.2% (p<0.001), respectively. In grades 1, 2 and 3, 0, 0 and one patient was in mRS of 0-2, one, seven and eight patients in mRS of 3-4 and 24, 18 and four patients in mRS of 5-6 (p<0.001).

Conclusions
Cerebral blood flow grading based on MR perfusion was useful for anticipating clinical outcome in CAO patients.
Time Intensity Curve from PWI

Time to peak (TP), Peak signal (PS) in the affected (a) and contralateral (c) MCA territory

(Filename: TCT_EP-78_1.jpg)
Possible CBF and relative CBF

- Affected side possible CBFa; PSa/TPa
- Contralateral side possible CBFc; PSc/TPc
- Relative CBF (CBF%); CBFa / CBFc

(Filename: TCT_EP-78_2.jpg)
Relative CBF grading

Time Intensity Curve from MRI-PWI

CBF%; CBFa / CBFc

grade 1: $\text{CBF}\% < 0.2$
grade 2: $0.2 = < \text{CBF}\% < 0.6$
grade 3: $0.6 = < \text{CBF}\%$

(Filename: TCT_EP-78_3.jpg)
K-M estimation of Survival Probability (n=63)

![Survival Probability Kaplan-Meier Curve]

**Purpose**
We postulated that a single exposure to a hypobaric environment (25,000 ft) with or without hypoxia, would induce transient MRI changes in fractional anisotropy, arterial spin labeling cerebral perfusion and spectroscopy data, in addition to changes in inflammatory biomarkers.
Our goal is to characterize the pathophysiologic response of the brain to high altitude exposure in order to understand its association with previously demonstrated subcortical white matter injury.

Materials and Methods
Four study limbs included: 1. Hypobaric and hypoxic (initial altitude chamber training); 2. Hypobaric, non-hypoxic (altitude chamber aerospace technicians); 3. Hypoxic, nonhypobaric (reduced oxygen breathing device, aircrew refresher training); and 4. Normal controls. Each limb of the study will consist of 50 volunteers with exception of limb 1 which will include up to 100 volunteers. Standard U.S. Air Force altitude chamber physiologic training includes exposure to a maximum of 25,000 feet above sea level. We performed MRI imaging on a 3T Siemens Verio magnet 1 day prior, 1 day post, and 3 days postexposure, conducted for initial and/or re-qualifying Air Force flight training requirements. MR protocol included six axial MPRAGE sequences with TI ranging from 766-801 (TR 2200, TE 2.88) and a summation series with motion correction, MRS with TE of 30 and 135 within the right and left frontal white matter and anterior cingulate gyrus, diffusion tensor and Q-space imaging, arterial spin labeling perfusion imaging, and 3-D FLAIR (0.8 mm, TR 4500, TE 311) images. Phlebotomy was performed for laboratory analysis immediately prior to altitude chamber or hypoxic exposure, immediately postaltitude chamber exposure, and prior to MRI #2 and MRI #3. Laboratory analyses included S100B, tumor necrosis factor alpha, interleukin-6, interferon gamma, and microparticle analysis. Control patients underwent the four blood draws at equivalent times during the day as the other three study limbs.

Results
Preliminary data from the first 19 subjects (16 from limb 1 and three from limb 2) demonstrates an increase in cerebral blood flow to both gray and white matter 24 hours after altitude chamber exposure in addition to an up-regulation of glutamate/glutamine in the anterior cingulate gyrus. Laboratory analyses are significant for an increase in microparticles < 1 um in size after altitude exposure (2nd and 3rd samples) and a more delayed platelet activation (4th sample). There is also an apparent increase in %CD62P expression on platelets and the median CD41 (platelet specific protein on the neutrophil surface), suggesting platelet-neutrophil interactions.

Conclusions
Initial MRI results suggest that a single altitude exposure to 25,000 feet results in an increased metabolic demand on the brain and oxidative stress. Initial laboratory findings suggest an inflammatory response after altitude exposure with an acute increase in microparticles and delayed platelet activation. The response is somewhat heterogeneous which may reflect inherent individual biovariability or small sample size.

EP-13
6:00AM - 3:00PM

Spontaneous Dilatation of Stents at Three Months after Carotid Artery Stenting without post-CAS Balloon Dilatation

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Purpose
The aim of our retrospective study was to investigate how wide stents were spontaneously dilated at 3 months after carotid artery stenting (CAS) without post-CAS balloon dilatation (BT).
Materials and Methods
We included in our analysis patients 1) who underwent elective CAS without post-CAS BT from January 2012 to August 2014, 2) who underwent follow-up conventional angiography at 3 months after CAS. Patients' baseline characteristics, stent types (open cell: OP or closed cell: CL), stent diameter (SD) at the site with minimum width on the lateral projection immediately and at 3 month after CAS were evaluated.

Results
Seventy-one lesions in 68 patients were analyzed. Their average age was 74.8 years old, median SD immediately after CAS was 3.27mm (3.06-3.68 : interquartile range), median SD at 3 months was 3.99mm (3.58-4.3), and thus SD was dilated spontaneously (p<0.0001). In OP types (18 cases), median SD changed from 3.59 to 4.05 mm and in CL types (53 cases) from 3.22 to 3.86 mm. Median SD after deployment was wider in OP type anytime (p<0.05), whereas dilatation rate seemed to be bigger in CL type.

Conclusions
Stents were dilated spontaneously about 10 to 20% without post-CAS balloon dilatation. Stent diameter at 3 months was wider in OP type, whereas dilatation rate at 3 months was bigger in CL type.

EP-02
6:00AM - 3:00PM

Structural MRI as a paraclinical tool for the diagnosis of corticobasal degeneration.

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Purpose
Corticobasal degeneration (CBD) is a progressive neurodegenerative disorder whose diagnosis currently is underestimated by its heterogeneous presentation that can mimic clinically other neurodegenerative diseases. Sporadic reports have described structural magnetic resonance imaging (MRI) findings showing intimate correlation with the pathology and potential accuracy for the diagnosis of the disease. We aimed to describe the main clinical and MRI findings in a series of patients with CBD.

Materials and Methods
Institutional imaging files from a single institution from January 2000 until December 2014 were reviewed retrospectively to analyze the structural MRI findings and their clinical correlation in a series of 23 patients with CBD, comparing our results with a systematic literature review to emphasize the clinical, demographic and imaging findings that subsidize the diagnosis.

Results
Although the clinical manifestations observed in our series were variable, cognitive changes (81.8%) and extrapyramidal symptoms (63.6%) have predominated. Generalized atrophy was the most prevalent imaging finding in this series (95.4%), what is also described in the literature. The presence of different degrees of asymmetric cortical atrophy associated with signal abnormalities in the frontal (59.1%) and parietal (63.6%) subcortical white matter were the discriminatory findings related to the diagnosis of CDB.

Conclusions
Our results reinforced the use of structural MRI with good correlation with clinical patterns of
CDB and the combined use of such information is encouraged by the authors for the in vivo diagnosis of this rare disease.

Fig. 1 – Corticobasal degeneration. Axial FLAIR demonstrated generalized cortical atrophy predominantly on the right frontoparietal area associated with subtle hyperintensity of the adjacent subcortical white matter (arrow).

Fig. 2 – Corticobasal degeneration. Axial FLAIR demonstrated generalized cortical atrophy in the left parietal and temporal lobe with subtle hyperintensity of the adjacent subcortical white matter (arrow).

EP-06

Susceptibility-weighted imaging of nigrosome 1 in Lewy body diseases: Comparison with dopamine transporter SPECT

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Purpose
Introduction: Both Parkinson disease (PD) and dementia with Lewy bodies (DLB) result from striatal dopaminergic depletion secondary to the degeneration of dopaminergic neurons in the substantia nigra (1). Dopamine transporter (DAT) single-photon emission computed tomography (SPECT) with 123I-FP-CIT is the imaging modality used most widely to assess nigral degeneration and thus diagnose PD and DLB (2, 3). However because DAT SPECT is costly and exposes subjects to radiation, noninvasive markers of dopaminergic degeneration are needed urgently. The loss of dopaminergic neurons in patients with PD or DLB is most prominent in the nigrosome-1 subregion (4); reportedly this is detectable with 3T susceptibility-weighted MRI (SWI) (5). In a retrospective cross-sectional study, we evaluated whether 3T SWI detects alterations in nigrosome 1 and accurately diagnoses PD and DLB. We also compared diagnostic accuracy between SWI and DAT SPECT.

Materials and Methods
We assessed 83 consecutive patients who underwent SWI and DAT SPECT (>50 years; 39 PD, 14 DLB, 30 non-PD). Two raters independently classified patients into 2 groups - those with PD or DLB and those without either disease according to the absence or presence, respectively, of nigrosome 1 and striatal DAT binding. Diagnostic accuracy was assessed against clinical diagnosis.

Results
Absolute inter-rater agreement was ≥92% (κ≥0.84, P<0.001). Susceptibility-weighted imaging readily revealed the healthy, oval-shaped nigrosome 1 in the dorsolateral SN of patients without PD or DLB, but this structure was absent on scans from patients with PD or DLB. The diagnostic accuracy of SWI versus that of DAT SPECT was 93% versus 87% (sensitivity, 95% versus 93%; specificity, 87% versus 70%; negative predictive value, 0.87 versus 0.80; positive predictive value, 0.95 versus 0.89), respectively.

Conclusions
Using SWI to assess nigrosome 1 has a potential equal to or greater than that of DAT SPECT as an easily applicable 3T MRI modality for diagnosing nigral degeneration in PD or DLB.
T1-weighted DCE-MRI as a Non-invasive Biomarker of EGFRvIII Status

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Purpose
Epidermal growth factor receptor variant III (EGFRvIII) is a common mutation in glioblastoma, found in approximately 25% of tumors. EGFRvIII may accelerate angiogenesis in malignant gliomas. We hypothesize that T1-weighted dynamic contrast-enhanced (DCE) MRI can be used as a noninvasive indicator of EGFRvIII status.
Materials and Methods
The primary cohort was formed by 82 consecutive patients with glioblastoma and known EGFRvIII status who had DCE MRI before surgery. Volumes-of-interest were drawn around the entire enhancing tumor on contrast T1-weighted images and then transferred onto coregistered DCE perfusion maps. Histogram analysis was performed to determine the mean, 75th percentile and 90th percentile values for the plasma volume (VP) and permeability transfer constant (Ktrans). A Wilcoxon rank-sum test was applied to assess the relationship between baseline perfusion parameters and EGFRvIII mutation status, and Cox proportional hazard model to examine the effect on survival.

Results
Increased VP and increased Ktrans parameters were associated with mutant EGFRvIII status. The VP histogram metrics (p<.0001) outperformed the Ktrans histogram metrics (p<.02). No difference in overall survival (OS) or progression-free survival (PFS) was found.

Conclusions
Dynamic contrast-enhanced MRI shows higher perfusion and leakiness in mutant EGFRvIII glioblastomas than in wild-type EGFRvIII glioblastomas. These results suggest that DCE perfusion MRI may be used as a predictor of EGFR gene amplification.

EP-55
6:00AM - 3:00PM

The Correlations of 3D Pseudo-continuous Arterial Spin Labeling and Dynamic Susceptibility Contrast Perfusion MRI in Brain Tumor

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Purpose
Dynamic susceptibility contrast (DSC) perfusion MRI and arterial spin labeling (ASL) are two common perfusion MRI methods to evaluate brain tumor. Recently Tmax was introduced as a reliable parameter to evaluate cerebral hemodynamics. The purpose of the study was to compare ASL with DSC perfusion MRI parameters especially including a new transit parameter 'Tmax' in brain tumor.

Materials and Methods
Thirty one (N=31) patients with brain tumor underwent ASL and DSC MRI. Arterial spin labeling cerebral blood flow (ASL CBF) was performed using 3D pseudo-continuous arterial spin labeling. The relative cerebral blood volume (rCBV), relative cerebral blood flow (rCBF) and time to maximum (Tmax) are obtained by DSC MRI. Absolute mean ASL CBF, rCBV, rCBF and Tmax value are estimated from the tumor. The ASL CBF ratio, rCBV ratio, rCBF ratio and Tmax ratio were estimated by tumor value divided by normal contralateral white matter. The statistical analysis was assessed by Spearman's correlation and T-test.

Results
Arterial spin labeling CBF ratio is correlated with rCBV ratio (r=0.652, p<0.001), rCBF ratio (r=0.738, p<0.001) and Tmax ratio (r=-0.417, p<0.05) in the brain tumor. The absolute ASL CBF, ASL CBF ratio, rCBV ratio and rCBF ratio are significantly higher in GBM than in III
grade glioma (p<0.05). Absolute ASL CBF, rCBV ratio, rCBF ratio are significantly higher in GBM than in PCNSL (p<0.05).

Conclusions
Arterial spin labeling is closely correlated with rCBV and rCBF in brain tumor. Additionally, there was a negative correlation between ASL and Tmax. Arterial spin labeling would include vascular transit delay which is contrary to rCBF and rCBV.

EP-75

The prediction of prognosis using ADC volume in endovascular revascularization therapy for acute ischemic stroke

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Purpose
The recent shift of endovascular treatment (ET) methods for acute ischemic stroke towards better outcome. We hypothesized that bigger core volume may be tolerable to further ET. This study was designed retrospectively to predict the prognosis using ADC volume in endovascular revascularization therapy for acute ischemic stroke.

Materials and Methods
Patients with acute ischemic stroke in anterior circulation territory and intra-arterial (IA) revascularization therapy were retrieved. Apparent diffusion coefficient volume taken before the IA therapy was calculated quantitatively with the margin thresholds of ADC value as 700x10^-5 mm²/s. Futile prognosis was defined as modified Rankin Scale 5-6 at 3 months. We divided patients into three groups. Group 1 represented with ADC volume less than 50 cm³, group 2 with 50 to 100 cm³ and group 3 with more than 100 cm³. Baseline characteristics (age, initial NIHSS score), imaging data (successful revascularization, TICI 2a-3) and clinical outcomes (good outcome, mRS 0-2 at 3 months; poor outcome, mRS 5-6) were compared among groups. Logistic regression and receiver operating characteristic (ROC) curve analyses were done.

Results
Finally, 76 patients were enrolled in this study. There is no difference of age and successful revascularization among the groups. Larger volume group show significantly high initial NIHSS score (p=0.027) and poor outcome (p < 0.001). Apparent diffusion coefficient volume more than 100 cm³ was associated significantly with futile prognosis [p=0.001, Odds ratio, 25.4 (95%CI, 3.874-166.673)]. The area under the ROC curve for ADC volumes was 0.675 (p=0.009). For predicting futile prognosis, sensitivity and specificity were 57.6% and 69.8% at ADC volume 50 cm³, 48.5% and 95.3% at 100 cm³ and 33.3% and 97.7% at 150 cm³, respectively.

Conclusions
A huge DWI volume was associated with the futile prognosis. This imaging marker, however, could not be a single sign for stopping further aggressive IA treatment for acute ischemic stroke because the area under the ROC curve was relatively small. When IA therapy is considered, well known harmful factors including old age, high NIHSS score and huge ADC volume should be combined altogether for 'no more to go'.
The Relationship Between Age and Infarct Volume In a Canine Stroke Model

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Purpose
Ischemic stroke is a disease that mainly affects the elderly, and increasing age is a strong predictor of poor clinical outcome (1). In the wake of many failed clinical trials of treatments that were first tested successfully on laboratory animals, the experimental studies received criticism for commonly employing young animals (2, 3). Since studies in rats have corroborated the importance of age by identifying physiological and histological differences in older stroke brains, careful examination of the relationship between age and outcome in other commonly used laboratory animal models of ischemic stroke is warranted (2-5). We therefore evaluated the
Effects of age and occlusion time on infarct volume in a well-established canine model of large-vessel occlusion. We hypothesized that increased age is associated with larger infarct volumes.

Materials and Methods
We retrospectively analyzed data from two studies that employed a similar model of ischemic stroke in canines. Unilateral large vessel stroke (MCA) was created in 16 female canines (n=10 in study 1, n=6 in study 2) by injection of an autologous blood clot under fluoroscopic guidance. Diffusion-weighted MRI was performed at 296±43 min after clot injection. Subject age was 3.13±1.21 years (range 1-5). Diffusion-weighted imaging MRI was performed at 296±43 min after clot injection. To study the effect of occlusion time on infarct volume, animals were assigned to either group 1 (<300 min; n=6) or group 2 (>300 min; n=10). Infarct volumes were calculated from manual segmentations of ADC maps using ITK-SNAP. Linear regression analyses were performed to test for effects of age and occlusion time on final infarct volume.

Results
Overall, mean infarct volume was 11807±6547 mm³. There was no significant correlation (R²=0.08) between age and infarct volume (Panel A). Mean occlusion time differed significantly between groups (p<0.001). Infarct volumes were 7403±6551 mm³ and 14449±5187 mm³ in group 1 and 2, respectively (Panel B). The difference between the groups was not statistically significant (p=0.052).

Conclusions
Unlike findings in rodent studies, our results suggest that infarct volume in a large vessel occlusion model in canines is largely unaffected by age. Nevertheless, the age range in our study was limited, considering that the average life expectancy of dogs is about 10 years. Furthermore, the wide range of infarct volumes may have limited our power to detect more subtle effects of age.
The Uniform Cortex Sign: A Diagnostic Sign of Diffuse Cortical Injury at MR Imaging of the Brain

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Purpose
The cortical thickness of the posterior bank of the central sulcus is amongst the thinnest in the brain, and the difference in cortical thickness across a single sulcus is greatest at the central sulcus. These features can be used to identify the sensory strip; we have termed this the thin cortex sign (TCS). With diffuse cortical injury, swelling can cause the cortical thickness across the paracentral gyri to become more equal; we have termed this the uniform cortex sign (UCS). This sign is introduced, and its performance as a test for the presence of diffuse cortical injury is evaluated.

Materials and Methods
Three experienced neuroradiologists were given a tutorial on the normal variation in cortical thickness of the paracentral gyri, and were shown the TCS in two control patients (screening for unruptured aneurysm in neurologically intact patients with family history of cerebral aneurysm) and the UCS in one patient with diffuse cortical injury from cardiac arrest. The paracentral gyri on selected axial DWI, axial T2, axial FLAIR, sagittal FLAIR and coronal FLAIR imaging of seven patients with UCS and seven control patients were assessed independently in a blinded fashion by these three readers for the presence of a UCS or TCS.

Results
The radiologists were able to correctly identify the thin cortex sign in 100% of normal cases (7/7), and the uniform cortex sign was correctly identified in 81% of cases (6/7) with diffuse cortical abnormality.

Conclusions
The UCS appears to be an accurate test for the presence of diffuse cortical abnormality, and the TCS may be a useful complementary method to identify the central sulcus.
EP-43 6:00AM - 3:00PM

**Time resolved Contrast Enhanced MRA and Post contrast TOF MRA offer additional value in the assessment of intracranial aneurysms treated by endovascular techniques**

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**Purpose**
MR angiography is now an acceptable alternative to catheter directed angiography in the long term follow up of both ruptured and un-ruptured intracranial aneurysms treated with endovascular techniques. However, unenhanced TOF MR angiography may underestimate the degree of recanalization, especially in larger aneurysms with recurrence following treatment. The purpose of this study is to determine the added value of contrast-enhanced MRA techniques – time resolved first pass (TRICKS, TWIST) and delayed TOF techniques by comparison to unenhanced TOF MRA, and when available, accuracy with respect to conventional invasive angiography in the surveillance of patients with intracranial aneurysms treated with endovascular techniques.

**Materials and Methods**
Patients with intracranial aneurysms previously treated with endovascular techniques underwent imaging follow up of their aneurysms with unenhanced time-of-flight MR angiography, time resolved contrast sensitive MRA (TRICKS, TWIST) and postcontrast time-of-flight MR angiography. A consensus read by two neuroradiologists assessed the value offered by each technique in depicting recanalization.

**Results**
Time resolved contrast sensitive MRA and postcontrast TOF offer additional value over unenhanced TOF in the assessment of treated aneurysms.

**Conclusions**
Contrast-enhanced time resolved MRA and postcontrast TOF MRA allows more reliable depiction and quantification of aneurysm recurrence and recanalization when compared to routine unenhanced time of flight MR angiography.

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EP-10 6:00AM - 3:00PM

**Transmantle sign and focal cortical dysplasia**

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**Purpose**
Focal cortical dysplasia (FCD) was first described by Taylor (1971) and very frequently is associated with refractory epilepsy. It can be diagnosed only by high resolution MRI, but the findings usually are negative. Among MRI abnormalities, the transmantle sign is a very useful
evidence, frequently related with FCD type IIb. It is characterized by an area of signal abnormality extending radially inward toward the lateral ventricle from the cortical surface and was first described in a subset of focal cortical dysplasia. Our objective was to evaluate how sensitive is the presence of the transmantle sign for FCD and determine its specificity.

Materials and Methods
We retrospectively reviewed brain MRI of 107 consecutive patients who underwent surgery for refractory epilepsy with diagnosis of focal cortical lesion between January 2009 and January 2014. Two neuroradiologists looked for the transmantle sign in MRI data. Based on histopathology, each lesion was classified on FCD (types I and II or III, according to ILAE 2011 classification), tumors, tuberous sclerosis (TS) and miscellaneous (glioneuronal hamartoma, polymicrogyria, astrogliosis, gray matter heterotopia and vascular malformations). Finally, they correlated the frequency of transmantle sign to each group of lesions.

Results
The transmantle sign was significantly more frequent in FCD II (p<0.05) and TS (p < 0.001) and specifically related to FCD IIb (p < 0.001). It also was observed as a pseudo transmantle sign with broad T2 hyperintensity through cerebral mantle to the ventricle, thicker than the classic transmantle sign, significantly more frequent in cortical long term epilepsy-associated tumors (p<0.001). Furthermore, in the absence of an abnormal diffuse white matter sign, it was associated significantly to type I FCD (p<0.001).

Conclusions
The recognition of transmantle sign is highly indicative of FCD IIb and may help to localize the epileptogenic lesion in epilepsy surgery candidates.

EP-30
Usefulness of Gd-enhanced 3D T2 fluid-attenuated inversion recovery imaging in various infectious meningitis

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Purpose
On fluid-attenuated inversion recovery (FLAIR) imaging with a three dimensional (3D) technique, flow artifacts disappear and the signals from the cerebrospinal fluid are better suppressed, compared to 2D FLAIR. The purpose of our study was to evaluate the usefulness of Gd contrast-enhanced 3D T2 FLAIR in cases with infectious meningitis.

Materials and Methods
The subjects were 35 consecutive cases diagnosed with acute infectious meningitis from April 2010 to September 2014 based on the clinical symptoms and spinal fluid findings and from whom Gd-enhanced T1-weighted and 3D T2 FLAIR images could be obtained at the same time by 3T MR machine. These comprised bacterial (including suspected) 13 cases, viral (including aseptic) 11 cases, tuberculous (diagnosed by elevation of adenosine deaminase) eight cases, and others three cases. For T2 FLAIR, the 3D technique was used and for T1-weighted images 3D SPGR (GRE) or 3D T1 FSE sequences were used, after administration of Gd-DTPA. Regarding the high signal intensity of the cerebral fissure cistern on contrast-enhanced FLAIR, the cistern (medullary cistern, pontocerebellar cistern, interpeduncular cistern, Sylvian fissure), and cerebral
fissure (cerebellar hemisphere, frontal lobe, occipital lobe, parietal lobe, temporal lobe) and other additional findings were evaluated visually. These were compared with those on contrast-enhanced T1-weighted 3D SPGR or FSE images.

Results
In bacterial, including pneumococcal, meningitis, scattered nodular enhancement was seen on the brain surface particularly in the deep portion of the interpeduncular cistern and Sylvian fissure. These lesions were easier to appreciate on enhanced FLAIR images than on enhanced T1-weighted images. In the cisterns, enhancement was noted in the interpeduncular and medullary cisterns. Viral meningitis was mostly of the pial type. On Gd-enhanced FLAIR, cerebral fissure enhancement was seen to be diffuse, being especially prominent in the cerebral fissure of the parietal and occipital lobes. In tuberculous meningitis diagnosed on the basis of adenosine deaminase positivity too, these cases showed high signal intensity diffusely in more of the cerebral fissure. These findings on Gd-enhanced 3D FLAIR were more detectable than those on Gd-enhanced T1-weighted images.

Conclusions
Gd-enhanced 3D T2 FLAIR imaging provided more information, compared to Gd-enhanced T1-weighted imaging in cases with infectious meningitis. Gd-enhanced 3D T2 FLAIR imaging plays an important role in diagnosing meningitis as a postcontrast study.
Utility of Arterial Spin Labeling (ASL) Perfusion as a Pronostic Factor of Cerebral Ischemia in Tumors which Encase and Stenose the Internal Carotid Artery (ICA) at the level of the Cavernous Sinus.

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Purpose
Evaluation of the risk of cerebral ischemia using arterial spin labeling (ASL) in asymptomatic patients with tumors invading the cavernous sinus and causing encasement and stenosis of the ICA. We hypothesized that reduced cerebral perfusion associated to stenosis of ICA evaluated with Angio-RM 3D TOF could be a prognostic risk factor for cerebral ischemia.

Materials and Methods
We performed arterial spin labeling CBF and Angio 3D TOF of the ICA complementing the standard MRI protocol in 14 patients with tumors that invaded the cavernous sinus (9 meningiomas and 5 acroadenomas). None of the patients had symptomatic ischemia. The evaluation of the grade of stenosis was performed by using Angio-RM 3D TOF comparing the affected ICA with the contralateral side. In all the cases stenosis was greater than 15%.
Quantitative mean cerebral CBF was measured and averaged at three consecutive images just above the centrum semiovale by using region-of-interest analysis (size 6000 mm²) comparing both hemispheres. Significant difference was considered when the medium value was superior to 10% from one hemisphere to another.

Results
Differences in the values of CBF between the two hemispheres was observed in all the patients with stenosis superior to 30% (six patients). In patients with stenosis between 15% to 30% a significant difference was observed in three patients and none in five patients.

Conclusions
Arterial spin labeling CBF could be a useful tool combined with Angio-RM 3D TOF as a prognostic factor for cerebral ischemia in patients with tumors invading the cavernous sinus that cause asymptomatic ICA encasement and stenosis.

EP-66
Utilization of CT perfusion to find impairment of vasodilatory capacity before carotid artery stenting

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Purpose
It is important to anticipate the risk of cerebral hyperperfusion syndrome (CHS) before carotid artery stenting (CAS) and impairment of vasodilatory capacity (IVC) is likely related to CHS.
SPECT usually is used to find the IVC. However, SPECT is not available in all institutions. If CT perfusion (CTP), which has been used widely, can be an alternative to SPECT for finding IVC, it is beneficial for many institutions. The aim of our study was to find which parameter had some relation to IVC in SPECT.

Materials and Methods
Included in our retrospective study were patients 1) who underwent elective CAS from January 2010 to December 2013, 2) who CTP and SPECT before CAS. Excluded from the study were patients 1) who underwent CAS within 30 days after last ischemic stroke, 2) who had bilateral carotid artery stenosis or occlusion, or 3) who had vasodilatory capacity (VC) of 100% or more. IVC was defined as VC of less than 10%. Evaluated were the relationship between IVC and usual parameters of CTP (CBF, CBV, MTT, TTP) measured in the territories of the bilateral middle cerebral artery (MCA). Comparing the affected side parameter with the contralateral one, CBF ratio was defined as CBFa divided by CBFe, CBV ratio as CBVa divided by CBVe, MTT delay as MTTa minus MTTe, TTP delay as TTPa minus TTPe.

Results
Sixty-six patients were analyzed. Ten patients had IVC and their median TTP delay was 1.35 s (p=0.08). Among eight patients with TTP delay of more than 1.35s, five patients had IVC (p<0.0005, OR; 16). However, other parameters of CTP had no relation to IVC.

Conclusions
TTP delay of more than 1.35 s had strong relation to IVC.

EP-08

Visualization of Perivascular Spaces on 3T MR Images of Alzheimer Patients: University Hospital-based Dementia Cohort Study

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Purpose
The aim of this study was to investigate changes in the visualization of perivascular spaces (PVS) in patients with Alzheimer disease (AD) in a university hospital-based dementia cohort study.

Materials and Methods
We included 35 patients with AD (16 men, 19 women, mean age 75±8.9 years) and 15 age-matched patients with subjective complaints (SC) (6 men, 9 women, mean age 73±7.7 years) who visited our memory clinic and underwent baseline and follow-up 3T MRI at least 9 months apart. When all clinical findings were normal we recorded SC. Parenchymal hyperintensity areas on axial T2-weighted images with an effective diameter of <3 mm, no FLAIR hyperintensity, and T1 hypointensity were considered to represent PVS. Two experienced neuroradiologists independently graded the baseline and follow-up MR images for the visualization of PVS in the gyri above the centrum semiovale using a 4-point system where grade 3 = visualization of PVS in more than two thirds of the gyri, grade 2 = visualization of PVS in one to two thirds of the gyri, grade 1 = visualization of PVS in less than one third of the gyri, and grade 0 = no visualization of PVS in any gyri. Final judgments were by consensus. Interobserver agreement
was determined with the χ coefficient. Differences in the mean scores of the two patient groups were as assessed with the Mann-Whitney test and Fisher's exact test.

Results
For the PVS grading score on baseline and follow-up MR images interobserver agreement was very good (κ = 0.86 and χ = 0.82, respectively). The mean score for the baseline MRI study was 1.60 ± 0.77 for AD and 1.93 ± 0.83 for SC patients; the difference was not statistically significant. On follow-up MR studies the PVS score fell in 11 of 35 (31%) AD patients; it remained unchanged in all SC patients. There was a significant difference between the two groups (p = 0.021). The PVS score rose in one of 15 (7%) SC, but not in any AD patients.

Conclusions
Our pilot study showed that PVS visualization on follow-up 3T MRI decreased in about one third of patients with AD. A change in the visualization of PVS on 3T MRI may be a useful diagnostic marker for AD.

EP-36

Voxel Transit Time is a More Sensitive Measure of Altered Tissue Perfusion than Mean Transit Time in Advanced Intracranial Atherosclerotic Disease.

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Purpose
Perfusion MRI is valuable in stroke imaging but continues to underestimate effects of contrast bolus delay and dispersion (DnD). We compare conventional MTT to voxel transit time (VTT) derived from a locally determined AIF. We hypothesized that VTT would be a more sensitive metric of hypoperfusion (i.e., prolonged MTT) than MTT in the setting of severe intracranial atherosclerotic disease (ICAD).

Materials and Methods
We retrospectively identified seven patients (3 Male, 4 Female; 66 +/- 15 years) with advanced ICAD (>50% supraclinoid ICA, ACA, MCA or PCA) who underwent a DSC MR PWI scan for clinical evaluation. Vascular territories associated with arteries with angiographically confirmed ICAD were compared to those fed by arteries that were free of disease. Excluded territories included those with <50% stenoses, regions of encephalomalacia involving >50% of the territory or those previously treated endovascularly. Images were coregistered to a standard 3D space, territories were segmented and MTT and VTT values were calculated in MATLAB. Voxel transit time was calculated by forward convolving the global AIF to remove the effects on the shape of the contrast bolus as it flows through the cerebral vasculature, including pial collateral arteries. The final deconvolution analysis then yields the much shorter mean time for the bolus to traverse the image voxel. Calculated values were compared using a two-tailed Student's t-test.

Results
Seventeen ICAD (2 ACA, 7 MCA and 8 PCA) and 16 normal (8 ACA, 4 MCA and 4 PCA) territories were analyzed. In advanced ICAD, mean MTT/VTT values were 3.8 +/- 0.21 sec/1.0 +/- 0.19 sec and, in nondiseased vascular territories, MTT/VTT values were 4.0 +/- 0.26 sec/0.36
Mean transit time differences were not significant before correction (p=0.46), but VTT values were statistically different between ICAD and normal territories (p<0.01).

Conclusions
Intracranial atheroscerotic disease alters the shape of the contrast bolus as it flows towards the parenchyma that it feeds. Mean transit time derived from standard deconvolution analysis includes effects that reflect the arterial network that feeds the parenchyma. Voxel transit time may better represent the transit time of flow-limiting pathologies such as ICAD where collateral supply is predominant. Voxel transit time unveils territories that are hemodynamically compromised, but would otherwise appear relatively similar to territories supplied by normal vessels.

**EP-63**

**White Matter Nulled Motion Corrected MPRAGE MR Techniques Provided Added Value in MR Imaging Of Multiple Sclerosis**

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Purpose
MPRAGE provides isotropic resolution and the very bright white matter provides high T1 contrast. Susceptibility to motion artifact can adversely impact image quality in a significant number of cases and the high white matter signal may interfere with cortical lesion detection. We retrospectively evaluated the added value of a novel 3D T1 MPRAGE sequence which incorporates an additional inversion pulse to null white matter (WMN) and prospective motion correction (PROMO) in routine brain imaging. Our aim is to evaluate the quality and added value of WMN PROMO MPRAGE in comparison to conventional techniques in MR imaging of multiple sclerosis (MS).

Materials and Methods
Thirty patients with known or suspected MS were scanned with WMN PROMO MPRAGE in addition to conventional imaging sequences on a clinical 3T MR scanner. Images were reviewed by two neuroradiologists who assessed image quality, motion resistance and added value in terms of cortical, subcortical and white matter lesion conspicuity compared to traditional T1, T2, FLAIR and T1-weighted techniques commonly employed in the evaluation of patients with MS. Results were compared with paired Wilcoxon test.

Results
WMN PROMO MPRAGE offered a novel image contrast with good motion resistance and provided added value in evaluation of brain lesions in patients with known or suspected MS.

Conclusions
WMN PROMO MPRAGE is a practical technique with good motion resistance, providing novel image contrast of value in evaluation of brain lesions and should be considered for routine use in the evaluation of patients with known or suspected MS.
A Wegener's Granulomatosis Case: Initial Presentation is Orbital Involvement

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Purpose
To report a Wegener's granulomatosis (WG) case initially presented with eye problems.

Materials and Methods
A 9-year-old girl admitted with complaints of eyes redness, eyelids edema, ptosis and exophthalmus. For diagnosis, orbital magnetic resonance imagining (MRI), blood and urine tests and histopathological examination were performed.

Results
Orbital MRI revealed bilateral intraorbital-extraconal soft tissue lesions with indistinguishable clear boundaries from extraocular muscles and lacrimal gland. Orbital biopsy was performed from the lesion. Myointimal thickening of the vessel wall, microthrombus and perivascular lymphocytic infiltration in the vessels lumen and intense fibrosis in the lacrimal gland were seen histologically. Urinalysis showed hematuria and proteinuria, renal biopsy revealed crescentic glomerulonephritis. Anti-Neutrophil Cytoplasmic Antibody (c-ANCA) positivity was present in patient. Hereby, WG was diagnosed in this patient who presented with orbital involvement initially.

Conclusions
Wegener's granulomatosis is a systemic disease that is characterized by necrotizing granulomatous vasculitis. Although, upper respiratory tract, lung and kidney involvement are the most common forms, ocular involvement is common too. Incidence of orbital-ocular involvement in WG is around 50-60% and first presentation form like orbital involvement is around 8-16%. Orbital pathology in WG can occur as a primary form of granulomatous vasculitis involvement and also it may be propagation of paranasal sinuses inflammation to the ocular cavity. Orbital manifestations can be episcleritis, scleritis, lacrimal gland obstruction, ocular pain, diplopia, periorbital cellulitis, retro-orbital mass, proptosis, optic neuropathy and blindness. Radiological modalities can help to distinguish WG from other entities. CT can show obliteration of tissue planes and bony erosion. On MRI, the lesions are hypo-intense in relation to orbital fat in T1- and T2-weighted imaging and enhance with gadolinium. In conclusion, orbital-ocular involvement should be kept in mind in WG and radiological assessment must be performed from this perspective.
Clinical and radiological presentation of rhinolithiasis; Analysis of 16 cases and review of the literature

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Purpose
Rhinoliths are the stones that are located in the nasal cavity and exist by accumulation of salt around exogen and endogen nidus. This study presents the clinical findings, diagnosis, and treatment of rhinolithiasis.

Materials and Methods
A total of 16 patients diagnosed with rhinolithiasis were identified. Age, sex, locations, diagnostic methods, and surgical technique were analyzed. Diagnosis was made by clinical examination and radiologic methods. Endoscopic evaluation was performed in all patients and computed tomography (CT) in 10 patients.

Results
Between January 2006 and June 2013, 16 cases (7 males and 9 females; median age, 32 years; age range, 8-74 years) with rhinolithiasis were diagnosed. All patients had purulent rhinorhea and nasal obstruction (100%). Seven patients had headache (43.8%), four patients had epistaxis (25%), three patients had oral malodor (18.8%) complaints.

Conclusions
Nasal endoscopy and CT gives extremely useful information in the diagnosis of rhinolithiasis. CT is helpful in determining full anatomical localization and complications of rhinoliths clearly. CT images were obtained before removing the rhinoliths. In the case of a 17-year-old adolescent girl, a button was the exogenous source of her nidus, which was remarkable (Figure 1).
Comparison of dual-energy CT and MR imaging for the evaluation of cartilage invasion by laryngeal and hypopharyngeal squamous cell carcinoma

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Purpose
To compare the usefulness of dual-energy CT and MR imaging in their ability to detect cartilage invasion by laryngeal and hypopharyngeal squamous cell carcinoma.
Materials and Methods
One hundred seven consecutive patients underwent 3T MR and 128-slice dual-source CT in dual-energy CT mode for laryngeal or hypopharyngeal cancer staging between September 2010 and September 2014. Two blinded observers evaluated laryngeal cartilage invasion using a five-point scale on MR images or on a combination of weighted-average (WA) and iodine-overlay (IO) images obtained with dual-energy CT. When assessing cartilage with MR imaging, cartilage invasion was considered to be present when the cartilage displayed a signal intensity similar to that of the adjacent tumor on T1WI, T2WI and contrast-enhanced T1WI. With dual-energy CT, combined WA images and IO images were used for evaluation of cartilage invasion as described in previous reports (Ref.). Fifty-five of the 107 patients (51%) underwent surgery, and findings from histopathologic examination in those patients were used as the standard of reference for evaluating the diagnostic performance with receiver operating characteristic (ROC) curve analysis and in terms of sensitivity and specificity. Sensitivity and specificity were evaluated by McNemar test.

Results
The specificity of dual-energy CT was superior to that of MR (97% versus 68%, respectively; P = .0002) for the evaluation of thyroid cartilage, but no evidence was found that the sensitivity of dual-energy CT differed from that of MR (88% versus 100%, respectively; P = .50). No evidence was found that the average areas under the ROC curve for dual-energy CT and MR were different (0.952 versus 0.938, respectively; P = .70).

Conclusions
Dual-energy CT provides specific information compared with MR imaging for the evaluation of thyroid cartilage invasion by squamous cell carcinoma, and may be at least as useful as MR for treatment decision-making in laryngeal and hypopharyngeal cancer patients.

EP-84
6:00AM - 3:00PM

CT Detection of Extracapsular Spread of Metastatic Cervical Lymph Nodes in Head and Neck Squamous Cell Cancer

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Purpose
To assess the accuracy of contrast-enhanced computed tomography (CT) and the utility of imaging criteria in the identification of extracapsular spread (ECS) of metastatic lymph nodes in head and neck squamous cell cancers (HNSCC).

Materials and Methods
The Institutional Review Board approved this project. Contrast-enhanced CT neck scans of 100 HNSCC patients who later underwent neck dissection and were found to have pathology proven metastatic nodes were reviewed retrospectively by two neuroradiologists. The radiologists offered their prediction of extracapsular spread based on imaging criteria (irregular capsular enhancement, infiltration of surrounding tissues, matted nodes, central node necrosis, indistinct margins). Their results then were compared with the pathology reports. Statistical analysis was done to determine sensitivity and specificity of CT in predicting ECS. Interobserver agreement
also was determined. Finally, we analyzed the correlation of individual criteria with the radiologists' accuracy in determining ECS.

Results
Radiologist 1 had sensitivity and specificity of 57.89 (95% CI 40.82-73.7), and 70.37 (95% CI 49.81-86.25), respectively. Radiologist 2 had sensitivity and specificity of 71.86 (95% CI 53.3-86.3) and 57.9 (95% CI 33.5-79.7), respectively. Interobserver level of agreement between raters was Kappa: 0.61 (95% CI 0.40-0.82). Among all imaging criteria, central node necrosis was found to have the highest correlation with pathologically proven ECS, sensitivity of 63.1579 (95% CI 0.46-78.19).

Conclusions
CT detection of ECS in metastatic cervical lymph nodes with HNSCC was not reliable. Individual imaging criteria did not consistently correlate with the presence of ECS. There was moderate interobserver agreement when predicting ECS presence and when identifying ECS imaging criteria.

EP-90

Difference between HPV positive and negative non-oropharyngeal cancer; texture analysis features on CT

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Purpose
Since human papillomavirus (HPV)-associated oropharyngeal cancer (OPC) is considered a distinct subtype of OPC, we hypothesized that there also may be underlying morphologic difference in the texture of tumors in HPV-positive (HPV+) and HPV-negative (HPV-) patients with nonoropharyngeal cancer (n-OPC). The purpose of this study was to investigate and identify specific texture parameters that may distinguish HPV+ and HPV- n-OPC.

Materials and Methods
Following IRB approval, 113 patients of n-OPC with primary sites of oral cavity, larynx, and hypopharynx with known HPV status who underwent CT between December 2009 and August 2014 were included in this study. Contrast-enhanced CT examinations for initial staging were reviewed retrospectively. Examinations with significant motion and metal artifacts and patients with very small lesions were excluded. Segmentation of the primary lesion was performed manually with a semi-automated graphical-user-interface. Following segmentation, an in-house developed texture analysis program extracted 42 texture features from each segmented volume. A t-test was used to evaluate differences in texture parameters between HPV+ and HPV- n-OPC.

Results
A total of 49 patients were included in the analysis. Eleven patients with HPV+ n-OPC (oral cavity n=5, larynx n=6) and 38 patients with HPV- n-OPC (oral cavity n=19, larynx n=13, hypopharynx n=6) were analyzed. Statistically significant differences were seen in 19 texture parameters including five histogram features (P= <0.03), four gray-level co-occurrence matrix features (P= <0.05), six gray level run-length features (P= <0.05), two gray level gradient matrix features (P= <0.02), and two Laws features (P= <0.04).
Conclusions
There are numerous texture features that showed statistically significant differences between HPV+ and HPV- n-OPC patients with analysis of contrast-enhanced CT images. This initial study demonstrates the potential use of a texture analysis for the discrimination of HPV status in n-OPC tumors.

EP-92
6:00AM - 3:00PM
Diffusion Weighted Magnetic Resonance Imaging as a Biomarker to Determine Human Papilloma Virus Positivity in Oropharyngeal Squamous Cell Carcinoma

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Purpose
There has been a recent increase in incidence of oropharyngeal squamous cell carcinoma (OSCC) believed to be due to human papilloma virus (HPV). HPV positive (HPV+) OSCC has a much better prognosis compared to HPV negative (HPV-) disease and may benefit from deintensified treatment. HPV+ OSSCs have larger and more cystic lymph nodes. Diffusion-weighted imaging can assess quantitatively cell density. Therefore, we hypothesize that HPV+ lymph nodes have more facilitated diffusion compared to HPV- lymph nodes and this can be used as an imaging biomarker to predict HPV positivity.

Materials and Methods
The study was approved by our institutional review board with waiver of informed consent. Pretreatment MRIs of 22 HPV+ and 11 HPV- patients with pathology proven OSCC were reviewed retrospectively. HPV status was determined by p16 immunostaining technique in our institution and the results were obtained from patients' electronic medical records. Axial T1 pre-contrast images were coregistered with apparent diffusion coefficient (ADC) maps using SPM8 (Wellcome Trust Centre for Neuroimaging, UCL, UK). Then, using Analyse 12.0 (Mayo Clinic, MN) the tumor and the largest ipsilateral level 2 lymph node were contoured separately to produce two volumes of interest (VOI) in each case. Maximum, minimum and average ADC values in each VOI as well as the volume of tumor and the volume of the ipsilateral level 2 lymph node were calculated and recorded in each case. The results are expressed as average ± standard deviation. Two-tailed Student's t-test was used to compare average values.

Results
The average age of HPV+ and HPV- patients was 56.05± 11.66 and 64.74± 8.43 years (P< 0.05) with male/female ratio of 18/4 and 11/0, respectively. There was a trend towards higher mean ADC values in HPV+ versus HPV- lymph nodes (1358.62±187.07 versus 1140.10±259.96 mm²/sec, P=0.07). There also was a trend towards larger volume of HPV+ vs. HPV- lymph nodes (64.28±50.64 versus 16.68±14.57 milliliters, P=0.08). No statistically significant difference in tumor ADC values or tumor volumes between HPV+ and HPV- patients (all P>0.05) was detected.

Conclusions
There was a trend towards higher mean ADC values in HPV+ versus HPV- lymph nodes representing more facilitated diffusion. This is consistent with more cystic changes in HPV+
nodes. Diffusion-weighted imaging can serve as a promising biomarker to predict HPV positivity in oropharyngeal squamous cell carcinoma. Increased patient recruitment can increase the statistical power of this study which is already undergoing in our institution.

**EP-93**

**Effective dose of Conventional Sialography in the modern era; with comparisons to standards.**

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**Purpose**

Conventional sialography, once a forgotten technique is making its resurgence in modern otolaryngology due to its two-fold ability to better detect ductal obstructive pathology and its invasiveness which gives a preoperative insight into cannulation before attempting a minimally invasive technique such sialendoscopy. There is a void in knowing what the effective dose of this procedure is with modern day equipment. With more radiation awareness, this may further be a weighting factor in choosing the appropriate procedure in the right setting along with providing help for patient counseling.

**Materials and Methods**

Sialograms performed over the last 3 years at the state's top tertiary care and referral center for otolaryngology were studied retrospectively. Studies documenting the dose area product (DAP) and fluoroscopy time were chosen. Out of 95 studies performed, 62 exams were chosen. The conversion factor for head and neck was applied to the DAP; using the latest ICRP guidelines. This yielded effective doses which were compared to standard doses in literature.

**Results**

Forty-three females and 19 males were present in the group with varied salivary gland pathology, including normal studies. The mean effective dose was 0.21 mSv with a standard deviation of 0.15 mSv. When compared to standard doses in literature, the effective dose was grossly equivalent to one cervical spine plain film and 21% of the total background radiation exposure to an average person in 1 year. It was 10.5% of the dose of an average head CT and 1.4 % the dose of a chest pulmonary angiography study.

**Conclusions**

The average effective dose of this procedure is very reasonable when compared to other diagnostic procedures involving radiation. These estimates, however, provide a gross view and should be tailored according to the individual patient depending on their age and sex.

**EP-89**

**Fetal MR imaging of normal thyroid gland: Detectability, signal intensity, shape and size.**

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Purpose
Fetal goiter may be observed with maternal Basedow disease or Graves disease on propylthiouracil therapy (1, 2) (Figure 1). Monitoring size of fetal thyroid gland usually is done by ultrasonography (3), but evaluation using MRI also is useful because it can visualize both enlarged thyroid gland and airways. To detect the abnormality in fetal thyroid, we have to know characteristics of normal thyroid gland on fetal MRI. However, fetal MR imaging of normal thyroid gland has not been described fully in the literature. Objective of this study was to clarify the imaging characteristics of normal thyroid gland on fetal MRI.

Materials and Methods
Sixty-two cases (21 weeks - 37 weeks gestational age) without maternal thyroid disease underwent fetal MRI between 2011 to 2014 in our hospital were involved in this study. One case was performed MRI twice. All MRI images were obtained with 1.5T MRI unit (Philips, Achieva) using 4-channel body coil. Coronal in/out phase FFE images (TR/TE=150/2.3,4.6msec, FA=60, slice thickness: 4mm, slice gap: 1mm, FOV40cm, matrix: 256x256, time of acquisition: 20sec/15slices) and coronal 2D-Balanced TFE (TR/TE=3.8/1.9msec, FA=90, slice thickness: 4mm, slice gap: 1mm, FOV40cm, matrix: 256x512r, time of acquisition: 20sec/15slices) were reviewed retrospectively. Visualization of thyroid gland, its signal intensity, and its size in maximum diameter were evaluated in each case. Correlation between the size of thyroid gland on MRI and gestational age also was evaluated.

Results
Thyroid gland was visualized in 40/61 cases on T1-weighted images but none on T2-weighted images. All thyroid glands showed hyperintense on T1-weighted images mostly with U (24 cases) or H shapes (12 cases) (Figure 2). The mean maximum diameter of fetal thyroid was 14.8mm (7mm-20mm). Size of thyroid of fetus correlated well with fetal gestational age (Figure 3).

Conclusions
Thyroid gland of the fetus can be identified on coronal view of T1-weighted image of fetal MRI as a hyper intense U or H shaped organ in neck at least after 21 weeks gestational age. Size of thyroid gland of fetus correlates well with fetal gestational age.
Fig 1. MRI of fetal goiter caused by maternal Basedow disease (31 wks gestational age)
Fig 2. MRI of normal fetal thyroid (31 wks gestational age)

T1WI

T2WI

(Filename: TCT_EP-89_Fig2normalfetalthyroid.jpg)
Kallmann Syndrome: An Investigation of the Olfactory Sulci

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Purpose
Kallmann syndrome is a rare genetic disorder characterized by hypogonadotropic hypogonadism and hyposmia (1, 2). Currently, the diagnosis of Kallmann syndrome is reliant on MRI to establish the morphology of the olfactory bulbs (1, 3, 4). When high resolution imaging of the skull base is unavailable, the presence of the olfactory sulcus has been used as an indirect marker of normal olfactory bulb development. We examined whether the olfactory sulcus is indeed a reliable marker for the development of the olfactory bulb.
Materials and Methods
Seventeen males with Kallmann syndrome (15-67 years, mean age=26) and 19 healthy volunteers were enrolled and consented under an IRB approved protocol including MRI at 3.0T (Philips Achieva, SR 3.3.3). Coronal STIR images were oriented perpendicular to the anterior skull base and extended from the sella through the nasion (3.0mm slice thickness, 0.35mm resolution). The olfactory bulbs and sulci were characterized as either normal, hypoplastic or absent. Hypoplastic sulci were further classified by (1) superior-inferior and (2) anterior posterior continuity.

Results
Morphologically normal sulci were present in six (35%) patients with absent or hypoplastic bulbs. The left olfactory bulb was absent in 16 patients and hypoplastic in one patient. The right olfactory bulb was absent in 13 patients and hypoplastic in three patients. The left olfactory sulcus was hypoplastic in 11 patients, but never absent. The right olfactory sulcus was hypoplastic in seven patients and absent only in one patient.

Conclusions
In our population, normal bulbs nearly always were associated with a normal sulcus. However, the converse was not true. Normal olfactory sulci were present in 35% of subjects with absent or hypoplastic bulbs. Therefore, direct imaging of the bulbs is required to exclude Kallmann syndrome. Reliance on the olfactory sulci as an indirect marker of bulb development is not adequate.

EP-96
6:00AM - 3:00PM

Osseus Adhesion between High Riding Jugular Bulb and the Ossicles

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Purpose
Aberrant jugular bulbs in the middle ear cavity have been reported in the literature as being associated with hearing loss, tinnitus, vertigo, as well as the cause of intraoperative bleeding during middle ear procedures. Cases of high riding jugular bulb or jugular bulb dehiscence is seen with association with dehiscence of the vestibular aqueduct as well as osseus adhesion/fusion between the ossicles and the jugular bulb. In this study, we examine patients with high riding jugular bulb to determine the incidence of osseus adhesion of the ossicles, and whether there is associated conductive hearing loss.

Materials and Methods
Retrospective analysis was performed on patients with high riding jugular bulb who had undergone high resolution CT scan of the head or dedicated temporal bone CT. Two observers participated in the study to determine the presence of osseus adhesion between the ossicles and jugular bulb and/or vestibular aqueduct dehiscence. Subsequently patient's history was analyzed to determine if there is evidence of hearing loss.

Results
A total of 53 patients with high riding jugular bulb were analyzed in the study. Out of these patients, 16 had evidence of vestibular aqueduct dehiscence and three had evidence of osseus
adhesion between the ossicles and the jugular bulb. Of the three patients with ossicular adhesion, one had confirmed history of conductive hearing loss.

Conclusions
In our study three out of 53 patients with high riding jugular bulb exhibited signs of osseous adhesion between the ossicles and the jugular bulb. One of these three patients has confirmed history of conductive hearing loss. These findings suggest a possible mechanism for the development of hearing loss in patients who high riding jugular bulbs.

EP-88
6:00AM - 3:00PM

The evaluation of orbital blood flow changes in diabetic retinopathy with color doppler ultrasonography

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Purpose
We aimed to investigation of the changes in ocular blood flow in patients with diabetes mellitus by color Doppler ultrasound (US) and investigation of the contribution of color Doppler US in early diagnosis of diabetic retinopathy.

Materials and Methods
Total 122 cases (80 DM patients and 42 healthy individuals) in the 35-65 age range were included in our study. Diabetic patients were divided into three groups: nonretinopathy group, nonproliferative diabetic retinopathy group (NPDR) and proliferative diabetic retinopathy (PDR) group. In our study, peak systolic velocity (PCV), mid diastolic velocity (MDV), end diastolic velocity (EDV), the resistive indices (RI), and pulsatility index (PI) values were measured by examining the ophthalmic artery (OA), central retinal artery (CRA), central retinal vein (CRV) and posterior ciliary artery (PCA). Results were compared between the control groups and diabetic groups.

Results
Ophthalmic artery peak systolic velocity and mid-diastolic velocity is found significantly higher in control group. Resistivity Index is found significantly higher in proliferative diabetic retinopathy group than control group. Central retinal artery pulsatility index value is found significantly lower in nonretinopathy diabetic group than control group and nonproliferative diabetic retinopathy group. Posterior ciliary artery peak systolic velocity is found significantly higher in control group and NPDR group than nonretinopathy DM group. Resistivity index value is found significantly higher in nonretinopathy DM group than DM groups with retinopathy.

Conclusions
Color Doppler US which is easy and inexpensive technique examination results show variations especially in patients with nonretinopathy and early stage retinopathy and color Doppler US can be used as a noninvasive test in early diagnosis of diabetic retinopathy.

EP-86
6:00AM - 3:00PM
The Influence of the Number and Location of Dental Amalgam Restorations on the Single-Energy Metal Artifact Reduction Effect on Computed Tomography Images

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Purpose
Metal artifacts due to dental restorations considerably deteriorate the quality of computed tomography (CT) images of the head and neck region. Projection-based single-energy metal artifact reduction (SEMAR) is an effective way to improve the imaging quality without increasing the radiation dose. However, to our knowledge, there is no report showing the influence of the number and location of metal restorations on the SEMAR effect. This study was performed to clarify this influence.

Materials and Methods
A novel phantom comprising the jaws, gingiva, and replaceable teeth with and without amalgam restorations was used. Twelve models with single to multiple restorations based on the tooth decay rate were scanned using a 320 detector row CT scanner (Aquilion ONE Vision Edition, Toshiba Medical Systems) with the following acquisition parameters: tube rotation time, 0.5 s; 120 kVp; 240 mA; slice thickness, 0.5 mm; field of view, 80 cm; and matrix, $512 \times 512$. Then, the raw data were reconstructed with/without the SEMAR algorithm into two volumes and the image quality was compared between the SEMAR and non-SEMAR groups.

Results
Models with single amalgam restorations (e.g., ADA #30, #08), multiple restorations on adjacent teeth (e.g., ADA #30 & 31), and no other metal in the same axial plane (e.g., ADA #30 & 03, #30 & 19) show improved CT image quality with an excellent metal artifact reduction effect. On the other hand, models with multiple restorations located at intervals in the same axial plane showed a relatively weak SEMAR effect with clearly visible metal artifacts.

Conclusions
The location of dental amalgam restorations has a greater influence on the SEMAR effect compared with the number of restorations, with the presence of multiple restorations in the same axial plane being the most important factor.
Use of Magnetic Resonance Angiography to Inform Vascularized Supraclavicular Lymph Node Transfer

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¹The Hospital of the University of Pennsylvania, Philadelphia, PA

Purpose
Vascularized lymph node transfer is a microsurgical technique shown to improve symptoms of lymphedema (1) in which a flap consisting of donor site lymph nodes, fat and vessels is transferred to a second site to relieve lymphatic obstruction. Inguinal flaps have been used most commonly, but right supraclavicular flaps, including the transverse cervical artery (TCA), transverse cervical vein, and part of the external jugular vein, are gaining in popularity due to reliable anatomy and low complication rates (2, 3). This study uses gadolinium-enhanced neck MRA to assess the size and distribution of right supraclavicular lymph nodes in relation to the TCA, factors that could affect surgical approach, and evaluates the hypothesis that lymph nodes are greater in number and size closer to the TCA origin.

Materials and Methods
We retrospectively reviewed enhanced neck MRA studies performed at our institution from January through September 2014. Exclusion criteria included supraclavicular mass or surgery, metastatic cancer, lymphoma or other known lymphadenopathy. We also excluded scans due to motion artifact or incomplete coverage of the region. This resulted in 30 studies of unique patients. Our standard MRA protocol uses coronal 3D acquisitions with 0.86 or 1.2 cm slice thickness at 1.5T or 3T with pre-contrast as well as post-contrast images in arterial and venous phases. On each study, the right TCA was identified and the diameter of its origin (a, arrow) was measured. Anatomy of the TCA and thyrocervical trunk was classified as classical or variant. Right supraclavicular lymph nodes were identified on pre-contrast T1-weighted images as low signal intensity foci (b, arrows) in a background of hyperintense fat and measured in long axis. Distance of each node from the TCA origin was measured in three dimensions.

Results
A total of 145 lymph nodes were identified with 4.8±1.9 lymph nodes per patient, more than an average of three nodes found in an ongoing study of cadaver flaps by two of our authors. Lymph nodes averaged 5.3±2 mm in size. With respect to the TCA origin, all lymph nodes were lateral, 97% superior, and 77% dorsal (c). Distance from the origin was 37±13 mm on average with a median of 38 mm. The TCA origin measured 2.7 mm ± 0.8 mm in diameter. Variant TCA or thyrocervical trunk anatomy was found in 37% of patients, higher than 17% reported in the surgical literature (3). MR imaging may find nodes that would be missed by surgeons or pathologists, but there are also limitations in our study in distinguishing small lymph nodes from vessels. We did not find a trend towards increased node number or size in proximity to the TCA origin, but our analysis does not provide proximity along the course of this tortuous variable vessel.

Conclusions
Contrast-enhanced MRA can be used to delineate the anatomy of the TCA and the number and
location of supraclavicular lymph nodes. Pre-operative MRA could be helpful in assessing site suitability or ease of transfer based on lymph node number and vascular variability. Imaging protocols could be further optimized for evaluation of the supraclavicular neck.
A Case of Transbrachial Coil Embolization of Unruptured Basilar Tip Aneurysm

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1
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Purpose
We describe a case of coil embolization of an unruptured basilar tip aneurysm via a transbrachial artery approach.

Materials and Methods
A 73-year-old female with a medical history of acute cerebral infarction, hypertension, and hyperlipidemia, presented with dysarthria and right sided limb weakness. Magnetic resonance angiography and digital subtraction angiography revealed an unruptured basilar tip aneurysm. She presented for a planned endovascular coil embolization.

Results
The initial attempt by transfemoral approach was complicated by persistent guide catheter instability and high risk of thromboembolism due to marked tortuosity of internal carotid artery and vertebral artery. The aneurysm was treated successfully by transbrachial coil embolization with a 5-French guide catheter. The patient recovered favorably without any further neurological deficit.

Conclusions
The transbrachial approach is a viable approach for endovascular aneurysm coil embolization in cases with an unstable guide catheter and high risk of thromboembolism due to tortuous vessels or abnormal anatomy when femoral access is complicated or contraindicated.
Accuracy of Semi-Automatic Software for Intracranial Aneurysm Parent Vessel Measurement

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Purpose
Precise measurements of the diameter and length of the flow diverter are necessary to avoid risk of complications. These measurements, which commonly are taken manually using 2D digital subtraction angiography (DSA), are subject to projection error, C-arm calibration error, and user error. This study aims to investigate the use of 3D rotational angiography images for parent vessel measurements and also evaluate the accuracy of a semi-automated software package.

Materials and Methods
3D rotational angiographic images from 23 patients who underwent Pipeline embolization (ev3-Covidien, Irvine, California, USA) procedures were used in this study in retrospective fashion. Manual measurements were made by the experienced neuro-interventional radiologist in the cross-sectional or multiplanar reconstruction views (MPR). Two views (sagittal and coronal) were aligned to the centerline of the parent vessel and the axial view was aligned orthogonal to the other two views and measurements were taken in the axial view (See Figure 1). These measurements were replicated using a semi-automated aneurysm analysis software package (syngo Neuro Aneurysm Analysis, Siemens AG, Forchheim, Germany).

Results
The average absolute error was 0.16 mm with a standard deviation of 0.19 mm. The minimum error was 0 mm and the maximum error was 0.8 mm. Most of the errors were below 0.25 mm as shown in Figure 1. Because these flow diverters are available in varying diameters with 0.25 mm increments, a one-tailed Student's t-test was used to show that the average absolute error between the physician measurements and the software measurements was less than 0.25 mm (p-value = 0.002).

Conclusions
The aneurysm analysis software can provide accurate measurements of the diameter of parent vessels of intracranial aneurysms. Therefore, it could be useful for the treatment planning process by providing an automatic and reliable method of obtaining these measurements in place of the manual approach.
Amplatzer vascular plugs using complex constructs provide effective rapid occlusion for internal carotid artery embolization

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\textsuperscript{2}University Hospital Case Medical Center, Case Western Reserve University, Cleveland, OH
Purpose
Complete occlusion of the common carotid artery (CCA), internal carotid artery (ICA) or external carotid artery (ECA) has various indications including fistula closure, surgical safety and control of arterial bleeding. Amplazer Vascular Plugs (AVPs) have been developed for rapid occlusion of large peripheral vessels. We reviewed and here describe our initial experience in neurointerventional applications of AVPs highlighting technical complexities.

Materials and Methods
The AVP device has been placed in three patient ICAs with ruptured distal cervical pseudoaneurysm (patient #1), presurgical sacrifice in the setting of carcinoma of the larynx (patient #2) and emergent occlusion of iatrogenic rupture during oropharyngeal abscess debridement (patient #3).

Results
In patient #1 (Figure 1) occlusion of the ICA was achieved by employing a compressed proximal AVP (blue arrow) after the fully expanded distal AVP (red arrow). The technique applied was a stacking and squishing technique by using a larger diameter proximal AVP. In patient #2 (Figure 2) a sandwich approach of AVP was used (red arrows) combined with packed microcoils (green arrows). In patient #3 AVPs were placed in a sequential fashion into the proximal ICA by selecting oversized AVPs relative to the target vessel size. This selection of oversized AVPs prevents melonseeding.

Conclusions
Our experience demonstrates that AVP placement is safe and feasible for internal carotid artery embolization with no procedural complications. The "stacking and squishing" technique has advantageous decreased procedure time. Amplazer vascular plugs combined with microcoil offers a current standard and fullest embolization. Oversizing of devices may prevent melonseeding by minimizing risk of later distal migration. Wider use and longer follow up may offer further lessons, yet for now this has provided an efficient quality outcome.
Angiographic and Clinical Result of Endovascular Treatment of Dissecting Aneurysm of the Posterior Inferior Cerebellar Artery

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Purpose
Isolated dissecting aneurysms of the posterior inferior cerebellar artery (PICA) are rare, but have a high risk of re-bleeding. Recently, endovascular treatment has been proposed as an alternative to surgery, but still they present a therapeutic challenge. We report results of various endovascular treatments in patients with isolated PICA dissecting aneurysms.

Materials and Methods
Eleven patients (mean age: 44.4 years, range: 15-58, M:F=5:6) with isolated PICA dissecting aneurysms were treated by endovascular techniques (graft stent insertion in three, coiling of aneurysmal sac in four, stent-assisted coiling of aneurysmal sac in two, and occlusion of parent artery by coil in two) in our institution between March 2005 and May 2012 and followed for up to 45 months. Clinical presentations were acute subarachnoid hemorrhage in seven patients, ischemia in two, severe headache in one and an incidental aneurysm of PICA in a ruptured
anterior choroidal artery aneurysm. Preprocedural occlusion test performed in five patients. We carefully examined the presence of contrast filling of the PICA by collaterals during parent artery occlusion.

**Results**

On immediate follow-up angiograms, dissecting aneurysms were occluded successfully in all patients. PICA flow was preserved well in nine of 11 patients by collaterals and sluggish PICA flow in remaining two with parent artery occlusion. One patient developed ipsilateral PICA territory infarction 2 days after parent artery occlusion, but fully recovered at discharge. There were two procedure-related thrombo-embolic complications, but no neurologic sequela occurred. Angiographic follow up (mean: 18 month, range: 3-45 months) was available in all patients. Follow-up angiograms showed total aneurysmal occlusion with well preserved PICA flow by collaterals in all patients. There was no newly developed neurologic event or re-bleeding in all patients during clinical follow-up periods (mean: 40.3 month, range: 6 - 60 months).

**Conclusions**

Various endovascular techniques are feasible and relatively effective, safe treatment modality of the isolated PICA dissecting aneurysm.

<table>
<thead>
<tr>
<th>Case No</th>
<th>Patient Sex/age (y)</th>
<th>Side</th>
<th>Site</th>
<th>Signs &amp; Symptoms</th>
<th>CT-MRI findings</th>
<th>Endovascular Procedure</th>
<th>Treatment related complication</th>
<th>Follow up Angiograph (months)</th>
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<tr>
<td>1</td>
<td>M/35</td>
<td>R</td>
<td>TM</td>
<td>Vertigo, nausea</td>
<td>Cerebellar infarction</td>
<td>VA sacrifice</td>
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<td>5</td>
</tr>
<tr>
<td>2</td>
<td>F/57</td>
<td>R</td>
<td>AM</td>
<td>Neck pain, LOC headache</td>
<td>SAH</td>
<td>Graft stent insertion</td>
<td>None</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>M/15</td>
<td>L</td>
<td>AM</td>
<td>LOC, Headache</td>
<td>SAH, IVH</td>
<td>Graft stent insertion</td>
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<td>45</td>
</tr>
<tr>
<td>4</td>
<td>F/50</td>
<td>L</td>
<td>AM</td>
<td>Neck pain, Headache</td>
<td>Incidental aneurysm</td>
<td>BAC</td>
<td>Coil protrusion Thrombus fontation</td>
<td>34</td>
</tr>
<tr>
<td>5</td>
<td>M/34</td>
<td>L</td>
<td>LM</td>
<td>Severe headache Transient LOC</td>
<td>SAH</td>
<td>BAC</td>
<td>Coil protrusion Thrombus fontation</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>F/58</td>
<td>L</td>
<td>AM</td>
<td>Severe occipital headache</td>
<td>SAH</td>
<td>Graft stent insertion</td>
<td>None</td>
<td>32</td>
</tr>
<tr>
<td>7</td>
<td>F/56</td>
<td>L</td>
<td>AM</td>
<td>Headache, Heaviness of occipital region</td>
<td>Incidental aneurysm</td>
<td>BAC</td>
<td>None</td>
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</tr>
<tr>
<td>8</td>
<td>M/39</td>
<td>R</td>
<td>LM</td>
<td>Ataxia, dizziness, Wallenberg’s syndrome</td>
<td>Lateral medullary infarction</td>
<td>BAC</td>
<td>None</td>
<td>15</td>
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<tr>
<td>9</td>
<td>F/45</td>
<td>R</td>
<td>AM</td>
<td>Occipital headache, transient LOC</td>
<td>SAH</td>
<td>VA sacrifice</td>
<td>None</td>
<td>12</td>
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<tr>
<td>10</td>
<td>M/50</td>
<td>L</td>
<td>TM</td>
<td>Severe headache Transient LOC</td>
<td>SAH</td>
<td>SAC</td>
<td>None</td>
<td>28</td>
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<tr>
<td>11</td>
<td>F/49</td>
<td>L</td>
<td>AM</td>
<td>LOC, Headache</td>
<td>SAH</td>
<td>SAC</td>
<td>None</td>
<td>3</td>
</tr>
</tbody>
</table>

**Table 1. Characteristics of eleven patients with isolated dissecting posterior inferior cerebellar artery aneurysms.**

Note:- M indicates male; F, female; R, right; L, left; AM, anteromedullary segment; LM, lateral medullary segment; TM, tonsillomedullary segment; VA, vertebral artery; LOC, loss of consciousness; SAH, subarachnoid hemorrhage; IVH, intraventricular hemorrhage; BAC, balloon assisted coil embolization; SAC, stent assisted coil embolization
Basilar Perforator Aneurysm Communicating with Pseudoaneurysm Cavity: Case Report and Literature Review.

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Purpose
Basilar perforator aneurysms are rare lesions. We describe a case of a 2-3 mm dissecting and ruptured basilar perforator aneurysm communicating with a separate, isolated 6 mm pseudoaneurysm cavity. This extremely unusual communication of a small perforator aneurysm and pseudoaneurysm cavity as rupture in the peri-mesencephalic and prepontine cisterns typically results in frank subarachnoid hemorrhage. Representing a difficult treatment paradigm with high morbidity and low potential for success either via endovascular coil embolization or flow diversion stenting versus microsurgical options. Medical management with meticulous antihypertensive control remains the mainstay of treatment for these poor surgical candidates.

Materials and Methods
A 76-year-old male with past medical history of hypertension, hyperlipidemia, diabetes, atrial fibrillation, acute myeloid leukemia presents with Hunt-Hess/Fisher Grade 4 subarachnoid hemorrhage. Conventional angiography for a potential endovascular treatment was performed which revealed a small 2-3 mm side wall mid basilar artery aneurysm as suspected, but then confirmed to be arising directly from a left lateral basilar artery perforator rather than the basilar artery wall on both 3D rotational and subsequent magnified oblique DSA imaging. There is sequential outflow from the aneurysm superiorly into a channel communicating with a larger 6 mm saccular pseudoaneurysm cavity, also suspected on prior CTA head imaging, consistent with a ruptured basilar perforator dissecting aneurysm into a frank pseudoaneurysm cavity exhibiting contrast stasis and slow washout in the capillary and venous phases.

Results
There has been a long-standing debate on surgical and endovascular management versus conservative medical management in such cases. On reviewing the literature, we found K. Maeda et al had reported two cases of cerebral aneurysms in perforating artery manifesting as intracerebral and subarachnoid hemorrhage. In both the cases the aneurysm was resected and the parent artery was clipped but postoperatively one of the patients was severely disabled and the other died of lung infection leading to septic shock. Another report by W. Hamel et al demonstrated an attempted surgical resection of the aneurysm after a failed endovascular coiling, which resulted in a tension pneumocephalus and the patient suffered psychomotor slowing and gait ataxia. Literature review by Bradley A. Gross et al investigated 12 cases of basilar perforator aneurysm of which three were managed conservatively, only one patient developed transient third nerve palsy and hemiparesis due to vasospasm but no permanent neurological sequelae. It also was noted that only 67% of patients treated surgically or by endovascular coiling were neurologically intact, the rest suffered from neurological sequelae primarily as a result of initial aneurysm rupture.

Conclusions
Lack of definitive endovascular and surgical treatment options along with variety of technical challenges and postoperative complications make conservative management the mainstay of treatment for co-morbid patients.
AP DSA images and 3D reconstruction demonstrates mid-basilar perforator aneurysm arising communicating superiorly with a contained pseudoaneurysm cavity in the delayed capillary (Filename: TCT_EP-105_basilarposter.jpg)

**EP-107**

6:00AM - 3:00PM

**Circular Color Coding vs. Parametric Color Imaging: Which one wins for shunt point detectability in dural arteriovenous fistulae?**

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Purpose
For dural arteriovenous fistulas (dAVFs), the therapeutic goal is to obliterate the dural vein close to the shunt point, whether by transarterial or transvenous approach. Thus, the detection of shunt point is crucial (1). Several papers reported that parametric color imaging such as TTP (Time-to-Peak) or TTA (Time-to-Arrival) was useful for the detection (2-3). We compared designated technique, the circular color coding (CCC), presented at previous annual meeting with TTP and TTA from a point of shunt point detectability.

Materials and Methods
Circular color coding, TTP and TTA were applied to 19 dAVFs with 27 shunt points, and two neuroradiologists and one neurosurgeon assessed the shunt points by CCC, TTP, and TTA images separately with a semiquantitative five-point grading scale (5=shunt points were detected accurately without DSA images, 3=shunt points were detected with referring DSA images, 1=impossible to detect shunt points).

Results
Circular color coding, TTP and TTA images for one of typical cases were shown in Figure 1(a), (b) and (c), respectively. Numbers of shunts points accurately determined (grade scale >3) were 55, 20, and 6 in CCC, TTP and TTA images, respectively (p=0.001).

Conclusions
Circular color coding was superior to TTP and TTA in detection of shunt points, mainly due to its well preserved temporal elements and repetitive display. Circular color coding could be a useful and reliable tool for detecting shunt points in the treatment of dAVFs.
Comparison of Surface Area to Volume Ratio in Unruptured and Ruptured Small Cerebral Aneurysms

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¹University of Minnesota, Minneapolis, MN, ²University of Minnesota, Minneapolis, MN

Purpose
Small (<7mm) cerebral aneurysms seem to have low risk of annual rupture according to available natural history data, but most subarachnoid hemorrhages (SAH) are due to small aneurysms. Laplace's equation for wall tension can be expressed as surface area to volume ratio (SAV). We believe that the SAV ratio may be predictive of rupture risk in small aneurysms.

Materials and Methods
We reviewed our clinical database from 3/2014 to 6/2014 and identified patients with unruptured and ruptured cerebral aneurysms. For unruptured aneurysms, we included patients with at least 1 year follow up, saccular morphology, <7mm size and not treated within the year of follow up. Ruptured aneurysms were included in the analysis if they were saccular in morphology and <7mm in size. We used either MRA or CTA to calculate the volume and surface area.

Results
Of the 36 cases reviewed, 26 met inclusion criteria. Eighteen patients had unruptured aneurysms and eight patients had ruptured aneurysms meeting the inclusion criteria. The unruptured aneurysm group had mean age of 52 years and 75% were female. The ruptured aneurysm group had mean age of 54.8 years and 100% were female. Co-morbidities were similar in each group.

In unruptured aneurysms, the mean SAV ratio was 1.82 with range of 1.33 to 2.98. The mean ruptured aneurysm SAV ratio was 1.14 with range of 0.77 to 1.48 (p <0.05).

Conclusions
Surface area to volume ratio may be useful in predicting a higher risk of rupture than typically assumed and may help guide clinical decision making in patients with unruptured aneurysms.

EP-116
6:00AM - 3:00PM

Efficacy of an AVM Classification System that Directs Endovascular Therapies Accurately

W Yakes¹, A Yakes¹
¹Vascular Malformation Center, Englewood, CO

Purpose
To determine if AVM angioarchitecture characteristics can be predictive and direct specific curative endovascular procedures accurately and consistently to treat high-flow malformations.

Materials and Methods
Angiographic analysis of high-flow vascular malformations determined four major angioarchitectures. Type I: Direct arterial/arteriolar to vein/venule connection; e.g., as commonly seen in pulmonary AVF, congenital renal AVF, etc. Type II: Arterial/arteriolar connections to a "nidus" that then have several out-flow veins with no intervening capillary beds in any of the vascular interconnections. Type IIIa: Arterial/arteriolar connections to an aneurysmal vein ("nidus" is the vein wall) that drains into a dominant out-flow vein with no intervening capillary bed in these connections. Type IIIb: Same angioarchitecture as Type IIIa, except that there are
more than one (several) out-flow veins. Type IV: "Infiltrative" form of AVM whereby innumerable micro-arteriolar branches fistulize through a tissue (e.g., ear) totally infiltrating it, shunting into multiple out-flow veins. Capillary beds also exist in the tissue and are mixed with the innumerable AVFs. Without the capillaries the tissue could not be viable, therefore must be present.

Results
Type I: Can be treated effectively with mechanical devices; e.g., coils, Amplatzer Plugs, etc.
Type II: Can be treated effectively with ethanol embolization. Type IIIa: Can be treated effectively by transcatheter ethanol, retrograde vein catheter access or direct puncture access of the aneurysmal vein and treatment with ethanol and coils, or even by coils alone. Type IIIb: Can be treated effectively as above, but can be more challenging by the vein route as more veins (not a single out-flow vein) require closure. Type IV: Can be treated effectively by transcatheter or direct puncture of the innumerable microfistulous AVFs by embolization with ethanol; transarterial injections require 50% - 50% ethanol/nonionic contrast mixture.

Conclusions
This never before reported classification system has a direct impact on determining the curative endovascular and direct puncture embolization procedures and also determines the embolic agents that successfully will treat complex AVMs in the body.

EP-110
6:00AM - 3:00PM
Endovascular management of exsanguinating vertebral artery transection

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¹Hadassah Hebrew University Medical Center, Jerusalem, Israel, ²Hadassah Hebrew University Medical Center, Jerusalem, Israel

Purpose
To assess our experience with endovascular management of vertebral artery transection (VAT) a rare injury that can lead to exsanguination and that is difficult to treat surgically, in a timely fashion.

Materials and Methods
We reviewed four consecutive male patients admitted to our institution between 2002 and 2013 with diagnosis of traumatic VAT. Medical history, physical examination, neurological findings, radiological studies, endovascular reports, and follow ups were reviewed from the patients' electronic charts.

Results
There were four males, the mean age was 31 years (range 20-49 years), admitted after penetrating injuries. Two presented following gunshot wounds (GSW) and two after penetrating glass cervical trauma. Severe external hemorrhage was the presentation in all patients. All were treated successfully using an endovascular approach with proximal and distal occlusion of the injured vertebral artery and when present embolization of associated pseudoaneurysm and/or AV fistula. No infectious or neurological complications in relation to the endovascular procedure occurred.

Conclusions
Vertebral artery transection is a rare, but life-threatening entity, manifesting with severe
hemorrhage. In our experience, endovascular approach was technically feasible, safe, and rapidly effective method for hemorrhage control.

EP-104  
6:00AM - 3:00PM

Evaluation of Visual Control during Fluoroscopic Onyx® (EVOH) Injections using a Novel Calibrated Vascular Model

R Mason1, G Gál2, G Benndorf3

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Purpose
Onyx® is a well established nonadhesive liquid embolic agent for the endovascular treatment (EVT) of brain arteriovenous malformations (AVMs). It offers some advantages over traditional adhesive liquids such as NBCA (acrylic glue) and has improved feasibility and safety of EVT of cerebral arteriovenous (AV) shunting lesions. Nevertheless, complications may occur, attributable in part to its inferior radiographic visibility when compared to standard iodine-based vascular contrast medium. We hypothesize that some of these complications may be the result of loss of visual control during therapeutic Onyx® injections under fluoroscopy with subsequent "silent migration" into small vascular channels causing inadvertent occlusion or invisible reflux. The purpose of this study was to evaluate the radiographic visualization of Onyx® in comparison to iodine-based contrast medium using a newly developed calibrated vascular model.

Materials and Methods
A vascular model was built using polyetheretherketone (PEEK) tubing of stepwise reduced calibrated diameters: 500 microns, 380 microns, 250 microns, 175 microns and 100 microns. The model was placed on an angiographic examination table into a skull phantom and injections were imaged on a Philips Allura system using the following settings: Cerebral 2 f/sec, "Blank" Roadmap, "Embo"- Mode 3 (high dose), FD size = 6 inch, (SID) = 90, Table Height = +5. Images were recorded using the Store Fluoro function and transferred to an external hard drive for postprocessing. Injections of standard vascular iodine contrast medium (nondiluted Omnipaque® 300) were performed using 1cc syringes. Onyx® -18 was prepared and injected according to the manufacturer's instructions for use.

Results
Injections of both Omnipaque®-300 and Onyx®-18 could be performed and documented in a reproducible manner using the designed vascular model. The stepwise-reduced caliber of the model tubing allowed accurate assessment of the radiographic visibility with regard to a certain luminal diameter. During the first 10 seconds of the injection, visualization of Omnipaque®-300 could be observed clearly down to a luminal diameter of 175 microns, while lost at a luminal diameter of 100 microns. Visualization of Onyx® -18 was noted to be inferior and lost at a luminal diameter of 250 microns

Conclusions
A newly designed calibrated vascular model allowed evaluation and comparison of radiographic visualization of contrast medium and a liquid embolic agent under standardized and reproducible experimental conditions. Loss of visual control during therapeutic injections of liquid embolic agents, such as Onyx®-18 may occur earlier than previously known and may be associated with
a risk of "silent migration" into small perforating arteries or reflux channels with potentially serious clinical consequences. Further studies are needed to confirm these results and to determine possible visualization thresholds for clinical practice that may further improve the safety of EVT using liquid embolic agents.

EP-103

6:00AM - 3:00PM

FLAIR signal abnormality as a Specific Imaging Marker for Dural Arteriovenous Fistula Symptomatic Cortical Venous Drainage

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Purpose
The natural history of dural arteriovenous fistulas (DAVFs) is poorly understood. The presence of cortical venous drainage (CVD) is associated annually with a morality rate of 10.4%, risk of intracranial hemorrhage of 8.1%, and risk of nonhemorrhagic neurologic deficit of 6.9%. The annual hemorrhage rate in DAVFs with CVD is different between patients who are asymptomatic (aCVD) at 1.5% and symptomatic (sCVD) at 7.4%. Therefore, close follow up to evaluate for conversion to a higher risk category is indicated. Furthermore, subdividing DAVFs with CVD (Borden type II and III) into aCVD and sCVD is useful for risk stratification. The purpose of this study was to investigate the association between symptomatic and asymptomatic Borden type II and III DAVFs with abnormal parenchymal MRI T2/FLAIR signal.

Materials and Methods
MR imaging of patients with DAVFs was analyzed retrospectively by a panel consisting of a vascular neurosurgeon, an interventional neuroradiologist and an interventional neuroradiology fellow. The panel was blinded to the identity of the patient, the angiographic grade of the DAVF and the presenting symptoms of the patient. The MRIs were obtained within 2 months prior to or after diagnosis, but before treatment. The angiographic grade of the fistulas and patient presentation then was determined and correlated with imaging findings. Parenchymal T2/FLAIR signal abnormality only was considered positive if present in a territory associated with the CVD.

Results
Forty-five patients were analyzed. Fifteen patients had Borden type I fistulas: 14 without and one with equivocal T2/FLAIR signal abnormalities. All nine asymptomatic DAVFs with CVD had no T2/FLAIR signal abnormalities. Of the 21 symptomatic DAVFs with CVD, 17 (81%) had definite and two (10%) had equivocal T2/FLAIR signal abnormalities.

Conclusions
There is a strong correlation between T2/FLAIR signal abnormality and sCVD that is not present with aCVD. Most likely as an indicator of venous congestion from retrograde CVD flow, T2/FLAIR may serve as a useful imaging marker for impending or recent conversion to a higher risk category by differentiating between aCVD and sCVD.

EP-109

6:00AM - 3:00PM
Flow Competition as a Factor of Jailed Arterial Branch Fate in Endovascular Flow Diversion: Model Description and Preliminary Results

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1CHU Limoges, Limoges, France, 2University of Limoges, Limoges, France

Purpose
Even though flow diverting stents are being used increasingly in intracranial aneurysm treatment, the fate of jailed side branches remains controversial. Clinical observations suggest that terminal type of arterial supply of the covered branch results in maintaining a blood aspiration effect after stenting.

Materials and Methods
Animal model validation and preliminary results of a translational study in large White swine is reported. Two animals were used to validate a terminal-type model of craniocervical circulation by selective endovascular occlusions, in a way that main arterial supply to the brain was maintained by the right ascending pharyngeal artery. Velocities and flow rates on the right APhA were measured before and after vascular modification, with a time-resolved three-dimensional magnetic resonance sequence (3D pcMRA). Two animals, one without modification and one modified, were evaluated by DSA and 3DRA under general anesthesia. They were embolized by flow diverting stents at the right carotid artery, in a way to cover the ostium of the right APhA and controlled at 3 months.

Results
The craniocervical flow modification was feasible. After terminal-type flow modification, an increase in velocities and flow rates of 30% was observed. Anesthesia for 3 hours was feasible without movement neither animal health compromise. Stents were patent at 3 months' controls. Forty point 22% of flow rate reduction was observed after stenting in the anastomotic-type model and 15.08% in the terminal type model. Control DSA findings showed near occlusion of the APhA in the first case and patency in the second, with normalized and diminished flow rates, respectively.

Conclusions
The terminal-type arterial modification in swine APhAs is feasible and manifests a 30% increase in velocities and flow rates. Flow diversion at the level of APhA ostium results in significant stenosis in cases of anastomotic circulation, while sufficient patency is observed in terminal-type circulation.

EP-99

High Intensity Signal Areas in FLAIR MRI (HISA) after Coil Embolization to Cerebral Aneurysms: Case series

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1Nara City Hospital, Nara, Nara, 2Saitama Medical University International Medical Center, Saitama, Hidaka-shi, 3Saitama Medical University International Medical Center, Saitama, Hidaka-shi, 4Saitama Medical University, International Medical Center, Saitama, Hidaka-shi,
Purpose
Postembolization high intensity signal areas in FLAIR MRI images (HISA) are infrequent. Pathogenesis of HISA that appeared following endovascular treatment was poorly understood. Recent studies showed that the HISA tends to occur in patients more than 40 years old, in cases with large unruptured carotid artery aneurysms embolization. In this presentation, we demonstrated six cases of cerebral lesion after coil embolization, and the mechanism of lesion appearance was discussed.

Materials and Methods
Case 1. A 74-year-old female. Coil embolization to unruptured left internal carotid-posterior communicating artery aneurysm was performed. Three months later after procedure, HISA appeared in left temporal lobe. Case 2. A 78-year-old female. Coil embolization to unruptured anterior communicating aneurysm was performed. Twenty-four months later after procedure, HISA appeared in right frontal lobe. Case 3. A 59-year-old female. Coil embolization to ruptured left basilar artery-superior cerebellar artery aneurysm was performed. Eighteen months later after procedure, HISA appeared in midbrain. Case 4. A 63-year-old female. Coil embolization to unruptured right internal carotid-posterior communicating artery aneurysm was performed. Three months later after procedure, HISA appeared in right occipitoparietal lobe. Case 5. A 70-year-old female. Coil embolization to unruptured right distal anterior cerebral artery aneurysm was performed. Four days later after procedure, HISA appeared in genu of corpus callosum. Case 6. A 58-year-old female. Coil embolization to unruptured left internal carotid ophthalmic aneurysm was performed. Two months later after procedure, HISA appeared throughout subcortical regions.

Results
We present five cases with HISA in perianeurysmal brain parenchyma. It seemed that direct effects to adjacent brain tissue by "coils-packed aneurysms", and one case with HISA mainly in subcortical regions remote from the aneurysms, obviously it seemed unlikely that direct effects. The lesions appeared at considerably different intervals in patients, e.g., from a few hours later to even up to several months. The case with HISA remote from the aneurysms, in whom left carotid-ophthalmic aneurysm underwent coil embolization, HISA was found 4 months later, and cognitive disorders were observed. In this case, the patterns of HISA resembled images of aggressive acute disseminated encephalomyelitis, and the association with allergic reaction of contrast media was considered. Methylprednisolone was administered and her symptoms disappeared. The others had no symptoms.

Conclusions
The mechanisms of HISAs after coil embolization were unknown, the adverse inflammatory reactions were proposed. Some of these cases seem to be curable in use of steroid. We should take care not only to the appearance of neurologic deficits, but HISA in brain parenchyma.

Purpose
Since rotating vortexes are important components of flow disturbance in cerebral aneurysms (1), our main goal of this case study is to demonstrate utility of automated analysis (e.g., morphology, temporal changes and energy carried) of flow vortex cores. Computer-aided flow analysis might be critically important because visual assessment of 4D flow characteristics through pattern recognition of hundreds of images may impose an extensive burden on reviewing physicians.

Materials and Methods
3D angiographic data were first obtained with a bi-plane C-arm system (AXIOM Artis, Siemens AG, Germany). All subsequent image segmentation and CFD simulations were performed using an integrated research prototype package (Siemens CFD prototype, Siemens AG, Germany). A physiological flow waveform (250 mL/min under 80 beat per minute) derived from MR measurements in normal ICAs was used. We then utilized in-house software based on Visualization ToolKit (Kitware Inc., NY, USA), an open source package, to perform subsequent vortex core extraction and analysis. Of note, the proposed vortex analysis was conducted only within respective dome of aneurysms using a published method to isolated aneurysm sacs (2).

Results
In this study, flow stability was defined as the change of the vortex core volume over a cardiac cycle and normalized between 0 and 1. This flow stability metric varied from 0.92 to 0.43 among 6 ICA lateral aneurysms and was consistent with assessments from a human observer. Our results also indicated that morphology of flow vortex cores varied significantly among aneurysms [e.g., red colored cores in two closely spaced lateral ICA aneurysms; Figure (b)], and could significantly change over a cardiac cycle (indicating flow instability).

Conclusions
Our preliminary results suggest that vortex core analysis could provide useful information toward automated and quantitative blood flow analysis, which is not readily available in the neuro-interventional suite.
Purpose
Transluminal angioplasty with stent is a method to resolve arterial stenosis. We intend to assess
the postoperative infarcted area of intracranial and cervical carotid stenting by diffusion-
weighted MR imaging (DWI).

Materials and Methods
From August 2012 to September 2014, 74 consecutive patients were treated with intra-arterial
stents; 37 patients were treated with carotid stents, and 37 were treated with intracranial or
unprotected stents (common carotid artery 3/ middle cerebral artery 15/ intracranial carotid artery
6/ posterior circulation 15). All of the patients were evaluated before and postoperatively within
1 day with brain MRI including DWI sequences. We compared the number of newly developed
embolic cerebral infarcts, the number of new infarcts with size greater than 5mm, and the total area of newly developed infarcts of both groups with 2-sample t-test.

Results
The mean age of patients is 69.2 years in carotid stent group and 62.3 years in intracranial stent group (Table 1). There is significant difference regarding the number of newly developed embolic cerebral lesions (1.43 ± 4.21 versus 5.32 ± 8.26, P=0.01), number of thrombus diameter greater than 5mm (0.11 ± 0.39 versus 0.81 ± 1.58, P=0.005), and total thrombus area (14.38 ± 39.4 versus 85.32 ± 143.91, mm², P=0.002).

Conclusions
Postoperative infarction is more likely to occur after intracranial stent than carotid stent. This may be due to protection device not used during intracranial stenting. This should promote research for advance devices.

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Group A (Carotid)</th>
<th>Group B (Intracranial)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Age (yr)</td>
<td>69.24</td>
<td>62.30</td>
<td>0.0016</td>
</tr>
<tr>
<td>Gender (Male/Female)</td>
<td>30/7</td>
<td>29/8</td>
<td>1.00</td>
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<tr>
<td>Treated Lesion Side (L/R/B/P)</td>
<td>18/18/2/1</td>
<td>10/16/0/15</td>
<td>-</td>
</tr>
<tr>
<td>Number of New Embolic Lesions</td>
<td>1.43 ± 4.21</td>
<td>5.32 ± 8.26</td>
<td>0.01</td>
</tr>
<tr>
<td>Number of New Embolic Lesions &gt; 5mm</td>
<td>0.11 ± 0.39</td>
<td>0.81 ± 1.58</td>
<td>0.005</td>
</tr>
<tr>
<td>Total Embolic Area (mm²)</td>
<td>14.38 ± 39.4</td>
<td>85.32 ± 143.91</td>
<td>0.002</td>
</tr>
</tbody>
</table>

L: left side, R: right side, B: bilateral, P: posterior circulation
* Some of the patients had multiple stenotic lesions treated

(Filename: TCT_EP-114_Table1Patientdata.JPG)

EP-106
6:00AM - 3:00PM
Onyx Embolization of Facial Vascular Malformations: Treat, Results and Follow-Up

T Schroeder¹, D Murph¹, J Tejada¹
¹Indiana University School of Medicine, Indianapolis, IN

Purpose
Superficial high flow vascular malformations of the face are relatively rare lesions that may present either as a small subcutaneous facial lump or a large pulsatile mass with propensity for massive hemorrhage. AV fistulas, AVMs, aneurysms, or hemangiomas may be demonstrated on catheter angiography. Available treatments include surgical excision, embolization, sclerotherapy, laser ablation, and electrothrombolysis. More recently liquid embolics have been employed. However reports of results and follow up are relatively scarce in the literature. We present our experience at a tertiary care hospital with percutaneous and transarterial embolization of facial vascular malformations with the liquid embolic Onyx.

Materials and Methods
IRB approval for this HIPAA-compliant study was obtained, with waiver of informed consent. Using our radiology archive we retrospectively identified all patients with superficial facial vascular malformations treated with Onyx at our tertiary care institution between January 2009 and March 2015. We documented age, gender, presenting symptoms, angioarchitecture of the lesion, treatment approach, and follow-up MRI/MRA and angiography results when available.

Results
Six male and three female patients underwent 14 procedures for facial vascular malformations treatment using Onyx-18 or -34. The mean age was 38 ± 13 years. Six patients presented with a pulsatile mass and swelling of the face. One patient with a recurrent mandibulofacial AVM presented with episodes of intractable spontaneous bleeding. One patient presented with enlarging jaw mass with life-threatening intra-oral bleeding. One lesion incidentally was found on radiographs for braces. Five patients underwent transarterial superselective catheterization of the arterial feeder and Onyx was injected under continuous road-map guidance until complete resolution or substantial devascularization of the malformation was achieved. Three patients underwent percutaneous embolization with direct puncture of the vascular malformations. One patient underwent a combined endovascular and percutaneous approach. Immediate post-treatment angiography in seven patients demonstrated complete cure of the lesion. Two patients had substantial devascularization of their lesions with palliation of the intractable mandibulofacial AVM and with pre-operative control of life-threatening hemorrhage due to a mandibular hemangioma. Three patients subsequently underwent complete surgical removal of their lesions. Six patients had available follow-up studies showing no recurrent or residual disease. One patient was lost to follow-up. Two patients were asymptomatic at clinic follow-up. No adverse effects including skin discoloration, blindness, nontarget embolization, stroke, or death occurred.

Conclusions
In our small case series transarterial and percutaneous Onyx embolization of facial vascular malformations is safe and effective for curing malformations, decreasing pre-operative surgical bleeding risk, controlling life-threatening hemorrhages, and palliating intractable lesions.
A. Superficial facial lesion pre-embolization
B. Superficial facial lesion post-embolization and postsurgery
C. Angiography of right external carotid artery pre-embolization
D. Angiography of right common carotid artery post-embolization
Safety of Cerebral Digital Subtraction Angiography in Pediatric Patients with Sickle Cell Disease.

E Wyse¹, J Carpenter², S Magge², R Fasano², M Pearl³
¹Johns Hopkins Hospital, Baltimore, MD, ²Children’s National Medical Center, Washington, DC, ³The Johns Hopkins University School of Medicine, Baltimore, MD

Purpose
Transcranial Doppler and MRI are the imaging modalities routinely used for the interrogation of cerebrovascular pathologies in pediatric patients with sickle cell disease (SCD). Cerebral digital subtraction angiography (DSA) traditionally has been avoided in these patients due to concerns related to increased risks of intravascular sickling. We present our series of pediatric patients with SCD who underwent diagnostic or therapeutic cerebral angiograms at a single institution to evaluate the safety of this procedure.

Materials and Methods
A prospective database of all children undergoing diagnostic or therapeutic cerebral angiography in children with SCD (HbSS, HbSC) at a single pediatric institution from July 2010 to December 2014 was reviewed. Records were reviewed for age, gender, clinical diagnosis, and intraprocedural or postprocedure complications. Reviewed complications included groin hematoma, allergic reaction, kidney impairment, stroke, hemorrhage, or sickle cell crisis.

Results
A total of 41 cerebral angiograms were performed in 28 patients (17 boys, 11 girls) with SCD, aged 3 to 18 years (median age 10 years). The majority of angiograms were performed electively and those patients (26 of 28) were admitted the night prior to the angiogram for hydration at 1.5 times the maintenance rate and were transfused to achieve a hemoglobin goal of 10 g/dL. Diagnostic angiograms were performed for the following diagnoses: moyamoya syndrome (n = 6), stroke (n = 7), intracranial aneurysm (n = 9), SAH (n = 2), and vasculopathy (n = 4). The following interventional procedures were performed: intra-arterial nicardipine infusion for vasospasm due to subarachnoid hemorrhage (n = 3), coil embolization for ruptured (n = 1) and unruptured (n = 1) aneurysms, stent-assisted coil embolization for unruptured aneurysm (n = 1). No intraprocedural complications occurred during diagnostic or therapeutic angiograms. One child (2.4%) suffered from a sickle cell crisis (acute chest syndrome) postprocedure, which resulted in readmission and an overnight stay in the PICU. No groin hematomas, strokes, or intracranial hemorrhages occurred. Figure 1. Neurovascular pathologies in children with sickle cell disease. A, B). Multiple intracranial aneurysms (arrows) are noted in two patients with sickle cell disease. The largest is a superiorly projecting ophthalmic segment aneurysm (asterisk). Postero-anterior (C) and lateral (D) views from a right internal carotid artery injection show diffuse vasospasm in a child with sickle cell disease and diffuse subarachnoid hemorrhage.

Conclusions
Cerebral DSA can be performed safely in pediatric patients with SCD and should be considered in the evaluation of cerebrovascular pathologies in this population.
Stent Assisted Coiling Technique: Preliminary Experience with a New Braided Stent

D Tampieri¹, M Cortes¹
Montreal Neurological Institute and Hospital, Montreal, Quebec

Purpose
The endovascular treatment of medium and large neck aneurysms continues to represent a challenge due to the possible coils migration and the elevated rate of recanalization. Recently a new stent, approved in Canada has been introduced: the LVIS junior stent (Microvention). The aim of this presentation is to review the use of this device in 11 patients with intracranial aneurysm, describe the technique and pitfalls of the device and the short term follow up.

Materials and Methods
A total of 11 patients were treated in our Institution since using the LVIS Junior. This is a novel implantable device formed by 12 wires of Nitinol braided with three strands of Tantalum. All patients had aneurysms with broad neck and unfavorable aspect ratio. Five patients presented with SAH and in six cases the aneurysms were unruptured. All the patients without SAH received antiplatelet premedication for 3 days prior to the procedure, while the cases with subarachnoid hemorrhage had a loading dose of crushed Clopidigrel (300mg) administered via the nasogastric tube. One patient with SAH did not receive any antiplatelet. All the cases had pre-operative anticoagulation with heparin. Heparin was maintained for 24 hours while patients were in the Neurointensive care following the treatment. All patients had a postendovascular procedure angiogram and at the time this abstract is being written only two patients had a follow-up angiogram at 6 months.

Results
In all cases the stent was deployed successfully. Two patients with subarachnoid hemorrhage developed intrastent clot, which resolved in both cases with the use of Reo-pro. One case required two stents due to the inadvertent deployment of the first one too distal in relationship with the aneurysm neck. The immediate angiogram follow ups demonstrated satisfactory exclusion of the aneurysm in all cases. In nine cases the stent was used in combination with coils. In all these cases the micro-catheter was jailed in the aneurysm at the time of stent deployment. There was no re-bleed in any of the cases of our series. In two patients clot formation was noted following the deployment of the stent and after coiling of the aneurysm. In both cases Reo-pro was used to successfully resolve the clot. The LVIS Junior stent achieved very good apposition to the parent artery in all cases, and we did not experience any "stent jumping" during or immediately following delivery.

Conclusions
Endovascular treatment of intracranial aneurysms with unfavorable aspect ratio still remains a considerable challenge. While in large or giant aneurysms the use of flow diverters can represent a viable option, in medium size aneurysms or in acute SAH the use of flow diverter may have limitation. The stent-assisted coiling technique has proven to be a very useful technique in these cases without added complication rate and lower recurrence rate. The unique design of the LVIS
Junior stent enables a very precise deployment. The results of long term follow-up in our patient's cohorts will be available shortly and they will be presented at the meeting.

**EP-102**

6:00AM - 3:00PM

**Treatment of distal dissecting postero-inferior cerebellar artery aneurysms with Onyx liquid embolic agent**

A Puri\(^1\), F Massari\(^1\), P Kan\(^2\), J Lozano\(^1\), S Hou\(^3\), A Kuhn\(^1\), M Howk\(^1\), M Perras\(^1\), C Brooks\(^1\), M Gounis\(^1\), A Wakhloo\(^1\)

\(^1\)University of Massachusetts, Worcester, MA, USA, \(^2\)University of South Florida College of Medicine, Tampa, FL, \(^3\)Stroke and Neurovascular center of Central California, Thousand Oaks, CA

**Purpose**

Dissecting aneurysms of the distal segments of the PICA are an extremely rare entity, accounting for only 0.5% to 0.7% of all intracranial aneurysms. Treatment of these aneurysms is challenging both with surgical and endovascular approach. We present our preliminary data regarding Onyx embolization agent utilization in the treatment of these aneurysms with proximal parent artery preservation.

**Materials and Methods**

A total of seven consecutive ruptured peripheral postero-inferior cerebellar aneurysms were treated, in seven patients, with superselective injection of Onyx. According to the Lister et al. anatomical classification, the aneurysms were centered in the lateral medullary segment (1), tonsillomedullary segment (1) and the telovelotonsillary segment (5) of the PICA. The technical feasibility, procedure-related complications, angiographic results, follow-up diagnostic imaging, and clinical outcome were reviewed.

**Results**

Endovascular treatment was successful in all cases, with complete aneurysm occlusion and proximal parent artery preservation at final postprocedural angiogram follow up. No treatment-related complications were noted. One patient with poor preprocedural clinical condition died during hospital stay, due to sequelae of extensive subarachonid (SAH) and intraventricular hemorrhage (IVH). No rebleeding or recanalization were observed during the follow up. Two patients had moderate to severe residual disability, instead favorable outcomes, with no or mild disability, were observed in four of the surviving patients.

**Conclusions**

Angiographic, diagnostic imaging, and clinical results of our series indicate that dissecting distal postero-inferior cerebellar aneurysms treatment with Onyx liquid embolic agent, with parent artery preservation, is an effective option with low morbidity and mortality rate, in those cases in which aneurysmal sac treatment is not suitable neither with surgical clipping nor with endovascular coiling.

**EP-115**

6:00AM - 3:00PM

**Utility of the Transbrachial Guide-sheath Specifically Designed for Direct Common Carotid Artery Cannulation in Common Carotid Artery Stenting**
S Kasakura¹, T Mori¹, T Iwata¹, Y Tanno¹, Y Aoyagi¹, K Yoshioka²
¹Shonan Kamakura General Hospital Stroke Center, Kamakura, Japan, ²Shonan Kamakura General Hospital Stroke Center, Kamakura city, Kanagawa pref.

Purpose
Transfemoral approach is a common technique for carotid artery stenting (CAS), and that involves the risk of distal embolism when high grade stenosis exists at common carotid artery (CCA). We usually use the originally designed guide sheath for direct cannulation to the 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 the 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 January 2012 and March 2014 in our institution. Technical success, procedure time, periprocedural complications and 30-day major cardiovascular events (stroke, myocardial infarction, and death) were investigated.

Results
Six patients were analyzed. Three of them underwent transbrachial CAS for right CCA stenosis, and the other three for left CCA lesion. In all cases, we were successful in direct cannulation to the target CCA with the guide-sheath, and achieved CAS safely. The median time from the arterial picture to the end of procedure was 59 minutes (IQR: 8.5). Neither periprocedural complications nor cardiovascular events within 30 days following CAS occurred.

Conclusions
We successfully and safely performed CAS for CCA stenosis with the specifically designed transbrachial guide sheath for direct cannulation to the CCA.

Monday
6:00AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exposition Hall A (Level 1)-4

Electronic Poster (eP) - Pediatrics
EP-128
6:00AM - 3:00PM

A practical review of common artifacts encountered in fMRI studies in the pediatric population and methods to avoid misinterpretation

K Shekdar¹, R Golemski¹, D Zarnow², A Vossough³, E Schwartz⁴, T Roberts⁵

Purpose
To describe some artifacts commonly encountered in the clinical fMRI studies in the pediatric population and methods to avoid their misinterpretation.
Materials and Methods
We retrospectively reviewed clinical fMRI studies performed at our institute from 2008 to 2014 and evaluated some of the commonly encountered artifacts, including false positives and false negatives, arising from cerebrovascular reactivity, motion and vascular pulsations, to highlight the detection of, and potential clinical impact of, these pitfalls. All fMRI studies were performed on a 3T Siemens scanner. Primary fMRI postprocessing was done on Siemens Leonardo postprocessing unit. A commercially available postprocessing software with augmented motion correction capabilities was also used in conjunction.

Results
A total of 38 clinical fMRI studies were performed in the time period of the study. At least eight studies had to be excluded due to technical degradation. Of the 30 studies 16 studies were for mass lesions predominantly tumors and four were for vascular lesions. The other main category was medically refractive epilepsy being considered for surgery. The fMRI evaluation was for motor mapping and language function. Majority of the artifacts encountered were due to motion. While most of the encountered artifacts were due to motion and the BOLD activity was away from region of interest but in few cases the activity was in the vicinity of lesion or region of interest. Some artifacts were related to stimulus correlated subtle motion and others due to presence of vascular structures or pulsation. The general linear model (GLM) described the time course of areas of apparent activation including translational and rotational parameters of movement, components of which we proceeded to regress out, yielding maps less contaminated by motion.

Conclusions
Performing fMRI studies in the pediatric population is challenging. It is important to be familiar with commonly encountered artifacts and methods to avoid misinterpretation.

Arterial Tortuosity as a Biomarker for Pediatric Stroke Risk

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¹University of Cincinnati College Of Medicine, Cincinnati, OH, ²Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Purpose
Evaluate feasibility of using cervical and intracranial arterial tortuosity as a biomarker for occult large vessel arteriopathy in pediatric arterial ischemic stroke (AIS).

Materials and Methods
Assessment of the arterial tortuosity index (ATI) was performed for discrete segments of cervical and intracranial internal carotid artery (ICA) and vertebral artery (VA) in 31 consecutive pediatric patients with nonperinatal AIS, unrelated to cardioembolism, major trauma or active infection. The ATI was measured using noncontrast MRA postprocessed with VitreaAdvanced® 3D volume rendering software. The ATI of each segment was calculated as the length of the luminal center-line between start and end points, divided by the length of the shortest distance between those points. The mean ATI of each segment was calculated and analyzed for subgroups differentiated according to etiology-dissection (N=7), bow-hunter's syndrome (BHS) (N=3), moyamoya arteriopathy (MMA) (N=3), transient cerebral arteriopathy of childhood (TCA)
(N=3) and cryptogenic stroke (N=15). Vessel segment analysis was performed on the proximal cervical vertebral artery (V1-V2), distal cervical vertebral artery (V3), intracranial vertebral artery (V4), basilar artery, cervical internal carotid artery, petrous internal carotid artery, and intracranial internal carotid artery.

Results
The mean age of the 31 patients (18 males) was 11 years (5 months to 19 years). The table in the graphic file summarizes the study population means and standard deviations for the various vessel segments measured. Marked cervicocerebral arterial tortuosity (> 2 SD above population mean) was found in two of seven (0.28) patients with arterial dissection and in six of 15 (0.4) patients with cryptogenic stroke. In three of the six cryptogenic stroke patients with elevated arterial tortuosity, two different vessel segments were > 2 SD above the mean.

Conclusions
The neurovascular ATI is increased abnormally in a significant minority of pediatric patients with AIS that is cryptogenic or due to arterial dissection, but not in pediatric patients with AIS due to bow-hunter's syndrome, moyamoya arteriopathy, or transient cerebral arteriopathy of childhood. Further study of arterial tortuosity as a biomarker of occult large vessel arteriopathy in pediatric AIS is warranted.
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<thead>
<tr>
<th>Vessel segment</th>
<th>V1-V2</th>
<th>V3</th>
<th>V4</th>
<th>Basilar</th>
<th>Extracranial ICA</th>
<th>Pe</th>
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<tbody>
<tr>
<td>Mean ATI</td>
<td>1.05</td>
<td>2.38</td>
<td>1.10</td>
<td>1.07</td>
<td>1.09</td>
<td></td>
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<tr>
<td>Range</td>
<td>1.01-1.16</td>
<td>1.8-3.12</td>
<td>1.02-1.34</td>
<td>1.02-1.15</td>
<td>1.01-1.51</td>
<td>1</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.04</td>
<td>0.35</td>
<td>0.07</td>
<td>0.04</td>
<td>0.12</td>
<td></td>
</tr>
</tbody>
</table>

(Filename: TCT_EP-121_AbstractIMAGE3.JPG)
Automated 3D Volumetry in Rasmussen Encephalitis with Neuroquant®

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Purpose
Rasmussen encephalitis (RE) is an immune-mediated disease characterized by progressive neuropsychological dysfunction and intractable seizures. Unilateral hemispheric atrophy on MRI is a central component of the diagnostic criteria for RE (1), and prior studies have shown correlation between degree of atrophy and progression of disease (4). The gold standard for MRI quantification of hemispheric atrophy requires laborious and operator-dependent manual planimetric segmentation of the brain (2, 3). The only previously described automated approach to volumetry in RE described requires lengthy processing with a custom-made multi-step bash script which is not publicly available (4). This study evaluates the efficacy of using the commercially available Neuroquant® (CorTechs Labs, San Diego, CA) software in automated volumetric analysis of MRI scans of patients with RE.

Materials and Methods
Ten MRI scans between 10/2009 and 10/2014 from seven patients with pathologically proven RE were analyzed retrospectively using Neuroquant®, requiring approximately 5 minutes each. Additionally, gold standard manual planimetric segmentation was performed on all scans as previously described in the literature (2, 3). Measurements were converted to relative hemispheric ratios (2, 3, 4) to quantify unilateral volume loss and minimize confounding by age-related growth or measurement method (planimetric versus volumetric methods). These relative measurements then were compared to determine concordance. Volumetric analysis additionally provided automatic segmentation of individual brain structures, relative ratios of which were compared to overall hemispheric ratios to determine concordance with hemispheric atrophy.

Results
Volumetric and planimetric hemispheric ratios correlated significantly (p=0.007), but as noted in previous studies, planimetric analysis underestimated degree of hemiatrophy compared to volumetric analysis (4). Additionally, volumetric hemispheric analysis proved more reliable, with 100% concordance with pathologic diagnosis, while planimetric analysis lead to confounding results in one scan. In segmental analysis, cortical white matter (p=0.001), cortical gray matter (p<0.001), and putamen (p=0.038) volumes correlated with hemispheric volume loss. Of note, while the amygdala and hippocampus previously have demonstrated the most severe atrophy (4), our analysis shows poor correlation between these structures and hemispheric atrophy.

Conclusions
Volumetric analysis with Neuroquant® allows quick and precise quantification of extent of disease in RE. This simple analysis can be implemented easily into standard clinical workflow to improve diagnosis and monitoring of RE without significant additional time.
Brainstem disconnection: two additional patients and expansion of the phenotype

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Purpose
Brainstem disconnection (BD) is a rare posterior fossa abnormality defined by the nearly complete absence of a brainstem segment with the rostral and caudal brainstem portions connected only by a thin cord of tissue. Brainstem disconnection has a poor outcome and the majority of children die within the first 2 months of life without achieving developmental milestones. Only 12 children with BD have been reported so far. We report on two new patients with BD and a prolonged spontaneous survival to expand the phenotype.

Materials and Methods
The clinical, neuroimaging and genetic findings of the patients have been reviewed retrospectively.

Results
In both children, neuroimaging findings included discontinuity between the upper pons and the medulla and vermian hypoplasia. Neither patient required intubation or mechanical ventilation and each survived longer than 2 months (patient 1 died at 8 months, patient 2 is alive at 4.5 years). Patient 1 is the only child with BD reported so far who achieved some developmental milestones. At the age of 8 months, he was able to hold brief fixation, smiled, looked at an object at near distance and reached for it. He brought his hands to his mouth and showed some emerging reaching skills. In both children, temperature instability and seizures were recognized and extracerebral involvement including hydronephrosis and left ectopic ureter in patient 1 and VACTERL association in patient 2. Whole exome sequencing in patient 1 and array CGH in patient 2 did not show causative genetic anomalies causative for BD.

Conclusions
Although the long term neurodevelopmental outcome of BD remains unfavorable, the expansion of the phenotypic spectrum may be important in terms of counseling. The pathogenesis (malformative versus disruptive) of BD remains unknown.

EP-126
6:00AM - 3:00PM

Changes in Neuroimaging as Result of Robotic Rehabilitation in Patients with Hemispherectomy

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Purpose
To investigate anatomical and functional changes in the brain as a result of robotic rehabilitation in patients with hemispherectomy, by using structural MRI, functional MRI and diffusion tensor imaging.
Materials and Methods
FSPGR, 25 direction DTI, and resting fMRI imaging was done on five out of seven posthemispherectomy patients (11.2±0.9 years; age at time of first surgery 0.25-9 years; all subjects >1 year from last surgery) before and after receiving 8 days of robot-assisted rehabilitation over 2 weeks. Two-timepoint percentage gray matter volume change and was estimated with SIENA (Smith 2002), part of FSL (Smith 2004). Diffusion tensor imaging and fMRI data are being processed at this time; we anticipate presentation of this additional data at the time of conference. Outcome measures were assessed pre- and postintervention in all seven participants on the hemiparetic side using Fugl-Meyer Assessment, Wolf Motor Function Test (WMFT) functional ability and time, Chedoke Arm and Hand Activity Inventory (CAHAI), Six-Minute Walk Test (6MWT), and 10 Meter Walk Test (10MWT).

Results
Increase in gray matter volume near the "hand knob" area of primary motor cortex was detected in three out of five subjects with cluster sizes of 31 voxels in subject one, 27 voxels in subject two, and 20 voxels in subject three. Comparing Fugl-Meyer scores prior to and after rehabilitation camp demonstrated: Fugl-Meyer scores improved from 31 to 38 in subject one, from 21 to 24 in subject two and remained at 22 in subject three. A second cluster (region of gray matter volume increase) was identified in primary sensory cortex of subject three. Diffusion tensor imaging and fMRI data are being processed at this time; we anticipate presentation of this additional data at the time of conference. Significant improvements were seen in Fugl-Meyer (P=0.02), WMFT Functional Ability (P=0.005), WMFT Time (P<0.001), 6MWT distance (P=0.04) and 6MWT speed (P<0.05) when evaluating all seven subjects. No significant improvement was seen in CAHAI or 10MWT.

Conclusions
Our results suggest that increase in gray matter volume can be measured in hemispherectomy subjects. In addition, increase in gray matter volume seems to correlate with improved Fugl-Meyer scores. Functional improvements and increased gray matter volume were seen despite patients being well out of the acute recovery period, supporting the idea of continuing neuroplasticity in the remaining cerebral cortex.
Diffusion tensor imaging reveals early dissemination of pediatric diffuse intrinsic pontine gliomas

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¹The Johns Hopkins University School of Medicine, Baltimore, MD, ²The Johns Hopkins Bloomberg School of Public Health, Baltimore, MD

Purpose
To elucidate whether diffusion tensor imaging (DTI) reveals early dissemination of diffuse intrinsic pontine glioma (DIPG) along white matter tracts that may not be detectable on conventional MRI sequences.

Materials and Methods
Diffusion tensor imaging data of children with DIPG and low-grade brainstem glioma (LGBG) and age-matched controls were analyzed with a region of interest (ROI)-based approach. Regions of interest were placed in the bilateral posterior limb of the internal capsule (PLIC), posterior third of the centrum semiovale (PCSO), and corpus callosum (CC). Diffusion tensor imaging scalars (FA, MD, AD and RD) of the tumor groups were compared to controls using rank-sum tests. Linear regression analysis was performed to adjust for age as confounder when comparing DIPG to LGBG.

Results
We included six DIPG and eight LGBG patients (mean age 5.74±1.28 years and 8.82±3.23 years, respectively) and two groups each of 25 age-matched controls. In DIPG patients compared to controls, FA was lower in the bilateral PLIC (p=0.001 and p<0.001, respectively), MD was lower in the left PLIC (p=0.048) and right PCSO (p=0.020), AD was lower in the bilateral PLIC (p=0.001 and p<0.001, respectively) and PCSO (p=0.015 and p=0.013, respectively), while RD was higher in the bilateral PLIC (p=0.023 and p=0.018, respectively). No significant differences were found between LGBG patients and controls. In DIPG compared to LGBG patients, AD was lower in the bilateral PLIC (p=0.049 and p=0.026, respectively) and RD was lower in the CC (p=0.023).

Conclusions
Reduction in FA and AD and increase in RD in DIPG patients compared to controls may reflect tumor dissemination alone or Wallerian degeneration of the corticospinal tracts. Lack of differences in DTI scalars between LGBG patients and controls and lower AD values in the bilateral PLIC in DIPG compared to LGBG patients favor tumor dissemination. Diffusion tensor imaging may detect early tumor dissemination and serve as a biomarker for tumor progress and treatment response in pediatric DIPG.
Purpose
Clinical concern neurocognitive impairment in some infants surviving dehydration associated with hypernatremia treated with oral rehydration prompted a pilot study including MR imaging in a subset of those treated with this rehydration protocol.

Materials and Methods
A 1.5T MRI was performed at hospital discharge following oral rehydration for an episode of diarrheal-induced dehydration associated with hypernatremia at the primary pediatric hospital in Dhaka. Clinic data were collected and scans (T1, T2, DWI and GE) retrospectively reviewed by two pediatric neuroradiologists. The study was approved by the local IRB.

Results
Four children studied (ages 4-11 months) were admitted with serum sodium between 165 and 208 meq/l; corrected with 400-672 ml oral rehydration over 22-24 hours. All were reported clinically normal at discharge. Brain MRs were abnormal in three of four children; mostly symmetric extrapontine foci of diffusion restriction were seen in central gray and internal capsule. In one infant, additional patchy areas of diffusion restriction were seen in the central white matter. No evidence of venous thrombosis or hemorrhage was detected.

Conclusions
MR imaging of infants treated with oral rehydration for dehydration presenting with hypernatremia revealed patterns of diffusion restriction suggesting osmotic demyelination, without perceived overly rapid correction or IV fluids. Osmotic demyelination syndrome usually has been associated with rapid correction of severe osmolyte derangement. Though the original cases involved the pons and were uniformly fatal, modern imaging has recognized less severe injuries and extrapontine myelinolysis. The present cases may have been complicated by malnutrition resulting in abnormalities in protein osmolytes. Recognition of this injury should prompt evaluation of rehydration strategies in infants presenting with dehydration and hypernatremia in this population.

EP-134

DWI/DTI MR Thermometry of the brain in children

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Johns Hopkins University School of Medicine, Baltimore, MD

Purpose
Previous studies in adults showed that DWI/DTI MR thermometry allows a reliable noninvasive calculation of the intraventricular brain temperature. Potential applications in the pediatric population include determination of the intraventricular brain temperature in children with hypoxic-ischemic injury or traumatic brain injury. This is the first feasibility study of DWI/DTI MR thermometry in children.

Materials and Methods
Using the "mode method" outlined in previous adult studies, we calculated the intraventricular temperature in children. Apparent diffusion coefficient values of the lateral ventricles were
extracted and temperature histograms were generated. After polynomial curve fitting, determination of the mode value led to the ventricular temperature. We validated the calculations with temporal artery measurements obtained before and after the acquisition of DWI/DTI data. The estimated intraventricular brain temperature consisted of the temporal artery temperature added by 0.4°C. The calculated intraventricular temperature and the estimated brain temperature were compared.

Results
One hundred twenty children were included in this retrospective study. Eight age groups including 15 children were created. Mean age ± standard deviation at MRI was 0.65±0.17 years, 1.57±0.28 years, 2.83±0.50 years, 5.01±0.57 years, 6.86±0.50 years, 9.00±0.42 years, 11.56±1.07 years, and 15.50±0.90 years. The mismatch between calculated and estimated brain temperature was 0 to 2.60°C for children with a ventricular volume >8000 voxels (22/120 children) and 0-8.65°C for children with a ventricular volume <8000 voxels (98/120 children).

Conclusions
Our results suggest that DWI/DTI MR thermometry can calculate reliably the intraventricular brain temperature only in children with marked ventriculomegaly. Diffusion-weighted imaging/DTI MR thermometry has limited application in the pediatric population.

EP-133

Image Quality Observer rating of Turbo spin echo Diffusion weighted brain imaging compared to Traditional Echo planar Diffusion weighted imaging

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¹Phoenix Childrens Hospital, Phoenix, AZ

Purpose
To determine observer ratings of image quality of TSE DWI compared to EPI DWI performed in pediatric neuroimaging.

Materials and Methods
The brain MRI images of 20 consecutive pediatric patients, who were imaged with both traditional EPI DWI and TSE DWI were identified retrospectively for review. All patients were imaged on a Philips Ingenia 3T. Two CAQ pediatric neuroradiologists (JM, JC), independently and blindly reviewed both sets of each patient's DWI images according to a rating scale assessing image quality. This scale rated image quality as "acceptable without significant artifact", "acceptable with clinically irrelevant artifact", "acceptable with potentially clinically relevant artifact" and "unacceptable/nondiagnostic". Observer variance was rectified by consensus review.

Results
Ten female and 10 male patients aged 6 months to 12 years (average age of 5 years) were identified for review. At final review, the EPI DWI image quality ratings were 5/20 "acceptable without significant artifact", 7/20 "acceptable with clinically irrelevant artifact", 7/20 "acceptable with potentially clinically relevant artifact" and 1/20 "unacceptable/nondiagnostic". At final review, the TSE DWI image quality ratings were 18/20 "acceptable without significant artifact", 1/20 "acceptable with clinically irrelevant artifact", 1/20 "acceptable with potentially clinically relevant artifact" and 0/20 "unacceptable/nondiagnostic".
Conclusions
Turbo spin echo DWI brain MRI demonstrated clinically acceptable image quality with a very low percentage of image artifacts in a cohort of pediatric patients undergoing routine neuroimaging. In comparison, standard EPI performed in the same patients demonstrated a much greater percentage of clinically irrelevant and relevant image artifacts. Substituting TSE DWI techniques for standard EPI DWI may prove to be a solution for the not infrequent presence of diffusion imaging artifacts encountered with current techniques.
Neonatal Meningitis: Magnetic-resonance-imaging-based Scores Analysis in Preterm and Term Newborns

Z Qiao¹, M Yang¹
¹Children's Hospital of Fudan University, Shanghai, Shanghai

Purpose
To describe the magnetic resonance imaging (MRI) patterns of brain damage in neonatal meningitis and to investigate the difference between preterm and term newborn by using MRI-based score analysis.

Materials and Methods
The clinical information and MRI dataset of 65 newborns with meningitis were reviewed, including 18 preterms and 47 terms. There were 13 basic image patterns identified on cranial MRI and graded from score 1 to 3 (Table 1). These 13 patterns were classified further into three groups - white matter abnormalities (WMA), gray matter abnormalities (GMA) and nonparenchyma abnormalities (NPA).

Results
Of all the newborns, 63% presented cerebral lesions (41/65) and 3% presented cerebral plus cerebellar damages (2/65). The frequencies and MRI-based scores of abnormal myelination of the posterior limb of internal capsules, ventricular dilatation and periventricular white matter volume loss were higher in the preterm than the term. The mean grading score of MRI in the preterm group was significantly higher than that of term group (mean17.17 ± 3.03 versus 14.87 ± 3.35, p = .000). Regarding the WMA, GMA and NPA, the score of WMA in the preterm was significantly higher than that of the term (p = .000) (Figure 1). While the differences of GMA and NPA scores between the preterm and the term were not significant (p = .076, .224, respectively).

Conclusions
The preterm neonates with meningitis were inclined to have white matter abnormalities and resulted in much more severe brain damages than the term ones.
Table 1. The brain abnormalities identified on magnetic resonance imaging (MRI) and MRI-based scoring

<table>
<thead>
<tr>
<th>Item</th>
<th>MRI Abnormalities</th>
<th>Score 1</th>
<th>Score 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ventricular dilation&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Negative</td>
<td>Mild</td>
</tr>
<tr>
<td>2</td>
<td>Periventricular white matter volume loss</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>3</td>
<td>Cystic abnormality</td>
<td>Negative</td>
<td>Focal</td>
</tr>
<tr>
<td>4</td>
<td>Abnormal myelination of the posterior limb of the internal capsule</td>
<td>Negative</td>
<td>Positive at corrected age &gt; 37 wk</td>
</tr>
<tr>
<td>5</td>
<td>Cortical gray matter signal abnormality</td>
<td>Negative</td>
<td>Focal</td>
</tr>
<tr>
<td>6</td>
<td>Intracranial extracerebral space abnormality</td>
<td>Negative</td>
<td>Focal</td>
</tr>
<tr>
<td>7</td>
<td>Basal ganglia signal abnormality</td>
<td>Negative</td>
<td>Focal</td>
</tr>
<tr>
<td>8</td>
<td>Non-cystic white matter signal abnormality&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Negative</td>
<td>Mild</td>
</tr>
<tr>
<td>9</td>
<td>Intraventricular hemorrhage</td>
<td>Negative</td>
<td>Grade I, Grade II</td>
</tr>
<tr>
<td>10</td>
<td>Pyocephalus</td>
<td>Negative</td>
<td>Focal</td>
</tr>
<tr>
<td>11</td>
<td>Abnormal meningeal enhancement</td>
<td>Negative</td>
<td>Focal</td>
</tr>
<tr>
<td>12</td>
<td>Abnormal ependymal enhancement</td>
<td>Negative</td>
<td>Focal</td>
</tr>
<tr>
<td>13</td>
<td>Encephalopathy</td>
<td>Negative</td>
<td>Focal and diameter &lt; 3 cm</td>
</tr>
</tbody>
</table>

<sup>a</sup> The dilatation of ventricular was defined when the largest atrial ventricular diameter at the level of the glomus of the choroid plexus was < 8 mm, while 8-10 mm was mild and > 10 mm was moderate or severe<sup>[26]</sup>.

<sup>b</sup> The mild non-cystic white matter signal abnormality was defined as the abnormalities of white matter with the size < 2 mm or fewer. The moderate was defined as the abnormality counting > 3, or with size > 2 mm but > 5% of the hemisphere involved<sup>[26]</sup>.

(Filename: TCT_EP-123_Table1.jpg)
Fig. 1 Comparison of MRI-based scores of the white matter, gray matter and non-brain-parenchyma injuries in preterm and term newborns. The white matter abnormalities (WMA) included ventricular dilatation, periventricular white matter volume loss, cystic abnormality of white matter, abnormal myelination of the posterior limb of the internal capsule, non-cystic signal abnormality of white matter; The gray matter abnormalities (GMA) included cortical gray matter and basal ganglia lesions; non-brain-parenchyma abnormalities (NPA) included ventricular dilatation, intracranial extracerebral space abnormality, intraventricular hemorrhage, pyocephalus, abnormal meningeal and abnormal ependymal enhancement.
Neuroimaging findings in pediatric cerebral sinovenous thrombosis

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Purpose
Pediatric cerebral sinovenous thrombosis (CSVT) is a potentially life-threatening condition, which usually is diagnosed by MRI. We analyzed the signal changes of the thrombus over time and the role of DWI/DTI in the diagnosis of CSVT.

Materials and Methods
Chart review for risk factors of CSVT, neurologic manifestation, and interval from onset of symptoms related to CSVT to the neuroimaging diagnosis was performed. MR imaging studies were evaluated retrospectively for the appearance of thrombi on T1- and T2-weighted, FLAIR, DWI/DTI, SWI, and MRV images.

Results
Thirty-three children with CSVT were included in this study. Seventy-seven thrombi were found. Seventy-four thrombi could be identified on T1- or T2-weighted images (96%), 72 thrombi were seen on DWI/DTI (94%) and 68 on FLAIR (88%). Diffusion-weighted imaging showed restricted diffusion in 29 thrombi (40%). Thrombi older than 1 day were more likely to have a T1-hyperintense signal (p=0.002). No additional correlation between signal intensity and age of the thrombi was found. Intraparenchymal changes secondary to CSVT were seen in 11 children.

Conclusions
MR sequences individually are not sensitive enough to provide the diagnosis. Diffusion-weighted imaging/DTI does not provide complementary diagnostic value. Approximation of the age of thrombus is difficult because of its poor correlation to signal intensity.

Pediatric Spinal Cord Atrophy Imaging: Quantitative Measures in Normal and Patients with Spinal Cord Injury

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Purpose
Atrophy measures estimate reduction in spinal cord cross-sectional area (SCCSA) using high resolution structural magnetic resonance imaging (MRI). The purpose of this study is twofold: 1-
To use a recently developed semi-automated method to measure the SCCSA in pediatric subjects [healthy and patients with spinal cord injury (SCI)] (1). 2- To correlate MRI ratings and clinical measures obtained in SCI patients with atrophy findings.

Materials and Methods
Twenty subjects (10 controls, 10 patients with chronic SCI) were scanned using a T2-weighted 3D-SPACE sequence in the sagittal plane covering the cervical and thoracic spinal cord (C1-T12; 2 slabs) using a 3.0T scanner. Imaging parameters: voxel size = 1×1×1mm3, TR=1500ms, TE=122ms, and number of averages= 2. Initially, cervical and thoracic spine images were stitched together. Next by combining Canny edge detection with nonmaximal suppression, the partial volume boundary between the cord and surrounding CSF was detected automatically for the entire length of the cord. Finally, the algorithm generates a cross-sectional image perpendicular to each point along the cord and selects the edge which intersects the sagittal profile and draws a contour which is considered as SCCSA.

Results
There were statistically significant differences (p<0.001) between SCCSA measurements averaged across all levels in cervical and thoracic regions in healthy subjects (62.54±9.46mm2 and 40.12±9.22mm2 respectively) compared to SCI (53.35±9.59mm2 and 30.33±9.83mm2 respectively) (Figure 1). Clinical measures of injury level measured using ISNSCI scoring showed positive, but weak correlations (Spearman CC <0.47) to SCCSA for motor, sensory, pin prick and light touch and neurologic level of injury in SCI subjects. Weak but negative correlations (<-0.29) were observed with MRI ratings.

Conclusions
Results show that SCCSA measures obtained in SCI patients with this technique might serve as an imaging biomarker to study progression and recovery of injury and evaluate treatment effectiveness longitudinally.
Radiation Injury Can Mimic Tumor Progression Following Proton Radiotherapy for Atypical Teratoid Rhabdoid Tumor in Pediatric Patients

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Purpose
Atypical teratoid rhabdoid tumors (ATRTs) are rare central nervous system tumors mostly...
affecting infants and young children with a historically dismal prognosis. Proton beam radiation therapy is a promising treatment for pediatric ATRT due, in part, to more specific delivery of radiation dose to the tumor with decreased dose to normal surrounding tissues; however, radiation injury can still occur. The imaging and clinical characteristics of proton beam radiation injury in pediatric patients have not been described well.

Materials and Methods
We performed a retrospective imaging and clinical review of a cohort of ATRT patients treated with proton therapy at three proton treatment centers who developed radiation injury.

Results
A total of four patients (age 4 months to 4 years) with ATRT were treated with two cycles of induction chemotherapy (including methotrexate) followed by proton therapy (50.4-54 Gy in 1.8 Gy fractions) and three cycles of consolidation chemotherapy (including thiopeta). All patients developed acute neurological symptoms (for example, seizure, hemiparesis, or eye deviation) at 4 to 7 months following proton therapy and underwent MRI evaluation. In all cases, MRI findings were suspicious for local tumor recurrence, including FLAIR hyperintensity, mass-like enhancement, and diffusion restriction, features similar to the original ATRT. In three of four cases, susceptibility-weighted imaging (SWI) and/or CT demonstrated parenchymal calcifications at 4 - 12 months following proton therapy. However, symptoms and imaging findings improved with supportive care and steroids, without reinitiation of oncologic treatment, consistent with radiation injury rather than tumor progression.

Conclusions
Although proton beam radiation therapy is a promising treatment for pediatric ATRT, with the potential for improved survival and decreased treatment complications, radiation injury can still occur. Moreover, radiation injury following proton therapy for ATRT can mimic tumor progression with concerning neurological symptoms as well as MRI findings of mass-like enhancement, increased FLAIR signal intensity, diffusion restriction, and parenchymal calcification as early as 4 months after treatment. Recognition of radiation injury is important since misinterpretation as tumor progression can lead to unnecessary toxic therapies in this vulnerable pediatric population.

EP-130

Recurrent Medulloblastoma: Role of diffusion weighted imaging

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Purpose
Surveillance MRI is performed routinely for detection of recurrent disease in patients with medulloblastoma. The purpose of this study was to compare the rate of detection of recurrent disease on diffusion-weighted imaging (DWI) with contrast-enhanced imaging.

Materials and Methods
MR images of patients with medulloblastoma were reviewed retrospectively. The presence of recurrent disease was defined as an area of hyperintense DWI signal with isohypointense signal on apparent diffusion coefficient map (ADC) and as an area of abnormal nodular enhancement on T1-weighted contrast-enhanced images.
Results
Database search from 2003 to 2013 revealed 45 patients with a clinical diagnosis of medulloblastoma. Out of these, 11 patients were suspected to have recurrent disease; nine patients had confirmed recurrence, and two patients had radiation necrosis. Mean age of patients at diagnosis was 17.16 +/- 14.49 years with a range of 4 to 47 years and median of 11 years. Male to female ratio was 8:4. The mean time interval from diagnosis to recurrence was 36.36 +/- 32.54 months with a range of 6 to 113 months. Distribution of lesions was as follows: cerebellum (n=7), subependymal (n=5) and basal cistern (n=1). All recurrent lesions exhibited restricted diffusion (100%), whereas only five patients had associated contrast enhancement (55%). One patient had nonprogressive persistent restricted diffusion without recurrence. Two patients with radiation necrosis developed contrast enhancing lesions, but did not have associated restricted diffusion.

Conclusions
Restricted diffusion signal commonly is seen in patients with recurrent medulloblastoma and can aid in the early detection of these lesions. In our study, DWI was positive in all patients with recurrence. Hence DWI images should be scrutinized carefully in all patients and suspicious areas carefully followed, even in the absence of abnormal enhancement.

Recurrent medulloblastoma seen as restricted diffusion along the wall of the lateral ventricle. Note absence of contrast enhancement.
Serial Evaluation in Cerebral Perfusion after Indirect Revascularization for Children with Moyamoya Disease Using Dynamic Susceptibility Contrast MR Perfusion Study.

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¹National Taiwan University Hospital, Taipei, Taiwan

Purpose
To evaluate the serial cerebral perfusion changes after indirect revascularization for children with moyamoya disease using dynamic susceptibility contrast (DSC) MR perfusion.

Materials and Methods
From Jan 2012 to Dec 2014, there was a total of 17 children (younger than 18 years) who underwent indirect extracranial-intracranial bypass for moyamoya disease and underwent a comprehensive imaging follow-up at our hospital. There are six girls and 11 boys, aged 4 to 18 years. Encephaloduroarteriosynangiosis (EDAS) was done sequentially on each side or only one side of the brain with a total of 31 EDAS done in these subjects. Imaging evaluation including conventional brain imaging, TOF MRA of whole brain and DSC MR perfusion was done before operation and 1m, 3m, 6m, 9m, 12m after operation. Serial time to peak (TTP) map from DSC MR perfusion was evaluated. Using cerebellar average TTP as the reference, those regions with TTP more than 2 seconds longer than cerebellum were regarded perfusion-impaired areas. The volume of perfusion-impaired area was calculated on each side of the brain and was divided by the whole supratentorial brain volume to obtain a percentage of perfusion impairment.

Results
Post-EDAS MRA findings show enlargement of the superficial temporal artery (STA) and middle meningeal artery (MMA). The findings could be seen on the first month follow-up imaging but are more pronounced after 3 months. Less visualized MCA and ACA signal on TOF MRA is found after the STA/MMA enlargement. Ten out 28 (35.7%) sides of the first month follow-up show a more than 5% volume improvement of impaired cerebral perfusion and 15 out of 24 (62.5%) sides of the sixth month follow-up show a more than 5% volume improvement of impaired cerebral perfusion. Hemispheres with poorer perfusion before operation tend to have a larger improvement after operation. Most of the cerebral perfusion status stabilized after 6 months.

Conclusions
Dynamic susceptibility contrast MR perfusion offers a quick and noninvasive evaluation of cerebral perfusion in the postoperative moyamoya subjects and from our experience the perfusion improvement occurs early in the first month after indirect bypass.

Spectrum of intracranial manifestations of Neurofibromatosis-1 with specific evaluation of brain stem

R Gawande¹, R Pluhm¹, D Nascene¹
Purpose
The presence of multiple nonenhancing T2 hyperintense lesions is well known in patients with NF-1. The purpose of this study was to evaluate the presence of intracranial lesions in patients with NF-1 with specific attention to brain stem.

Materials and Methods
Brain MRI of patients with NF-1 were evaluated retrospectively. The location of T2 hyperintense lesions in the brain was divided into eight areas: globus pallidus, putamen, caudate nucleus, thalamus, midbrain, pons, medulla and cerebellum. The presence of brain stem enlargement and optic glioma was noted. The lesions were graded visually on a 4-point scale as absent (0), mild (1), moderate (2) and severe (3) by degree of T2SI. Additional unexpected lesions were recorded.

Results
Two hundred sixty-four patients with a diagnosis of NF-1 were identified. Neuroimaging studies were available in 93 patients. Mean age was 10.72 +/-10.85 years (median 8 years). The most common location of T2 hyperintense lesions (NF-1 spots, Figure 1) was cerebellum (65.5%, mean grade 1.2), globus pallidus (56.9%, 0.95), thalamus (51.6, 0.7), pons (46.2%, 0.73), medulla (46.2%, grade 0.69), putamen (6.4%, 0.02) and caudate nucleus (1.07%, 0.02). Optic pathway gliomas were present in 41.9% patients. Enlargement of the brainstem was present in 35 (37.6%, Figure 2). Of these patients, four had suspected brain stem glioma, including one with pathologically proven juvenile pilocytic astrocytoma (JPA). Follow-up imaging was available in 30 patients, which showed stable or decreasing brain stem enlargement over several years. Additional lesions included other gliomas (n=5), cystic lesions (n=7), nonenhancing lesions at other location (n=9), enhancing lesions (n=3) , sphenoid wing dysplasia (n=3) and a patient with ethmoid osteofibroma.

Conclusions
Nonenhancing T2 hyperintense spots commonly are seen in the cerebellum and brainstem in patients with NF-1. Associated brainstem enlargement frequently is seen and should not be misinterpreted as brain stem neoplasm.
The Effects of Chemotherapy on the Pediatric Brain

C Kim¹, K Yeom², M Iv³

¹Stanford University, Stanford, CA, ²Stanford University, School of Medicine, Palo Alto, CA, ³Stanford University Medical Center, Stanford, CA

Purpose
Acute lymphoblastic leukemia (ALL) is the most common childhood malignancy. Management involves a variety of aggressive chemotherapy regimens involving methotrexate and approaches a success rate of 90%. However, methotrexate is associated with neurotoxicity, such as neurocognitive deficits or leukoencephalopathy. The radiologic signs of leukoencephalopathy include increased white matter signal intensity on T2-weighted magnetic resonance imaging (MRI). Studies have shown the incidence of leukoencephalopathy increases with methotrexate
dose, and the risk decreases upon treatment completion. The purpose of this study was to evaluate for possible subclinical imaging markers of neurotoxicity in patients receiving methotrexate. We measured cerebral blood flow in children with ALL who received methotrexate but did not have radiologic signs of leukoencephalopathy. The cerebral blood flow of these patients was compared with that of children who received chemotherapy for Langerhans cell histiocytosis (LCH), excluding methotrexate, and of children with negative MRI examinations and no known medical pathology. Identifying early signs of central nervous system neurotoxicity may help physicians adjust treatment regimens to avoid leukoencephalopathy and long term morbidity, including cognitive deficits, in children receiving methotrexate.

Materials and Methods
MR imaging exams of 40 patients with ALL were stratified retrospectively into those with negative findings or significant pathology. These patients were compared with 23 patients who received chemotherapy for LCH. Furthermore, comparison was made to patients with no known medical pathology. Regions of interest were drawn in multiple vascular territories, basal ganglia, and centrum semiovale bilaterally to measure the cerebral blood flow on arterial spin labeling. Preliminary statistical analysis included the Mann-Whitney U test.

Results
Preliminary statistical analysis demonstrated no statistical difference in cerebral blood flow among children with ALL who received methotrexate but demonstrated no abnormal MRI findings, patients with LCH who received chemotherapy regimens excluding methotrexate, and patients with no known significant medical history or MRI findings.

Conclusions
Our preliminary findings showed no difference of cerebral blood flow in children who received methotrexate for ALL, patients with LCH, and patients with no known medical pathology or radiologic findings in the brain. Potential future studies include assessing similar parameters using larger cohorts, comparing cerebral blood flow factoring methotrexate doses, following serial cerebral blood flow values as patients undergo induction, maintenance, and remission, and quantifying cerebral blood flow after patients receive oral, intravenous, or intrathecal methotrexate. Identifying early or subclinical markers of neurotoxicity may help physicians adjust chemotherapy regimens to minimize adverse reactions. As a result, patients may avoid developing fulminant leukoencephalopathy and curtail potential cognitive deficits from methotrexate.
The Reduction of Flow Artifacts in T1-Weighted Spiral Spin-Echo Brain Imaging: A Preliminary Study in Children

H Hu¹, Z Li², D Wang², J Karis², J Miller¹, J Pipe²
Purpose
Contrast-enhanced T1-weighted (T1W) 2D imaging using spin echo (SE) and turbo spin echo (TSE) sequences are used widely in neuroradiology. Postcontrast Cartesian SE/TSE axial imaging is sensitive to flow artifacts arising from the venous sinuses. In this work, we propose an alternative 3D spiral non-Cartesian technique to mitigate these artifacts. The purpose of the study was to compare the performance of spiral T1W SE to its Cartesian TSE counterpart in pediatric patients and evaluate the severity of flow artifact and the diagnostic quality of the resultant images.

Materials and Methods
To date, 13 patients were examined on a 3T Philips Ingenia scanner (10 males, 3 females, 1-13 years). After contrast injection, the Cartesian TSE was scanned, followed by the spiral SE sequence. Parameters for the Cartesian sequence were: 22cm FOV, 1.0x0.8 mm resolution, 3 mm slices, 0.3 mm gap, 15 slices, TR/TE=674/9 ms, and scan time of 2 min 30 s. The spiral data were acquired similarly, except for 0.85x0.85 mm resolution, TE=10 ms, and a scan time of 1 min 18 s. Results were reviewed independently by two neuroradiologists. For each patient, the paired Cartesian and spiral images were presented in a random and blinded fashion. A 5-point scale was used.

Results
Figure 1 shows representative images, illustrating TSE and spiral SE results. Flow artifacts noticeable in the Cartesian images are minimized in the spiral SE data. Both radiologists noted improved performance in flow artifact reduction with the spiral strategy and preferred the spiral images in terms of overall diagnostic quality. In two cases, Cartesian and spiral data were equally preferred. No cases were found where spiral was rated worse than Cartesian images. Scores from the radiologists were not statistically different.

Conclusions
The faster and more efficient spiral SE technique evaluated in this work reduces flow artifacts commonly observed in postcontrast Cartesian TSE T1W imaging, yields comparable image quality, and is a viable alternative.
Figure 1. Representative images from Cartesian TSE (top) and spiral SE (bottom) in 2 patients, post Gd contrast injection. Dashed boxes denote flow artifacts in the Cartesian data, which are mitigated in the spiral images.
Monday
6:00AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exposition Hall A (Level 1)-5

Electronic Poster (eP) - Socioeconomics
EP-140

10 Years of Radiopaedia.org; Lessons Learned While Building the Largest Collaborative Radiology Resource.

F Gaillard¹
Radiopaedia.org, Melbourne, Victoria

Purpose
1 - to discuss the history and underlying philosophy of Radiopaedia.org, founded in 2005. 2 - to highlight insights gained over that time, specifically pertaining to: community engagement; website design; and use of social media.

Materials and Methods
Radiopaedia.org was founded in 2005 by Dr. Frank Gaillard, in Melbourne, Australia. Since then it has grown into the largest free collaborative radiology resource currently available. Using google analytics data, historical screen captures, and case studies the development history and current state of the site will be reviewed. Additional data from our various social media platforms will be used to examine growth and impact of social media on our community.

Results
Currently Radiopaedia.org has over 7,000 reference articles and 17,000 cases, all created by hundreds of dedicated volunteers. The site is accessed by over 1.5 million individuals every month from all over the world, who visit over 7,000,000 pages each month. Radiopaedia.org also has build a strong social media presence with over 1 million followers spread across Facebook, Twitter, Instagram, Pinternet, Tumblr and Youtube.

Conclusions
Over the past 10 years many lessons have been gained: a community of dedicated volunteers, who share a common goal can create a successful radiology resource used by the entire radiology community; a bespoke user-interface with continual development is crucial to adequately present imaging; social media platforms such as facebook and twitter are essential in maintaining a large community.

EP-144

Axial T2-weighted images only yield excellent accuracy in the determination of normal and abnormal pediatric brain MRI studies

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The Johns Hopkins University School of Medicine, Baltimore, MD
Purpose
To determine the sensitivity, specificity, and accuracy of axial T2-weighted images only in the evaluation of pediatric brain MRI studies.

Materials and Methods
We retrospectively evaluated consecutive brain MRI studies of children. Standard of reference was the final report of neuroradiology attendings as available in the PACS system. Three readers, a pediatric neuroradiologist with 20 years of experience, a neuroradiologist with 2 years of experience, and a 4th year radiology resident were blinded for clinical diagnoses. They evaluated axial T2-weighted images alone and then combined with the remaining sequences as acquired for each case based on the clinical indication. Diagnoses were noted as normal or abnormal. Sensitivity, specificity, and accuracy were measured.

Results
Consecutive MRI studies of 158 patients (72 girls) were included. The mean age ± standard deviation of children was 7.47±5.78 years. Axial T2-weighted images yielded a sensitivity of 77-88%, a specificity of 92%, and an accuracy of 84-90% for a normal or abnormal diagnosis. All sequences had a sensitivity of 89-95%, a specificity of 86-93%, and an accuracy of 87-94%.

Conclusions
The evaluation of axial T2-weighted images only has a high accuracy in the determination of a normal or abnormal pediatric brain MRI study. Axial T2-weighted images alone can identify abnormal studies with high reliability. High level of experience further increases sensitivity and specificity. These results suggest that axial T2-weighted MR can serve as a survey tool in a high percentage of cases.

EP-141
6:00AM - 3:00PM

Fully Automated Application for Workflow Optimization and Quality Control in Routine MRI Setting

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¹University Medical Center Hamburg-Eppendorf, Hamburg, Germany

Purpose
Cost effectiveness and capacity utilization of MR scanners become increasingly significant in both private practice and medical centers. The purpose of this project was to develop a fast, fully automated, low-cost workflow to monitor utilized capacity of the MR scanner in real time using examination specific information stored in the DCM header.

Materials and Methods
The workflow was developed for a Siemens Skyra utilizing the phoenix report, which contains the extracted meta-information of the DCM-header and is available for each series. The phoenix report is sent automatically from the scanner to a dedicated dem4chee-PACS server (freeware PACS-client, low hardware demand). Queries to the phoenix-PACS were run via PHP-script. All study-specific information was extracted from the phoenix report and visualized with a java-based chart-tool in real-time.

Results
Automatic forwarding of the phoenix report from the scanner to the PACS was fast and robust. Information was extracted and available for further processing directly. Real-time diagrams of
current scanner idle times, patient numbers and protocol frequency were available (Figure 1). In 01-06/2014 daily mean examination time was 25 mins, mean idle times 14 mins and number of applied protocols 103.

Conclusions
The fully automatic workflow offers a valuable tool to monitor scanner performance and provides information for quality assessment, workflow evaluation and optimization. Currently further analyses of idle times to identify sources of delay and evaluate scanner capacity are conducted. This tool can be adapted easily to other scanner brands by extracting the information directly from the DCM header of a single DCM file per series that can be sent to the dedicated PACS.

(Filename: TCT_EP-141_Skyra_Figure1.jpg)

EP-139
6:00AM - 3:00PM

Head Holder Image Artifact: Shadows in the midst of Light, and How We Fixed It.

F Yang¹, I Ikuta¹
¹Norwalk Hospital, Norwalk, CT
Purpose
We will elucidate the etiology of a head CT image artifact which may hinder image interpretation, and how to avoid creation of the image artifact.

Materials and Methods
Prior to noting that this was a head holder image artifact, multiple diagnostic checkups of the CT scanner were performed by a certified technician. Finally, we observed that CT scans with this image artifact were encountered during CT brain scans of patients with heads in hyper-extension. To obtain axial slices of properly aligned, the gantry was tilted, resulting in the artifact described.

Results
CT head holders are designed to be radiolucent; however, we encountered several cases of CT artifacts at our institution relating to a widely used CT head holder. This artifact was position-dependent and seen on CT brains where the gantry was tilted at an angle where the resultant x-ray beam was in line through an oblique portion of the CT head holder. This resulted in profound x-ray attenuation and marked darkening on the involved single slice.

Conclusions
Due to the position and gantry angle dependent nature of this artifact, the following are a few suggestions to reduce this artifact. 1. Scan axial slices of CT brain without tilting of the gantry to minimize this artifact. 2. Position the patient's head cephalad relative to the angled base of the head holder to move the artifact outside the field of view, however this would not be ideal if patient were to also obtain a CT of the cervical spine. 3. Reduce hyper-extension of the head if possible. 4. Educating the CT technologists of these protocol procedures.
Impact of Stent-assisted Recanalization of Carotid Artery Occlusion on Brain Volume Changes

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1Department of Radiology, Uludag University Faculty of Medicine, Bursa, Turkey, 2Department of Neurology, Uludag University Faculty of Medicine, Bursa, Turkey, 3Department of Biostatistics, Uludag University Faculty of Medicine, Bursa, Turkey, 4Department of Radiology, Afyon Kocatepe University Faculty of Medicine, Afyonkarahisar, Turkey

Purpose
Stent-assisted recanalization of severe occlusion of carotid artery, which is involved in the etiology of ischemic stroke, is an up-to-date treatment approach. The purpose of this study was to assess the impact of stenting on the prognosis by making brain volume measurements in patients with severe occlusion of carotid artery.

Materials and Methods
Between June 2013-April 2014, stenting was performed in a total of 21 severe occlusions of carotid artery (on the left side in nine patients; on the right side in four patients; and on both sides in four patients) in a total of 17 patients [14 (82.4%) males and 3 (17.6%) females]. The patients' mean age was 65.76±5.68 years (ranging from 56 to 77). Among these patients, 88% had hypertension, 47% had coronary artery disease, 41% had a history of smoking, 18% had diabetes, 18% had a history of cerebrovascular events, and 12% had hyperlipidemia accompanying the occlusion. High resolution 3D T1A images were obtained on 3T MRI using 32-channel head coil 24 hours before the operation and 7.18±3.6 months (mean±standard deviation) (ranging from 2 to 12 months) after the operation in these 17 patients who received stents for severe occlusion of the carotid artery. Using Free Surfer version 4.5.0, intracranial total gray matter, total cortical white matter, white matter hypointensity and total intraventricular and subcortical gray matter volumes were assessed on the images.

Results
Statistical analyses of intracranial total gray matter, total cortical white matter, white matter hypointensity and total intraventricular and subcortical gray matter volumes that were assessed in Free Surfer version 4.5.0 were performed in SPSS 22.0 statistical package program. Whether the data demonstrated a normal distribution or not was determined using Shapiro-Wilk test. Dependent groups were compared using Wilcoxon signed rank test and matched pairs t-test. Level of significance was set at α=.05. No significant difference was found in total gray matter volume (p=.902). However, a significant reduction was observed in total cortical white matter and subcortical gray matter volumes (p<.05). Furthermore, a significant increase was found in white matter hypointensity and total intraventricular volume (p<.05).

Conclusions
Impaired cerebrovascular autoregulation associated with stenosis in patients with severe occlusion of carotid artery may lead to capillary hyperperfusion and baroreceptor reaction after stent-assisted recanalization. In this study, the significant reduction in the postoperative intracranial total cortical white matter and subcortical gray matter volumes and the significant increase in the white matter hypointensity were considered to be the outcome of subclinical
oxidative stress which occurred as a reperfusion response. The significant increase in the postoperative total intraventricular volume, on the other hand, might be relative to the reduction in the total white matter volume. It might be valuable to support this study with postmortem studies and to confirm the findings in other brain analysis programs.

EP-142

6:00AM - 3:00PM

Low Dose Head Computed Tomography Protocol for Evaluation of Non-traumatic Emergencies in Children

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¹Mallinckrodt Institute of Radiology, St. Louis, MO

Purpose
To report the effects on dose and technical parameters using automated dose reduction technologies in a pediatric patient population.

Materials and Methods
We retrospectively reviewed 644 pediatric head CT scans performed between January 2013 and December 2013. Of the 644 scans, 489 were performed using the full dose protocol to assess for traumatic emergencies and 155 head CT scans were performed using low dose protocols to evaluate for nontraumatic emergencies. All pediatric head CT scans were performed on a FLASH scanner (Siemens Healthcare) using automated tube kilovoltage (kV) selection (CARE kV) and automated milliamperage (mAs) modulation (CareDose 4D) technologies. Full dose scans used quality references of 330 mAs and 120 kV. Low dose scans used references of 150 mAs and 100 kV. All CT scans were reviewed for CT Dose Index Volume (CTDIvol) in mGy, Dose Length Product (DLP) in mGy.cm, mAs and kV. Data were recorded from the patient dose record shown at the CT console. Results of the high and low dose scans were evaluated using nonparametric statistical analysis.

Results
Median patient ages for high and low dose head CT protocols were 7.0 and 6.0 years respectively. Median CTDIvol for high and low dose CT protocols were 27.2 and 8.2 mGy respectively (p < 0.05). Median DLP for high and low dose CT protocols were 473 and 146 mGy.cm respectively (p < 0.05). Median mAs for high and low dose CT protocols were 281 and 90 mAs respectively (p < 0.05). For high dose CT scans, kV was dropped from 120 kV to 100 kV in all cases. For low dose CT scans, kV was maintained at 100 kV. All low dose pediatric head CTs were of diagnostic image quality.

Conclusions
Low dose head CT protocols in children using automated technologies to select mAs and kV reduce CTDIvol, DLP, and mAs by > 70%. These results indicate that low dose pediatric head CT protocols are feasible in a nontraumatic scenario.
<table>
<thead>
<tr>
<th>Indication</th>
<th>Emergency High Dose Head CT</th>
<th>Emergency Low Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trauma</td>
<td>330</td>
<td>150</td>
</tr>
<tr>
<td>Exclude Stroke</td>
<td>330</td>
<td>150</td>
</tr>
<tr>
<td>Need for IV Contrast</td>
<td>120</td>
<td>100</td>
</tr>
</tbody>
</table>

(Filename: TCT_EP-142_Table1.jpg)

**Image Quality**

**High Dose**
- Reference mAs: 330
- Reference kV: 120

**Low Dose**
- Reference mAs: 150
- Reference kV: 100

(Filename: TCT_EP-142_HighLow.jpg)
Purpose
The purpose of this study is to retrospectively evaluate radiation doses and fluoroscopic time in fluoroscopic-guided lumbar puncture (LP).

Materials and Methods
We retrospectively reviewed all fluoroscopic-guided LP performed at our institution over a 9-month period. Information regarding fluoroscopic radiation dose and fluoroscopic time was obtained from the Picture Archiving and Communication System (PACS). Three neuroradiology fellows and a physician assistant performed the fluoroscopic-guided LPs during the study period. We performed group comparisons of radiation dose and fluoroscopic time between patients stratified by age (older versus younger than 50 years), gender, puncture site, operator, and study indication. Statistical analyses were conducted using Mann-Whitney tests. Differences were considered statistically significant when p < 0.05.

Results
A total of 188 fluoroscopic-guided lumbar punctures [median age (SD) = 47 (19); age range = 10-86 years] were reviewed. Indications for the LP were as follows: altered mental status in 17 cases; abnormal neurological exam in 13 cases; evaluation for leptomeningeal tumor in 33 cases; infection in 30 cases; idiopathic intracranial hypertension in 61 cases; demyelinating disease and other inflammatory process in 22 cases; normal pressure hydrocephalus in six cases; seizure disorder in two cases; miscellaneous other indications in four cases. Fluoroscopic time and radiation dose were not available on PACS in 18 patients. Median radiation dose values and fluoroscopic time (range, SD) used to perform the examinations were respectively 26 seconds (6-193, 9) and 9.6 mGy (0.9-263, 8). Fluoroscopic times but not radiation dose estimates were significantly different among operators (respectively p = 0.02 and p = 0.062). There was no significant difference in fluoroscopic time and radiation dose between the three fellows and the physician assistant. Fluoroscopic times but not radiation dose estimates were significantly lower in patients younger than 50 years (respectively p = 0.004 and p = 0.467). Radiation dose estimates but not fluoroscopic time were significantly different across indication categories (p = 0.001 and p = 0.425), with the greatest radiation dose in patients referred for idiopathic intracranial hypertension. There were no significant differences in fluoroscopic time or radiation exposure between males and females, and between puncture sites.

Conclusions
We evaluated the radiation dose and fluoroscopic time in fluoroscopic-guided LP at our institution as part of a quality improvement project. Monitoring fluoroscopic time and radiation dose in fluoroscopic-guided LP is essential to ensure the quality and safety of this procedure and to minimize radiation exposure for both patients and staff.
Web-based Cervical Spine Trauma Report Generation Facilitates Accurate and Consistent Reporting

P Do¹, J Dorr¹, P Krishnarao¹, M Patel¹
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Purpose
Subaxial cervical spine injury, a common and serious occurrence in emergency departments and trauma centers worldwide, is an important diagnosis to identify and communicate appropriately with emergency physicians and trauma surgeons. Treatment decision-making is based on imaging findings and can be challenging, therefore it is essential for radiologists to provide accurate and consistent reports. Several classification systems have arisen in an attempt to provide standardized nomenclature schemata as well as a framework for guiding management and reporting treatment outcomes. While these systems each have their advantages with regards to standardization, their multitude ironically creates an overall fragmentation of reporting. A role for web-based, interactive, standardized report generation thus emerges.

Materials and Methods
A web-based, graphical report generator was created for the reporting of subaxial cervical spine injury identified on plain radiographs, CT, or MR images. Special emphasis was placed on adherence to strict nomenclature schemata and use of a simple, attractive, and intuitive user interface. The interpreting radiologist simply selects the spinal level, then chooses a single descriptive term from the Subaxial Injury Classification (SLIC) for each of its three main categories: morphology, disco-ligamentous complex, and neurologic status. The report generator then synthesizes a report that can be transferred easily to a dictation system. This web application includes educational functionality with images and captions depicting and describing nomenclature. A retrospective blinded review was conducted, comparing reports generated with and without use of this application.

Results
Conformity with consensus nomenclature was found in 38% of reports without the use of this application, and 100% with the use of this application. A survey of eight residents and five attendings revealed that nine of 13 users' subjective efficiency and 12 of 13 users' subjective clarity and consistency improved while using this application.

Conclusions
Appropriate use of standardized nomenclature aids clinicians in managing disease. The above-described report generator improves conformity in reporting and increases radiologist efficiency, while finding widespread acceptance among those surveyed.
Adult-Derived Mesenchymal Stem Cells and Stromal Vascular Fraction from Adipose Tissue as a Therapeutic Treatment for Osteoarthritis

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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 in and about facet joints. The more recent advent of obtaining MSCs 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 with and without 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 extracted surgically 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 evaluated at variable intervals according to clinical practice to assess long term therapeutic effect based off self-reported pain scores.

Results
Forty-seven patients at baseline presented with an average pain score of 7 due to facet joint arthropathy and were injected at inflamed levels as determined by postcontrast MRI analysis on T1 fat suppression sequencing. Thirty of those patients were re-evaluated at 1, 3, 6, 9, 12, 15, and 18 months respectively. Average pain follow-up scores were 3 for the aforementioned returning patients following interventional treatment. Patients reported an average of 4 weeks until optimal results were achieved. No adverse events were encountered. Upon 18-month follow up, an average pain score of 4 was recorded to indicate current pain level.

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.
52/F with LBP and anular tear at L4-5
Clinical response to CT-guided percutaneous aspiration and fenestration of symptomatic lumbar facet synovial cysts

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Purpose
Lumbar facet synovial cysts most commonly arise in degenerative facet arthropathy, and may be associated with pain or radiculopathy when they extend into the spinal canal or adjacent foramen. Percutaneous fluoroscopic aspiration and fenestration of symptomatic lumbar synovial cysts has been described previously, with controversial outcomes. Our aim was to retrospectively assess the efficacy of CT-guided aspiration and fenestration in terms of its success with short term pain relief and in obviating surgery over a 6-month postprocedure interval.

Materials and Methods
Following IRB approval, a radiology database search was performed to retrospectively identify patients previously undergoing CT-guided needle aspiration and fenestration of symptomatic lumbar facet synovial cysts over an 8-year period. Included patients had adequate documentation following the procedure to assess response to treatment. We reviewed medical records and the preprocedure MRI and recorded patient demographic information, cyst location, cyst size, change in symptoms at initial follow up, and whether surgical management was necessary by 6 months following the procedure. A neuroradiologist performed all procedures. The cysts were accessed percutaneously using needles between 19- and 22-gauge in size. In all but three cases, intra-articular access of the parent facet joint first was performed to opacify the cyst via articular contrast injection, and to inject corticosteroid and local anesthetic. Several patients underwent additional minimally invasive spine therapies at the time of synovial cyst treatment most commonly lumbar epidural injections and nerve blocks.

Results
During the 8-year study period, 26 patients underwent percutaneous CT-guided synovial cyst aspiration and fenestration. Three patients had the procedure performed twice for recurrent symptoms. The study population included eight males and 18 females with the average age 61.8 years (range: 46-82). The L4-L5 facet joints were the most common origin of the treated synovial cysts (57.7%). The average cyst size was 9.1 mm (range: 6-15). There were no procedure-related complications. At first clinical follow up, 76.9% of patients reported either partial or complete resolution of symptoms. Three patients had no change in symptoms and three had increase in pain following the procedure. During the 6-month postprocedure interval, 11 patients subsequently underwent surgery either due to failure of CT-guided therapy or recurrent symptoms.

Conclusions
CT-guided aspiration and fenestration of symptomatic lumbar facet synovial cysts provides short term symptomatic benefit in a majority of patients, and may obviate the need for surgery at 6-month follow up.
Correlation between Lee’s MR grading system for central lumbar spinal stenosis and the surgical intervention

H Park¹, C Han²

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²Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Seoul, Korea

Purpose
To evaluate the correlation between Lee's grades and surgical intervention for CLSS and to assess whether this grading system can be used as a decision-making tool for the surgical treatment of this condition.

Materials and Methods
This retrospective study included 290 patients (M:F = 156:134; mean age, 46 years) who underwent MRI of the lumbar spine at our institution. Radiologists assessed the presence and grade of CLSS at the stenosis point according to Lee's grading system. Correlation coefficients (rs) between Lee's grades and the operation were calculated with Spearman rank correlation.

Results
In the operated patients, grade 2 was most common (50-58%), grade 3 was less common (35%), and grade 0 was least common (2-3%). In the nonoperated patients, grade 1 was most common (63-65%), grade 0 was less common (15-16%), and grade 3 was least common (8%). The distribution of grades differed between the operated and nonoperated groups (p < 0.001). Whereas grades 0 and 1 occurred in less than 25% of patients who underwent surgery, grades 2 and 3 occurred in more than 88%. A moderate correlation between grade and operation was found (rs = 0.632 and 0.583, Table 5). This correlation was moderate to relatively high (rs = 0.670 and 0.754) in young patients and lower than 0.5 in older patients.
Conclusions
Lee's grade was correlated moderately with the surgical intervention. Lee's grading system can be used as a decision-making tool for surgical treatment of CLSS.

EP-154

Evaluation for Soft Tissue Injuries on CT in Acute Cervical Spine Trauma with MR Imaging Correlation

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1Saitama Medical University, International Medical Center, Saitama, Japan, 2University of Washington Medical Center, Seattle, WA, 3Boston Medical Center, Boston University School of Medicine, Boston, MA

Purpose
Soft tissue injuries including ligamentous injury, muscular injury, and prevertebral edema/hematoma are common imaging findings of cervical spine trauma. Although MR can clearly demonstrate these injuries, the utility of CT in their detection often is underappreciated. The purpose is to assess whether CT with soft tissue windowing can help identify soft tissue injuries and to compare CT with MR imaging findings in patients with acute cervical spine trauma.

Materials and Methods
A retrospective search was performed to identify patients who underwent both CT and MR imaging for acute traumatic spinal injury between January 2010 and November 2014. Images were reviewed with special attention directed toward soft tissue changes. These soft tissues were interspinous, supraspinous, and prevertebral soft tissues, and posterior cervical musculature. The CT images were reviewed in soft tissue and bone windows and MR images were reviewed in T1, T2-weighted, and STIR images.

Results
One hundred fifty-seven patients (14-92 years old; 123 males, 34 females) were identified during the 5-year period. Abnormality in the paraspinal soft tissue was seen in 59 patients (37.6%) on CT and 92 patients (58.6%) on MR imaging. Of 92 patients with paraspinal soft tissue injuries by MR, CT failed to identify the abnormalities in 35 patients (38%). Sixty-one percent (36/59) of the patients who showed paraspinal soft tissue abnormalities on CT had spinal cord signal abnormalities on MR imaging and 11 patients (18.6%) with abnormal paraspinal soft tissue without fracture or dislocation on CT had spinal cord injury.

Conclusions
Although MR imaging is highly sensitive for detecting cord injury, ligamentous injury and paraspinal soft tissue injuries, paraspinal soft tissue abnormalities often are seen on CT in patients with suspected acute cervical spine injury. Approximately 20% of patients who showed paraspinal soft tissue abnormalities on CT had spinal cord injury without fracture or dislocation.
EP-150

Imaging Findings of Extraosseous Chordomas Arising from the Cervical Spinal Region

R McDonald\textsuperscript{1}, C Inwards\textsuperscript{1}, J Morris\textsuperscript{1}
Purpose
Extraosseous chordomas are extremely rare slow growing tumors arising from notochordal remnants along the central neuraxis. In the current study, we sought to better define the imaging characteristics of extraosseous chordomas arising in the cervical spinal region to help discriminate these lesions from other extradural pathologies arising in this region.

Materials and Methods
In this institutional review board approved single-center retrospective study, we reviewed the clinical data and imaging findings of four pathologically proven cases of extraosseous chordoma that were treated or diagnosed at our institution during the last 5 years. All imaging studies were reviewed by two or more senior neuroradiologists.

Results
Four patients, 12-53 years of age (3:1 M:F), had pathologically proven cases of chordoma of the cervical spine. Pne case was at C4 and three were cases predominantly in the C2/3 foramen. One of the four cases (C4) demonstrated predominant midline intraosseous involvement and bony destruction with anterior epidural extension with the remaining three were predominantly extraosseous with intraforaminal and anterior and lateral paraspinous extension, mimicking a schwannoma (Figure 1). MR imaging demonstrated these lesions to be heterogeneously enhancing, T1 hypointense, and markedly T2 hyperintense, relative to surrounding paraspinal musculature. All cases demonstrated internal septations on T2-weighted imaging. Two cases spanned greater than two vertebral levels. One case was resected incompletely at an outside institution with the thought that it represented a schwannoma and the remaining three were resected en bloc.

Conclusions
Extraosseous chordomas of the cervical spine have similar imaging characteristics to more common skull base and sacral chordomas. However, these lesions initially can be misdiagnosed, because chordomas in the cervical spine are less likely to arise from the midline, have a dominant intraforaminal component, and are extremely rare. Accurate radiographic description of these lesions is critical to forming a well defined differential diagnosis that includes schwannoma, lymphoma, plasmacytoma, chordoma, and extradural meningioma. Inclusion of chordoma in the differential diagnosis influences the percutaneous biopsy and surgical approach to these lesions as chordomas must be resected en bloc along with the biopsy track while others may be biopsied through lateral approaches and/or surgically removed piecemeal. Chordomas are locally aggressive and carry a high rate of recurrence if not resected properly with the potential to cause significant neurological impairment from localized mass effect or morbidity from recurrent treatments. The neuroradiologist should be aware of the imaging findings of chordomas in the cervical spine and help triage the patients accordingly.

EP-145

In-Vivo Longitudinal Evolution of Degenerative Intrervertebral Disc Changes in MR Imaging in Stressed and Non-Stressed Segments of the Lumbar Spine

P Javadi¹, S Bagade², C Hildebolt², S Lancaster², A Sharma³
Purpose
Magnetic resonance imaging in the younger population with pars interreticularis and pedicle stress injuries has been used successfully as a model to study the complex mechanical forces involved in degenerative disc disease and has shown the early degenerative changes involving individual intervertebral disc in stressed segments. The aim of this study is to evaluate the in vivo temporal evolution of degenerative disc disease in individual stressed segments.

Materials and Methods
We identified a total of 16 consecutive individuals <25 years old (6 female and 10 male; mean age 15.1 years, range 5-19) with 17 stressed segments who had follow-up MR imaging of the lumbar spine with a mean duration of follow up between the two exams of 14.9 (range 2-47 months) for pars interreticularis and pedicle stress injuries. Two certified neuroradiologist assessed the stressed intervertebral lumbar discs as well as loading-matched nonstressed discs for signs of progressive degeneration in the annulus fibrosus, nucleous fibroso, and end plate in initial and follow-up imaging.

Results
On follow-up imaging, significantly higher number of stressed segments (7/17, 41.7%, p=0.007) showed worsening of at least one of the degenerative parameters compared to the loading-matched control discs (0/16, 0% showing worsening). In two of these patients, the stress reaction had improved on follow-up without appearance of a bony defect. Increased propensity for worsening disc degeneration was seen for discs located both superior and inferior to the level of bony stresses. For superior stressed discs, worsening parameters included two (11.8%) new ATs (both radial), one (5.9%) worsened Pfirrman's degeneration grade (by 1 grade) and three (17.7%) worsened signal intensity grades (by 1 grade in all). Worsened parameters of inferior stressed discs included one (5.9 %) new AT, two (11.8%) new herniation, three (17.7%) worsened Pfirrman's degeneration grades (by 1, 2, and 4 grades), and four (23.5%) worsened signal intensity grade (by 1, 2, 3 and 4 grades).

Conclusions
Spinal segments demonstrating imaging evidence for increased bony stresses have increased likelihood for progressive degeneration of intervertebral discs compared to those in nonstressed spinal segments.

Labeling the Lumbar Vertebral Bodies: Is There a Process You Can Count On?

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¹NYU Langone Medical Center, New York, NY, ²The Icahn School of Medicine at Mt. Sinai, New York, NY

Purpose
Accurate, consistent numbering of the lumbar spine is necessary to communicate the level of pathology. A reliable way to identify and label spines with lumbosacral transitional vertebrae (LSTV) has not been established; although, many features, including the iliolumbar ligament,
disc morphology, and level of anatomical structures, have been proposed (1, 2). Research in cadavers suggests a significant difference between the craniocaudal dimensions of the L3-L5 spinous processes (3, 4). Use of spinous process height would be quick and applicable to both CT and MRI. Our purpose was to determine if craniocaudal height can be used to reliably identify the lumbar vertebrae level in normal spines and those with LSTV.

Materials and Methods
We retrospectively reviewed the total spine MRI of 50 normal cases [mean age 53 years (range 23-92 years), 26 male] and 31 LSTV cases [mean age 55 years (range 17-83 years), 11 male] performed for any clinical reason from January 2013 through December 2014. Lack of a reported LSTV constituted a "normal" case. Lumbosacral transitional vertebrae cases were identified using "transitional," "lumbarized," and "sacralized" as search terms. Vertebrae were designated by counting from C2 on whole body sagittal counter sequences. Landmarks were used to localize if a whole body counter was not available. The lumbar spinous process craniocaudal dimension was measured from superior to inferior cortex, perpendicular to the long axis of the spinous process, on sagittal T1-weighted sequences. Differences in dimension were analyzed within the whole group and between the transitional and normal groups.

Results
There was a significant difference in craniocaudal dimension between L4 and L5 and between L3 and L4 (p < 0.0001 for all). L5 was smaller than L4 in 96% of cases and L3 was larger than L4 in 80% of cases, as shown in Table 1. Although not statistically significant, L4 was the same size as L3 in 26% of cases under 50 years old versus 16% in those over 50, suggesting degenerative change may factor into use of spinous process height.

Conclusions
L3 correlating with the largest lumbar spinous process in height is not a reliable anatomical marker. L5 having the shortest spinous process is a more reliable marker that can be obtained quickly by visual inspection. The overall accuracy of the shortest lumbar spinous process correlating with L5 is 96%, which is the same as use of the iliolumbar ligament to identify L5 (5). Of note, in cases of LSTV, the S1 spinous process was not considered here but may complicate analysis when it is unknown if an LSTV is present.
New Hybrid Monochromatic CT Images Achieve High Suppression of Metallic Artifacts While Preserving Soft Tissue and Iodine Contrast

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Purpose
Dual energy computed tomography (CT) images reconstructed at increasing monochromatic energies provide reduced metallic artifact conspicuity at the expense of limiting soft tissue contrast. The purpose of this study is to evaluate effect of blending high and low energy monochromatic images on the resulting image quality and soft tissue/iodine contrast.

Materials and Methods
We retrospectively evaluated CT myelographic images of the cervical spine acquired with a fast-kV switching dual-energy CT at 80 and 140 kVp from a single patient with anterior metallic fusion hardware. Hybrid images are the weighted average of the extrapolated 70-keV and 130-keV images, favoring the contribution from the 70-keV image unless a particular voxel is in close proximity to metal (defined as voxels over 1100 Hounsfield units) or if the 70-keV voxel demonstrates significantly lower attenuation than the corresponding 130-keV voxel, which implies an area of streak artifact. The ratio of voxel intensities in contrast-filled thecal sac to muscle was used to assess iodine/soft-tissue contrast. Blinded review of the images by radiology trainees (n = 24) was conducted and the participants were asked to rank 70, 130-keV and hybrid images based on the conspicuity of intrathecal contrast material, the severity of metallic streak artifacts and the contrast of soft tissues and bone.
Results
The readers preferred the hybrid method, and indicated their top choices as (62.5% Hybrid, 29.2% 130-keV, 8.3% 70-keV). Condorcet method also revealed similar ranking: Hybrid versus 130-keV [17:7, 70.8% (confidence interval 48.9 to 87.4%)], Hybrid versus 70-keV [21:3, 87.5% (C.I. 67.6 to 97.3%)], 130-keV versus 70-keV [16:8, 66.6% (C.I. 44.7 to 84.4%)]. The contrast difference between iodine and muscle was 444 HU (Hybrid) versus 472 HU (70-keV), 148 HU (130-keV).

Conclusions
Most readers preferred the new hybrid algorithm over either a high or low energy reconstruction. Metallic streak artifacts were most conspicuous on 70-keV images. Visualization of iodinated contrast was worst on 130-keV images.
Psammomatous Melanotic Schwannoma of The Spine: A Rare Case Report

S Bakan, Y Kayadibi, E Ure, M Asik, Z Hasiloglu

1Istanbul University Cerrahpasa Medical Faculty, Istanbul, Turkey, 2Istanbul University Cerrahpasa Medical Faculty, ISTANBUL, Turkey, 3Istanbul University Cerrahpasa Medical Faculty, ISTANBUL, Turkey.
Purpose
Our purpose in this case report is to discuss the imaging findings of a rarely seen psammomatous type of melanotic schwannoma.

Materials and Methods
A 31-year-old woman admitted to our department with back pain. Magnetic resonance (MR) imaging and computed tomography (CT) were performed.

Results
MR imaging revealed a paravertebral, extrapleural soft tissue mass measuring about 2.5 cm that was originating from spinal canal and extending into neural foramen at the level of T4 - T5. The mass contained focal hyperintensity on T1-weighted images and contained a cystic component. The lesion was enhancing homogeneously. CT showed punctate calcifications inside of this soft tissue lesion. Positron emission tomography (PET)/CT scan revealed an increased FDG. Patient underwent surgery and pathological examination revealed spindle-shaped Schwann cells and melanin pigmented cells which were diagnostic for psammomatous type of melanotic schwannoma.

Conclusions
Melanotic schwannoma is an intermediate tumor between schwannoma and malignant melanoma which both originate from neuroectodermal tissues. These tumors are usually in benign nature but in literature malignant degeneration, recurrence and metastasis had been reported in 26-38.9% of the cases. There are two subtypes of melanotic schwannoma including psammomatous type and sporadic type. Psammomatous type of schwannomas coexists within Carney complex (CC) in 50% of cases, so patient should be investigated with further examinations in terms of CC. Our patient had no clinical and physical findings that supported CC. Melanin containing lesions that included malignant melanoma, melanositoma, pigmented neurofibroma, paraganglioma, leptomeningeal melanosis, hemorrhagic metastatic lesions due to breast cancer, thyroid cancer, choriocarcinoma and lung cancer must be considered in differential diagnosis which are other reasons of T1 shortening. There is no characteristic clinical or imaging finding and PET/CT has limited value in differential diagnosis. The exact diagnosis could be confirmed only by surgery and immunohistopathological examination.
Use of a Novel MRI-Compatible Head-Positioning Device for the Three Dimensional Kinematic Analysis of the Cervical Spine in Axial Rotation

J Bitra¹, J Phung¹, K Weber², N Inoue³, A Espinoza Orías³, T Parrish²
¹Illinois Mathematics and Science Academy, Aurora, IL, ²Northwestern University, Chicago, IL, ³Rush University Medical Center, Chicago, IL

Purpose
Magnetic resonance imaging (MRI) provides a noninvasive method to analyze the kinematics of the cervical spine during axial rotation of the head (1-3). Previous studies assessing the kinematics of the cervical spine with MRI have not used a head-positioning device to limit rotation to the axial plane and control the magnitude of the angular displacement. The purpose of this study was to design and test an MRI-compatible head-positioning device for imaging of the cervical spine in varying degrees of axial rotation of the head.

Materials and Methods
An MRI-compatible head-positioning device was custom-fabricated from ABS plastic and a commercially available helmet (Riddell, Rosemont, IL, USA) using a simple wheel and axle design. The device fits inside a Siemens 3.0 T Tim Trio scanner (Erlangen, Germany), mounts into the head coil slot on the scanner bed, and permits 180° degrees of head rotation about the longitudinal axis (Figure 1). To test the feasibility and usability of this device, six healthy volunteers (4 males and 2 females, mean age 33.5 ± 8.2 years) without neck pain were recruited. High-resolution T1-weighted images of the cervical spine were obtained in neutral and 40° of left and right head rotation using a navigated multi-echo 3D MPRAGE acquisition with IPAT (TE 1.74 ms, 3.60 ms, 5.46 ms, and 7.32 ms; TR 2540 ms; flip angle 7°; 1 average; 1 mm x 1 mm x 2 mm voxel size; scan time 5.32 minutes per volume). To receive the signal, two 4-channel flex coils were placed anterior and posterior to the head and neck. Rotations and translations for each vertebral segment were calculated as described previously (Figure 1) (4).

Results
All participants completed the study, image quality was adequate to analyze all the images, and the segmental motions were comparable to previous studies (Figure 1).

Conclusions
The imaging device allowed passive axial rotation of the cervical spine in a controlled manner and was tolerated by the healthy volunteers. In the future, the feasibility of using this device in a neck pain population will be assessed.
Figure 1

A and B) An MRI-compatible head-positioning device was fabricated from ABS plastic and a commercially available helmet using a simple wheel and axle design. C) Device setup on the scanner bed with two 4-channel flex coils placed anterior and posterior to the head and neck for signal detection. D) An example T1-weighted image of the cervical spine.

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Monday
6:00AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exposition Hall A (Level 1)

Scientific Poster-Print - Adult Brain (P)
A Semi-Automated Pipeline for Noninvasively Acquiring and Quantifying Perfusion Reactivity and Flow Territories with MRI

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¹Vanderbilt University, Nashville, TN, ²Vanderbilt University Medical Center, Nashville, TN, ³Vanderbilt University School of Medicine, Nashville, TN

Purpose
We present a versatile and intuitive semi-automated pipeline for visualizing cerebral blood flow (CBF) maps as well as major neurovascular blood flow territories via the input of planning-free, vessel-encoded pseudo-continuous arterial spin labeling (VE-pCASL) MRI data and compare these results with digital subtraction angiography (DSA). A current major obstacle to acquiring such comprehensive information is limited access to the required methodology within clinical centers.

Materials and Methods
Healthy volunteers (n=5; age=25.6±5.3 years; 3M/2F) as well as patients with intracranial (IC) cerebrovascular disease (n=8; age=47.3±7.9 years; 3M/5F) were selected as a subset from a large cohort of subjects enrolled in a longitudinal noninvasive imaging study evaluating the hemodynamic mechanisms underlying stroke risk. Only volunteers and patients that also had undergone MRA and DSA imaging, respectively, within ±40 days of VE-pCASL MRI were included in the analysis. All participants provided informed, written consent. A board-certified neuroradiologist, blinded to clinical history, graded circle of Willis (COW) variants on DSA or MRA and perfusion findings on DSA after separately reviewing flow territory maps for each subject. Qualitative comparisons were made between blood flow distributions on angiography and VE-pCASL MRI with regards to COW variants.

Results
Five of eight patients had a complete COW configuration, all of whom demonstrated expected normal flow territory distributions. The remaining three patients had a hypoplastic or occluded A1 unilaterally on DSA; two of these patients demonstrated expected compensatory filling by the contralateral anterior territory on the blood flow territory maps (see Figure 1), while the remaining patient demonstrated symmetric, midline separation of the anterior territories. Of the five volunteers, three had an aplastic or hypoplastic A1 vessel unilaterally, each with corresponding cross-filling of this region by the contralateral anterior circulation. The remaining two volunteers with normal A1 vessels bilaterally showed evenly distributed anterior flow territories. Figure 1: Vascular territories with semi-automated analysis. A) Screenshot of the ASL software toolbox, which will be available for Windows, Mac, and Linux platforms. B) VE-pCASL blood flow territory map from a 57 y/o patient with moyamoya disease demonstrates left occipital perfusion from a fetal configuration PCOM. Additionally, the left ACA territory is perfused from the right ICA, as the left A1 segment is occluded. These findings are confirmed on AP projections from the right (C) and left (D) ICA injections from DSA, with perfusion of both ACA territories from the right ICA injection (white arrow) in (C) and an occluded left A1 (black arrow) and fetal-configuration PCOM to the occipital lobe (gray arrow) in (D).

Conclusions
Our preliminary results using a semi-automated pipeline for visualizing cerebral blood flow
maps as well as major neurovascular blood flow territories correspond with circle of Willis variants and vascular occlusions.
Angioarchitectures of arteriovenous malformation predict long-term seizure control after radiosurgery

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¹Taipei Veterans General Hospital and National Yang-Ming University, Taipei, Taiwan, R.O.C., ²Taipei Veterans General Hospital and National Yang-Ming University, Taipei, Taiwan, Province of China, ³Taipei Veterans General Hospital, Taipei, Beitou District, ⁴Far Eastern Memorial Hospital, New Taipei City, Taiwan, Province of China

Purpose
The current study is aimed to evaluate the effects of gamma knife radiosurgery (GKRS) on seizure control for patients with brain arteriovenous malformation (AVM) and their correlation with the angioarchitectures and the postradiosurgical imaging changes on MRI.

Materials and Methods
We retrospectively investigated 97 brain AVM patients treated with GKRS in our hospital between 2008 and 2009. Total 25 patients with AVM-related epilepsy or seizures before GKRS were recruited in the current analysis. In six patients, the GKRS was used as a booster treatment for residual AVM after previous GKRS or embolization. Their angioarchitectures at GKRS, serial follow-up MRI, medical records and updated clinical information were assessed retrospectively. Seizure outcome was assessed using the Engel seizure frequency scoring system.

Results
Of the 25 patients with AVM-related epilepsy or seizure before radiosurgery, 68% (17/25) were seizure-free and 32% (8/25) were medication-free at the mean 70 months after last radiosurgery. Of the patients who achieved angiographic AVM obliteration, 86.7% (13/15) were seizure-free while 40% (4/10) of those patients who did not achieve AVM obliteration were seizure-free (p=0.022). Those with dilated feeding arteries, venous ectasia, long-course of drainage vein and fistula component had longer obliteration time than those without (p=0.001, 0.043, 0.007, and 0.022, respectively). Of the 14 patients without intracranial hemorrhage (ICH) before radiosurgery, 100% (6/6) with fistula component were seizure-free while 37.5% (3/8) without fistula component were seizure-free (p=0.031). The Engel seizure frequency score at last visit did not differ significantly between patients with single or repeated radiosurgical sessions, or different degree of permanent adverse radiation effects on last MRI.

Conclusions
Our study suggests that dilated feeding arteries, venous ectasia, and long course of drainage vein are indicators of delayed cure of AVM by radiosurgery. Presence of fistulae in AVM predicts better seizure outcomes in AVM GKRS. Gamma knife radiosurgery improves AVM-related seizure control after AVM being cured.

Anton-Babinski Syndrome Mimicking Multifocal Abscesses Following Post Operative Hypovolemic Shock
Purpose
To present neuroimaging features and differential diagnosis in a patient with hypoxic brain injury.

Materials and Methods
A 70-year-old diabetic patient admitted for elective laparoscopic cholecystectomy became hypotensive in the 24 hours following surgery. Emergency laparotomy found a large peri-hepatic hematoma. In recovery she developed supraventricular tachycardia and became profoundly hypotensive postoperatively. In the 48 hours following she developed a fever and thrombocytopenia (platelets ~30). This was treated with platelet transfusion and intravenous meropenem and metronidazole. She required three further laparotomies to evacuate and over the next 10 days and 15 days after the initial operation she was weaned off sedation but her GCS did not recover.

Results
A CT brain was performed on day 16 which showed the following (Figure A). The "ring enhancing" lesions were seen without contrast enhancement and originally reported as likely abscesses. She was started on treatment for intracerebral abscess. A TOE was unremarkable. Subsequent MRI did not show restricted diffusion (Figure B) and a lumbar puncture was acellular with normal biochemical components, both of which would be unusual for multiple cerebral abscesses. Given her thrombocytopenia the question of hemorrhagic hyperperfusion injury following global ischemic insult was raised. A Tc99 MHPAO SPECT scan demonstrated reduced uptake characteristic of ischemia and the diagnosis of global hypoxic brain injury with hemorrhagic conversion was made. The scan appearances are suggestive of hypoperfusion of the medial temporal lobes/hippocampus including occipitoparietal regions, left more than the right associated with some amount of global hypoperfusion of the frontal lobes. These findings are consistent with known diffuse hypoxic brain injury.

Conclusions
Global brain hypoperfusion injuries could present as peripherally located ring enhancing hemorrhagic lesions and mimic multifocal abscesses.

P-10
6:00AM - 3:00PM

Assessment of MRI Findings in Geriatric Epilepsy: New Onset vs. Longstanding Epilepsy

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SUNY Upstate Medical University, Syracuse, NY

Purpose
Brain MRI detects more abnormalities in geriatric epileptic patients than younger ones but the difference in MRI findings is not well described between new-onset and longstanding epilepsy. We aimed to compare different MRI features of geriatric onset epilepsy (GOE; onset 60 years or older) versus non-GOE (age of onset less than 60 years) in geriatric population.
Materials and Methods
Upon IRB approval, we retrospectively obtained the list of all patients age 65 years or older at our institution between January 2013 - July 2014, with a diagnosis of seizure and epilepsy utilizing ICD codes 345/780. Among identified patients, 140 of them were selected randomly and collection of demographic and MRI data were performed. Patients with unconfirmed diagnosis of epilepsy or psychogenic nonepileptic seizures were excluded. Sixty-five patients had MRI that was observed for any abnormalities. Age of onset of seizure disorder was identified, and patients with MRI were stratified into GOE and non-GOE groups.

Results
Forty-six patients were in GOE group. The two groups did not differ significantly in regard to age and sex. The mean age of first seizure in GOE and non-GOE groups were 73.8 and 35 respectively (p < 0.001). MR imaging revealed focal lesions in 35 (76%) patients of GOE group in comparison to nine (47%) patients of non-GOE group (p = 0.02). Regarding multiple subgroups of focal findings, the GOE group had a higher percentage of ischemic stroke, intracranial hemorrhage and space occupying lesions in their MRI but did not differ significantly between two groups (All p > 0.05). Age-related white matter changes were seen in 35 (76%) patients of GOE and 13 (68%) patients of non-GOE (p = 0.52). The details of demographic data and MRI findings are mentioned in the attached table.

Conclusions
Significantly higher detection of focal lesions in MRI of GOE patients emphasizes its importance as a high yield diagnostic tool to disclose the etiology and thereby facilitate the appropriate therapy in this vulnerable group in comparison to non-GOE patients.
Table: Comparative analysis between geriatric onset epilepsy (GOE) and non-geriatric onset epilepsy (non-GOE) on demographic data and MRI findings

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Purpose
We investigated whole brain white matter integrity, including upper motor neuron tracts, by using diffusion tensor imaging (DTI) in eight patients with Kennedy's disease (KD), in which disease severity was evaluated using the Amyotrophic Lateral Sclerosis Functional Rating Scale (ALSFRS).

Materials and Methods
From DTI acquisitions we obtained maps of fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (L1) and radial diffusivities (L2,L3). We then used tract-based spatial statistics (TBSS) to investigate within-patient correlations of DTI invariants with ALSFRS and disease duration (DD).

Results
We found a significant correlation between a decrease in ALSFRS and a decrease in FA in association commissural and projection fibers, and with an increase in L3 in commissural tracts and fronto-parietal white matter. Additionally, we found a significant association between an increase in DD and a decrease in FA in the genu and body of corpus callosum, association fibers and midbrain and with an increase in L1 in projection and association tracts.

Conclusions
The associations between clinical variables and white matter microstructural changes in areas thought to be spared by the disease process supports the hypothesis of a multisystem involvement in the complex pathogenic mechanisms responsible for the clinical disability of these patients.
Can A Small Solitary White Matter Lesion Turn into Demyelination (MS) during a 4 Year Annual Follow Up? An Example by Illustrating an Interesting Case.

S Derakhshani¹, A Chaudhuri²

¹Essex Neuroscience Centre, Queens University Hospital, Essex, United Kingdom, ²Queen's University Hospital, London, London

Purpose
Pictoral presentation of a single white matter lesion and changes in the brain that turned into demyelinating lesions after 4-year annual follow up.

Materials and Methods
A 35-year-old female presented in early 2011 with right sided weakness that resolved by itself after a week. Her initial CT scan was unremarkable and MRI showed a single small left sided
corona radiata lesion perpendicular to the lateral ventricle with no acute ischemic lesion. Her symptoms were interpreted as TIA. She underwent cardiac investigation and diagnosed with a closed patent foramen ovale. She was reviewed in stroke clinic annually with follow-up MRI scans. Late 2014 she developed a second episode of loss of vision in one eye and cerebellar ataxia. On examination she had optic neuritis associated with right sided visual field defect and left sided cerebellar ataxia. MR imaging showed multiple infra and supratentorial demyelinating lesions.

Results
Spatial and temporal transition of white matter demyelinating lesions.

Conclusions
A solitary white matter lesion perpendicular to the lateral ventricle is strongly predictive of demyelination.

P-36
6:00AM - 3:00PM

Can K2 Differentiate Recurrent Malignant Glioma from Treatment Related Change? : Comparison with CBV

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Purpose
To evaluate whether K2, which is the leakage coefficient derived from dynamic susceptibility contrast (DSC) perfusion study (1), can differentiate recurrent malignant glioma from treatment related change (TRC) in comparison with relative cerebral blood volume (rCBV).

Materials and Methods
Eleven patients with newly appeared enhanced lesion within the radiation field after tumor resection followed by radiochemotherapy for malignant gliomas (2 glioblastomas, 6 anaplastic oligoastrocytomas, 2 anaplastic oligodendrogliomas and 1 anaplastic astrocytoma) were recruited. They underwent DSC perfusion study using a gradient-echo single-shot echo-planar sequence at a 3T-MR scanner. A definitive diagnosis was established at subsequent surgical resection or clinicoradiologic follow up. The contrast between the enhanced lesion appeared within the radiation field and normal appearing white matter (NAWM) on K2 map and rCBV map was assessed visually using a 3-point grading scale. The maximum K2 and the standardized rCBV ratio defined as the ratio between the maximum rCBV within the enhanced lesion and that in the contralateral NAWM were measured. Comparison of the visual assessment for K2 and rCBV between tumor recurrence and TRC was done by using a Mann-Whitney U test. Comparison of K2 and standardized rCBV ratio between tumor recurrence and TRC was done by using an unpaired t-test.

Results
The visual assessment score of rCBV and the standardized rCBV ratio in patients with tumor recurrence were significantly higher than those in patients with TRC (p = 0.03 for visual assessment score and p = 0.014 for standardized rCBV ratio). Although there was a trend of higher visual assessment score of K2 and quantitative K2 in tumor recurrence than those in TRC, the statistical significance was not observed.
Conclusions
When differentiating recurrent malignant glioma from TRC, the visual assessment of rCVB map and standardized rCBV ratio are more useful than those of K2.
K₂ map of TRC
Cerebral cavernous malformations associated to meningeoma: high penetrance in a novel family mutated in the PDCD10 gene

f garaci, f brancati, S Marziali, l marsili, g simonetti, r floris

Università degli Studi di Roma “Tor Vergata, Rome, roma, fondazione policlinico tor vergata, roma, Italy, Università degli Studi di Roma “Tor Vergata, Rome, Italy, fondazione policlinico tor vergata, roma, Italy

Purpose
Multiple familial meningiomas occur in rare genetic syndromes, particularly neurofibromatosis type 2. The association of meningiomas and cerebral cavernous malformations (CCM) has been reported in few patients in the medical literature. The purpose of our study is to corroborate a preferential association of CCM and multiple meningiomas in subjects harboring mutations in the PDCD10 gene (also known as CCM3)

Materials and Methods
Three members of an Italian family affected by seizures underwent conventional brain magnetic resonance imaging (MRI) with gadolinium contrast agent including gradient echo (GRE) imaging. The three CCM-causative genes were sequenced by Sanger method. Literature data reporting patients with coexistence of CCM and meningiomas were reviewed.

Results
MR imaging demonstrated dural-based meningioma-like lesions associated to multiple parenchymal CCM in all affected individuals. A disease-causative mutation in the PDCD10 gene (p.Gln112PhefsX13) was identified.

Conclusions
Based on neuroradiological and molecular data as well as on literature review, we outline a consistent association between PDCD10 mutations and a syndrome of CCM with multiple meningiomas. This condition should be considered in the differential diagnosis of multiple/familial meningioma syndromes. In case of multiple/familial meningioma the use of appropriate MRI technique may include GRE and/or susceptibility-weighted imaging (SWI) to rule out CCM. By contrast, proper postgadolinium scans may aid defining dural lesions in CCM patients and are indicated in PDCD10-mutated individuals.

Clinical Correlates and Prognostic Implications of Cerebral Microbleeds in Patients with Ischemic Stroke

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Purpose
Cerebral microbleeds (MBs) detected using gradient echo (T2*-weighted) from brain magnetic resonance imaging (MRI) have been shown to correlate with various cardiovascular risk factors as well as adverse clinical outcome following ischemic stroke (ISS) (1). Recently, susceptibility-weighted imaging (SWI) has been noted to be a much more sensitive technique in detection of cerebral MBs (2). However, literature on clinical correlates and prognostic implications of cerebral microbleeds detected using SWI is scarce.

Materials and Methods
All patients with MRI brain performed on a 3T MRI scanner (Achieva, Philips Healthcare) in a University Hospital were reviewed retrospectively during the period from March 1st 2008 to December 31st 2012. The parameters of 3D VEN BOLD sequence were as follows: TR- 28ms, TE- 23ms, flip angle- 15 degree, voxel size- 0.9 mm x 0.9 mm x 1 mm, number of slices- 135. Detection and location of cerebral MBs (Figures 1 and 2) were scored according to the Microbleed Anatomical Rating Scale (3) and grading of severity according to number of microbleeds (4) i.e., Grade 0- absent, Grade 1 (mild) - 1 to 5, Grade 2 (moderate) - 6 to 15, and Grade 3 (severe) - above 15. Two blinded observers (Year 3 medical students) supervised by a neuroradiologist (HM) analyzed all the images. Clinical characteristics, cardiovascular risk factors, medications on discharge after index hospitalization of ISS as well as subsequent clinical outcome of study patients were retrieved from the clinical database.

Results
A total of 724 patients with ISS were included in the final analysis. Three hundred eighteen patients were noted to have cerebral MBs on cerebral MRI, of which 249, 42 and 26 patients were classified as having MBs of grade 1, 2 and 3 respectively. The intraobserver reliability of the two observers were 0.91 and 0.94 (intraclass correlation); while the interobserver reliability was 0.97 in the grading of MBs. Grading of cerebral MBs was correlated significantly with age, underlying hypertension and glomerular filtration rate (all P<0.05). After adjustment for confounding risk factors, severity of cerebral MBs was identified as an independent predictor of subsequent risk of recurrent ISS [hazards ratio (HR) 2.80, 95% confidence interval (CI) 1.06 – 7.38, P<0.05], and hemorrhagic stroke (HR 3.11, 95% CI 1.19 – 8.11, P<0.05). Presence of cerebral MBs did not predict other major adverse cardiovascular events nor mortality after ISS. In addition, higher risks were associated with high grade deep gray/white matter and infratentorial than lobar MBs (see Table 1).

Conclusions
Cerebral microbleeds detected by SWI using Microbleed Anatomical Rating Scale have high interobserver and intraobserver agreement. Microbleeds are strongly associated with age, hypertensive status and renal function and are an independent predictor of recurrent ISS and hemorrhagic stroke in patients with ISS. Also, higher risks were incurred by high grade deep gray/white matter and infratentorial microbleeds.
Table 1. Multi-variate Cox regression analyses on predictors of endpoints by region of microbleeds

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All recurrent stroke</th>
<th>Recurrent ischemic stroke</th>
<th>Recurrent hemorrhagic stroke</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
<td>Adjusted§</td>
<td>Unadjusted</td>
</tr>
<tr>
<td></td>
<td>HR (95% CI)</td>
<td>HR (95% CI)</td>
<td>HR (95% CI)</td>
</tr>
<tr>
<td>Infratentorial microbleed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 0</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>Grade 1</td>
<td>1.87 (1.08-3.31)†‡</td>
<td>1.64 (0.95-2.86)*</td>
<td>1.95 (1.10-3.49)†</td>
</tr>
<tr>
<td>Grade 2</td>
<td>0 (0.00-0.00)</td>
<td>0 (0.00-0.00)</td>
<td>0 (0.00-0.00)</td>
</tr>
<tr>
<td>Grade 3</td>
<td>5.68 (1.38-23.31)†‡</td>
<td>3.53 (0.83-14.98)*</td>
<td>2.61 (0.36-19.93)</td>
</tr>
<tr>
<td>Deep microbleed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 0</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>Grade 1</td>
<td>1.63 (0.95-2.80)*‡</td>
<td>1.40 (0.81-2.53)</td>
<td>1.40 (0.77-2.55)</td>
</tr>
<tr>
<td>Grade 2</td>
<td>1.91 (0.60-6.13)†‡</td>
<td>1.42 (0.44-4.60)</td>
<td>1.31 (0.32-5.41)</td>
</tr>
<tr>
<td>Grade 3</td>
<td>7.33 (2.27-23.65)‡‡</td>
<td>5.75 (1.75-18.94‡‡</td>
<td>2.02 (0.28-14.65)</td>
</tr>
<tr>
<td>Lobar microbleed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 0</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>Grade 1</td>
<td>1.52 (0.94-2.48)*‡</td>
<td>1.39 (0.85-2.29)</td>
<td>1.27 (0.74-2.17)</td>
</tr>
<tr>
<td>Grade 2</td>
<td>1.48 (0.46-4.78)‡</td>
<td>0.96 (0.29-3.23)</td>
<td>0.53 (0.07-3.85)</td>
</tr>
<tr>
<td>Grade 3</td>
<td>3.89 (1.53-9.85)‡‡</td>
<td>2.07 (1.19-7.92)†‡</td>
<td>3.12 (1.11-8.75)</td>
</tr>
</tbody>
</table>

*P<0.10; †P<0.05; ‡P<0.01.

Abbreviations as in Table. HR=hazard ratio, CI=confidence interval

§Adjusted for age, history of TIA or stroke, AF, heart failure and AB; ||Adjusted for age, ever-smoker, history of TIA or stroke, AF, heart failure and AB; #Adjusted for history of TIA or stroke and GFR
Figure 1. Grade 3 involving bilateral thalami and left putamen (deep).
Figure 2. Grade 1 involving right insula (lobar), right putamen and left deep periventricular white matter (deep).
Clinical Impact of I-123 Ioflupane SPECT (DaTscan) Imaging Results in Patients with Parkinsonism versus Essential Tremor

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Purpose
Essential tremor and parkinsonian syndromes share similar clinical characteristics, especially early in the disease process. Similar symptoms and a lack of specific findings on basic imaging modalities such as MRI make a definitive diagnosis difficult to make. I-123 Ioflupane is a radiotracer which localizes to the presynaptic dopamine transporter, thus assessing the presence and density of active nigrostriatal dopaminergic neurons. The purpose of this study was to evaluate the clinical management of patients both before and after I-123 Ioflupane (DaTscan) imaging. Quantitative analysis of the striatal radiotracer activity also was compared with the clinical visual interpretation.

Materials and Methods
The DaTscan imaging protocol requires SPECT imaging of the brain 3 to 6 hours after injection of 5mCi of I-123 Ioflupane. A retrospective chart review of patients referred for DaTscan imaging between 2011 and 2014 was completed. Specific attention was paid to the working clinical diagnosis and subsequent management both before and after imaging. The quantitative mean striatal to visual cortex ratio was included in the dataset when available. Clinical diagnosis and management before and after imaging was compared to the clinical imaging result using a two-sample z-test for proportion. The striatal to visual cortex ratio was compared between patients with visually positive and visually negative DaTscan results. A p-value < 0.05 was considered significant.

Results
Seventy patients were evaluated and three were lost to follow up, leaving 67 for analysis. DaTscan results were concordant with the pre-imaging diagnosis in 16 of 67 patients (24%). The diagnosis was either changed or established in the remaining 51 patients (76%). Parkinsonism was diagnosed in 31 patients, 20 patients were given a diagnosis of essential tremor. A statistically significant difference was identified in the patients establishing a new diagnosis. The striatal to visual cortex ratio was reduced significantly in parkinsonisms when comparing to those with essential tremor (2.87±0.68 versus 3.84±0.65 for the left striatum, and 2.80±0.71 versus 3.70±0.73 for right, both p< 0.0005). Including age and sidedness in the analysis did not significantly change the results.

Conclusions
Clinical management was altered in 76% of the study population after DaTscan imaging. The results suggest that DaTscan is an effective method for establishing diagnosis and guiding therapy in the setting of nonspecific parkinsonian symptoms.
Clinical Utilization of MRI in Cardiac Arrest Survivors Undergoing Therapeutic Temperature Management

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\(^1\)Maine Medical Center, Portland, ME

Purpose
Magnetic resonance imaging (MRI) findings correlate with neurological prognosis after cardiac arrest, but usual clinical practices related to MRI in this population have not been described.

Materials and Methods
This retrospective, IRB approved study of patients undergoing MRI after resuscitation from cardiac arrest included demographic and clinical data, MRI findings, patient characteristics and outcomes, and withdrawal of life sustaining therapy (WLST). MRI scans were scored blinded to outcomes using the qualitative system of Hirsch et al.*, for overall (range 0-168) and cortical injury (range 0-48) scores. Quartiles of injury severity were determined and compared to other biomarkers of brain injury using descriptive statistics and correlation coefficients which evaluate sets of matched data points.

Results
Forty-five of 342 (13%) encephalopathic cardiac arrest survivors admitted 2009-2013 underwent MRI a median of 5 (IQR 4,6) days post-ROSC. Patients were 53±18 years, 33% female, 39.5% VT/VF, 74.4% witnessed, with mean CPR duration 21±15 (n=40) minutes. Median whole brain injury score was 34 (IQR 4, 58) and cortex score was 13 (IQR 0, 28). The most common regions of injury were the parietal (62.2%), occipital (57.7%), and frontal (55.5%) cortex, caudate (48.8%), putamen (46.6%), and thalamus (42.2%). The highest quartile of injury severity was 58-87, and all 12 patients died. The lowest quartile of injury severity score was 0-4, with 10/12 patients conscious at hospital discharge. Quartiles of MRI injury severity correlated with median serum neuron specific enolase (82.3, 32.3, 32.6, 21.7), initial BIS (processed EEG) scores (21.6, 20.4,21.0, 9.3), the physical exam finding of myoclonus (67%,45,30,9), and consciousness at the time of hospital discharge (0%,10,50,83) – all differences significant at p≤0.05. Of 45 patients undergoing MRI, 28/44 (63.3%) had WLST within 48 hours of the scan – in this subset, median total and cortical injury scores were 44.5 (IQR 34, 67), and 26 (IQR 13, 32.3), compared to 0 (IQR 0, 8, p<0.001,) and 0 (IQR 0, 1.75, p<0.001) among patients not having WLST.

Conclusions
MR imaging after cardiac arrest is utilized primarily among patients still comatose after resuscitation day 4. Qualitative MRI injury severity scores correlate with EEG activity, serum biomarkers of injury, incidence of myoclonus, and recovery of consciousness. Withdrawal of life sustaining therapy within 48 of MRI was common (63.3%), suggesting clinical weight is attributed to the findings. Despite limited data describing the implications of MRI findings after cardiac arrest, clinicians appear to apply MRI findings to prognosticate. Prospective trials defining best practice thus are needed urgently.

P-48

Comparison of Different Multispectral Segmentation Methods for Quantitation Brain Volume in MRI

*Hirsch et al. *Neuroimage* 2015
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Purpose
Quantitative analysis of brain tissue volume is an important issue in the processing of magnetic resonance images (MRI). In this study, we proposed a new multispectral approach (TRIOA) for quantitative volumetric analysis of multispectral brain MRI. We compare the performances of SPM8-single (T1WI segment), SPM8-multispectral (New Segment, an SPM8 extension tool) and our proposed multispectral (trio-algorithms, TRIOA) segmentation methods.

Materials and Methods
Ninety healthy volunteers (from 32 to 85 years) were scanned with a whole body 1.5 T MRI system (Aera, Siemens) with a phase-array head coil. The imaging protocol included three high resolution 3DFT acquisition sequences: T1WI with MPRAGE, T2WI and FLAIR with SPACE technique. SPM8-multispectral and TRIOA methods were used to segment brain tissues in multispectral MRI. SPM8-single method was performed to process T1WI dataset for the segmentation. The preprocessing steps included skull stripping, motion and inhomogeneity correction. Brain volumes and fractions of gray matter (GM), white matter (WM), and cerebrospinal fluid (CSF) were computed for each subject. Volume fraction (%) is a percentage of intracranial volume.

Results
Figure 1 shows corresponding scatterplots for the relationships of age on the various brain tissues and the corresponding SPM8-single, SPM8-multispectral and TRIOA segmentation results for each subject. We found three segmentation results had the similar trend which is individuals between 20 and 83 years old exhibited an age-associated decline in GM volume fractions. SPM8-single and TRIOA segmentation results revealed the inflection curve of WM volume fractions around 50 years old, but no inflection by using SPM8-multispectral method.

Conclusions
As compared with the performance by using SPM software, the proposed TRIOA method provided appreciate brain tissue classification and volume measurements of multispectral MRI. The results would illustrate the potential applicability of the TRIOA method for clinical brain volumetric analysis.
Corticospinal Tract Edema in the Midbrain: A Novel MR Finding in Patients With Spontaneous Intracranial Hypotension

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¹Cedars Sinai Medical Center, Los Angeles, CA

Purpose
Spontaneous intracranial hypotension (SIH) has several characteristic findings on MRI of the brain. Corticospinal tract edema (CTE) due to mass effect on the midbrain has not been described previously.

Materials and Methods
Retrospective analysis of 23 consecutive patients with the diagnosis of SIH secondary to CSF leak. Two blinded radiologists categorized the corticospinal tracts within the midbrain as either edematous (Group A) or nonedematous (Group B). Twelve additional patients who presented with nonorthostatic headaches and normal MRI brains served as controls (Group C). Normalized ADC values for the corticospinal tracts were measured to substantiate the presence of vasogenic edema.
edema. The ponto-mammillary distance (PMD) and the distance of the cerebellar tonsils to the foramen magnum were measured in all patients.

Results
Of the 23 patients with the diagnosis of CSF leak, 13 were determined to have CTE (57%). The average normalized ADC in this group (1.2 +/- 0.13) was significantly higher than in the 10 Group B, nonedema patients (0.85 +/- 0.08) as well as the 12 Group C controls (0.87 +/- 0.08) (p < 0.01 A versus B and A versus C). PMD was significantly less in Group A (2.7 mm +/- 2.4) compared to Group B (6.3 mm +/- 1.3) and Group C (7.3 mm +/- 1.2) (p < 0.01 A versus B, p < 0.01 A versus C). There was no statistical difference between Groups B and C in either ADC or PMD.

Conclusions
In a subset of patients with SIH we present the novel observation of corticospinal tract vasogenic edema which can be validated on the basis of increased diffusivity. Diminished PMD correlates with the presence of edema, whereas the degree of tonsillar ectopia does not. We suggest that the PMD can reflect potentially significant distortion to the midbrain.
Purpose
The diagnosis of cholesteatoma is based on both clinical and morphological CT findings; therefore, it is not possible to distinguish recurrence from other inflammatory signs or granulation tissue based exclusively on imaging. MR imaging sequences in diffusion non-epi (Propeller) allows such differentiation. The aim of the study is to obtain data on the validity and reliability of the fusion of the two techniques in the study of cholesteatoma.

Materials and Methods
A prospective study will be carried out including a total of 22 patients diagnosed with cholesteatoma in our center; 18 clinically diagnosed de novo, and four previously intervened with suspected recurrence. Morphological CT and MRI-Propeller studies will be performed in all cases. The images acquired will later be merged and correlated with surgical findings and histological results.

Results
Initial results include four patients (3 females and 1 male) aged between 16 and 65 years, surgically treated for cholesteatoma with suspected recurrence. All of them underwent CT and MRI-Propeller. The presence of a soft-tissue mass in the antrectomy cavity was identified at CT and Propeller study revealed signal restriction, highly suggestive of cholesteatoma recurrence. All patients were re-operated, and the diagnosis was confirmed both surgically and histologically.

Conclusions
The fusion of CT and MRI-Propeller images is a valid and reliable technique in the diagnosis of cholesteatomas under 2mm, allowing determination of the location and discrimination between postsurgical changes and recurrence/residual tumor.

P-03
6:00AM - 3:00PM

Dentate nucleus high T2 FALIR signal: clinical associations and differential diagnosis

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University of Minnesota, Minneapolis, MN, University of Minnesota and Hennepin County Medical Centers, Roseville, MN

Purpose
To determine associated clinical symptoms and etiology of cerebellar dentate nucleus T2 hyperintensity.

Materials and Methods
We retrospectively reviewed the medical and imaging records of all patients who underwent brain MRI from 1/2006 to 1/2014 at our center, and had the word "dentate" in their official report. Patients with cerebellar and/or medullary pathology with extension into dentate nuclei were excluded. Patients' symptoms at the time of presentation, clinical diagnosis, and imaging
follow up were evaluated. Medication history was searched specifically for prior metronidazole or isoniazid use.

Results
A total 53 patients were included in this study. The most common etiology of dentate nuclei high T2 signal included small vessel ischemic disease (n=13, %25), and metastasis (n=8, 15%) – primary cancer in either lung or breast. Notably, seven (13%) patients had neurofibromatosis type-1 with dentate nuclei high T2 signal being the only abnormal finding in three patients. HIV-associated neurocognitive disorder was the etiology of dentate nuclei high T2 signal in four (8%) patients; all of whom with brain parenchymal volume loss. Also, three (6%) patients with isolated dentate high FLAIR signal had cerebellar degeneration and/or developmental delay (1 with partial chromosome 5 deletion). Of eight patients with history of metronidazole use; medication-induced encephalopathy was confirmed in only one case treated with high dose IV metronidazole. Age-appropriate high T2 signal also was found in five patients (all<3 years old). Overall, T2 hyperintensity was bilateral in half of the patients (26). Follow-up MRI scans were available in 23 patients; and dentate nuclei high T2 signal remained unchanged in 16/23.

Conclusions
While the most common cause of dentate nuclei high T2 signal are chronic small vessel ischemic disease and metastasis, differential diagnosis also include Type 1 neurofibromatosis, HIV-associated neurocognitive disorder, cerebellar degeneration/developmental delay, and medication toxicity. (Isolated) dentate nuclei T2 hyperintensity can be seen in patients with Type 1 neurofibromatosis, HIV associated neurocognitive disorder, developmental delay, and medication toxicity (e.g., metronidazole and isoniazid).

P-51
6:00AM - 3:00PM

**Deriving Kinetic Parameters of Glioma Growth from Routine Neuro-Imaging: Anatomical Boundaries Matter**

J Jacobs¹, A Hawkins-Daruud¹, S Johnston¹, R Rockne¹, K Swanson¹
¹Northwestern University, Chicago, IL

**Purpose**
Volumetric measurements of routine clinical MRI scans can be used to estimate kinetic parameters for glioblastoma multiforme (GBM). The motility (invasiveness) and rate of cellular division (proliferation) of glioma cells can be used to predict the occurrence of hypoxia, necrosis, response to radiation therapy, and overall survival in GBM patients. Utilizing anatomical boundaries evident in neuro-imaging can improve volumetric estimates of these kinetic parameters and allow for more effective predictions of the course and extent of the individual patient's disease.

**Materials and Methods**
Using observable differences on MRIs of the preferential migration of glioma cells through white matter, we integrate the constraints of anatomical boundaries into current MRI-measurement-derived and volumetric estimates of growth and invasion kinetics for eight GBM patients. Both original and revised kinetic parameters are implemented in a mathematical model with anatomical boundaries and compared to measurements from neuro-imaging. The
effectiveness of the revised parameters to reproduce MRI-observable growth in-silico is compared to the original purely volumetric estimates.

Results
Accounting for anatomical boundaries to glioma growth improves estimation of invasiveness by up to 75%, whereas estimates of proliferation remain stable. Improved accuracy is demonstrated by the volumetric fit of the anatomically constrained mathematical models to measurements of pretreatment neuro-imaging.

Conclusions
Distinct improvements in estimating patient-specific, disease parameters are made by taking into account anatomical boundaries observable on neuro-imaging. These improved estimates enable more effective predictions of the course and extent of the MRI-observable disease. Better models equate to more effective treatment planning and evaluation of treatment success when compared to the absence of treatment.

P-46 6:00AM - 3:00PM

Differentiation Between Cystic Pituitary Adenoma and Wreathe Cleft Cyst: A Diagnostic Model Using MRI

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Purpose
Cystic pituitary adenoma sometimes mimics RCC when there is no solid enhancing component on MRI. Preoperative differentiation between cystic pituitary adenoma and RCC is important because they require different treatment strategies. Therefore, the purpose of this study was to investigate the diagnostic potential of MRI features for differentiating cystic pituitary adenoma from RCC and to develop a diagnostic model.

Materials and Methods
This retrospective study recruited 54 patients with cystic pituitary adenoma and 28 with RCC who underwent MRI followed by surgery. The following imaging features were assessed qualitatively: fluid-fluid level, hypointense rim on T2-weighted images, septation, off-midline location, intracystic nodule, size change, and signal change. Based on the results of logistic regression analysis, a diagnostic tree model was developed to differentiate between cystic pituitary adenoma and RCC. External validation was performed in 16 patients with cystic pituitary adenoma and eight with RCC.

Results
Fluid-fluid level, hypointense rim on T2-weighted images, septation, off-midline were more common in pituitary adenoma, whereas intracystic nodule was more common in RCC. Multiple logistic regression analysis showed that cystic pituitary adenoma and RCC can be distinguished based on fluid-fluid level, septation, off-midline location, and intracystic nodule (P = 0.006, 0.032, 0.001, and 0.023, respectively). Among 24 patients in the external validation population, 22 patients (91.7%) were classified correctly based on the diagnostic tree model.
Conclusions
Systematic approach with the diagnostic tree model can be helpful in distinguishing cystic pituitary adenoma from RCC.

Differing MRI Edema Profiles of Brain Metastases

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\textsuperscript{1}Northwestern University - Feinberg School of Medicine, Chicago, IL

Purpose
Brain metastases (mets) are a complication that occurs in about 40% of patients with systemic...
cancer and, when present, are typically the causes of mortality (1). All brain mets have been treated historically the same regardless of the primary cancer; however, optimal treatment may vary with brain met histology. One possible target that would suggest differential treatment is angiogenesis. Kienast et al. found that in pre-clinical models melanoma metastases tend towards co-opting existing vasculature, while lung metastases are dependent on classic angiogenesis (2). We aim to determine if this dichotomous relationship to brain vasculature holds true in a human population by analyzing the edema on magnetic resonance images (MRIs). We hypothesize that lung metastases will have more edema because they construct their own haphazard angiogenic vessels, causing more fluid to leak into the parenchyma.

Materials and Methods
We analyzed MRIs of patients with primary lung cancer (n=13) and primary melanoma (n=5) and at least one supratentorial brain met. The spatial extent of mets on T1-weighted gadolinium-enhanced (T1-Gd) and T2-weighted (T2) MRI volumes were delineated using a semi-automated in-house software. We then calculated the edema index as the ratio of the T2 met volume to the T1-Gd met volume. The means of the edema index between the two populations were compared (one-tailed t-test).

Results
We found that melanoma patients had, on average, more lesions than lung patients. The mean edema index was larger for lung mets (10.7) compared to melanoma mets (1.8) (p = 0.003).

Conclusions
This study shows that mets from lung and melanoma primary cancers have different edema indices, which supports the concept that they may grow using different angiogenic mechanisms resulting in different imaging phenotypes. If this is an appropriate surrogate for angiogenesis, then anti-angiogenic therapy could be specifically beneficial for lung cancer patients with brain mets.
P-22

**Diffusion Tensor Imaging of Catatonic and Non-Catatonic Schizophrenia Patients**

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**Purpose**

Catatonia is a psychomotor syndrome, composed of mental symptoms such as stupor,
negativism, mutism, ecophenomena, staring and aberrant manifestation of the motor system such as rigidity, posturing and waxy flexibility. In a subset of schizophrenia patients, exacerbations are manifested as catatonia, while the remaining portion has only psychosis with no catatonic features. It is still unknown whether these two subsets of schizophrenia differ or they represent a similar neuropathological process. Our aim was to compare, for the first time, diffusion tensor imaging in catatonic and noncatatonic schizophrenia patients, thus finding a structural basis for the hypothesis that catatonia is a distinct neural process in schizophrenia.

Materials and Methods
Nine catatonic and eight noncatatonic schizophrenia patients (in remission) were evaluated clinically using BFCRS and PANSS clinical score scales. Each patient was evaluated with DTI at 3.0 T MR. Region of interest (ROI)-based techniques were used to analyze fractional anisotropy (FA) and mean diffusivity (MD) in the basal ganglia nucleoli, corpus callosum, subcortical frontal and parietal white matter, internal capsule and middle cerebellar peduncle (MCP). Correlations between DTI changes and clinical parameters (clinical score, age and duration of illness) also were queried.

Results
Groups did not differ on mean age, length of illness and PANSS. Significant differences were found in the MD of the left MCP (p=0.05), in right to left ratio of MD of posterior limb of the internal capsule (p=0.05), and in the right to left ratio of FA of the putamen nucleus (p=0.04). In most of examined brain areas, no significant DTI changes were found. Patient's age and chronicity of the disease had strong influence on various areas' DTI values, most prominent in the genu of the corpus callosum, i.e., FA changes (r=-0.86, p<0.001 and r=-0.69, p=0.002, respectively).

Conclusions
Patients with catatonic schizophrenia might differ in brain connectivity properties from patients with noncatatonic schizophrenia in specific brain areas. This might imply that catatonic schizophrenia is a distinct neuropathological process than noncatatonic schizophrenia. The effects of patient's age and chronicity of schizophrenia on DTI might overwhelm subtle differences between these two clinical entities. Further studies taken earlier following disease presentation are needed to substantiate our novel observation.

Discriminating between Pre- and Post-Season fMRI Connectivity Networks After a Single Season of High School Football: A Machine Learning Study

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Purpose
The purpose of this study is to determine if cumulative head impacts in nonconcussed high-school football players have an effect on resting state functional magnetic resonance imaging (rsfMRI) connectivity networks.

Materials and Methods
Thirty high-school football players without history of prior concussion participated in this study.
Six minutes of rsfMRI was obtained pre and postseason from each subject. Functional MRI data preprocessing was performed using FSL. For each subject, fMRI data were band-pass filtered at 0.01-0.1 Hz and registered to the same subject structural data. Independent component analysis (ICA) was performed for each scan. For 16 scans, ICA components were classified manually to noise and signal. These data were used to train the FMRIB's ICA-based Xnoiseifier (FIX) classifier. Artifact removal and motion correction were performed using the FIX classifier. The cleaned data were normalized to the Montreal Neurological Institute (MNI) space. Group ICA (gICA) analysis resulted in 29 gICA maps. Dual regression was performed in order to obtain subject version of the group maps. Network analysis was performed using the FSLNETS toolbox. Brain networks were constructed by computing pairwise temporal correlation between ICA components through various full and partial correlation approaches. Various machine-learning approaches were performed in an effort to distinguish pre from postseason networks. The classifiers were validated using leave-one-out approach.

Results
Seventeen networks were identified using gICA analysis after removal of noise ICAs. Using a variety of machine-learning classifiers we achieved a high accuracy in classifying scans as either pre or postseason reaching over 93% accuracy as shown in Table 1.

Conclusions
Our findings indicate that there are network changes between pre and postseason fMRI networks such that support vector machine classified the partial networks with a 93.3% classification accuracy. These findings suggest that there are identifiable changes in brain connectivity during a season of high school football (1, 2).

Table 1. Classification accuracy (%) obtained using various machine-learning approaches

<table>
<thead>
<tr>
<th>Classifier</th>
<th>Network Analysis</th>
<th>Covariance</th>
<th>Amplitude</th>
<th>Full Correlation</th>
<th>L1 Regular Partial</th>
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<tr>
<td>Fisher linear discrimination</td>
<td></td>
<td>76.7</td>
<td>66.7</td>
<td>56.7</td>
<td>50.0</td>
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<tr>
<td>Fisher linear discrimination-mean</td>
<td></td>
<td>76.7</td>
<td>90.0</td>
<td>76.7</td>
<td>86.7</td>
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<tr>
<td>Two-group T weighting</td>
<td></td>
<td>80.0</td>
<td>93.3</td>
<td>76.7</td>
<td>90.0</td>
</tr>
<tr>
<td>Two-group maximum T weighting</td>
<td></td>
<td>46.7</td>
<td>43.3</td>
<td>50.0</td>
<td>63.3</td>
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<tr>
<td>Two-group thresholded T weighting</td>
<td></td>
<td>83.3</td>
<td>86.7</td>
<td>80.0</td>
<td>80.0</td>
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<tr>
<td>Two-group T/ std dev weighting</td>
<td></td>
<td>76.7</td>
<td>86.7</td>
<td>80.0</td>
<td>86.7</td>
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<tr>
<td>Support vector machine</td>
<td></td>
<td>86.7</td>
<td>90.0</td>
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<td>93.3</td>
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P-06

6:00AM - 3:00PM

Early Brain Magnetic Resonance Imaging can Predict Short and Long-term Outcomes after Organophosphate Induced Status Epilepticus in a Rat Model

S Shrot¹, M Tauber², T Kadar³, Y Cohen⁴
Purpose
The goals of this study were to explore early brain MR findings in organophosphate poisoned animals, to assess the efficacy of central acting antidotal treatment and to find whether early imaging findings can predict delayed cognitive dysfunction.

Materials and Methods
Sprague-Dawley rats were poisoned with the agricultural OP paraoxon and were treated with immediate atropine and obidoxime (ATOX) to reduce acute mortality due to peripheral inhibition of acetylcholinesterase (AChE). Animals were divided randomly into three groups based on the protocol of central acting antidotal treatment: group 1- no central antidotal treatment (n=10); group 2- treated with midazolam (MID) 30 minutes post poisoning (n=9), group 3 – treated with a combination of MID and scopolamine (SCOP) 30 minutes post poisoning (n= 9) and controls. Each animal had brain MR examination 3 and 24 hours post poisoning. Each MR examination included the acquisition of a T2 map and a single-voxel 1H-MR spectroscopy (localized on the thalami). Eleven days post poisoning each animal underwent Morris Water Maze to assess hippocampal learning function. Eighteen days following poisoning, animals were euthanized, brains dissected, fixed and processed for histology.

Results
All paraoxon poisoned animals developed generalized convulsions, starting within few minutes following paraoxon injection. Brain edema was maximal on MR imaging 3 hours post poisoning. Both MID and MID+SCOP prevented most of cortical edema, with equivalent efficacy. Brain metabolic dysfunction, manifested as decreased NAA/Cr, appeared in all poisoned animals as early as 3 hours post exposure (1.1±0.07 and 1.42±0.05 in ATOX and control groups, respectively) and remained lower compared to nonpoisoned animals even 24 hours post poisoning. MID and MID+SCOP prevented much of the 3 hours NAA/Cr decrease with advantage to the MID+SCOP (1.22±0.05 and 1.32±0.1, respectively). Significant correlations were found between imaging findings (brain edema and spectroscopic changes) and clinical outcomes (learning dysfunction, weight loss and pathological score) with correlation coefficients of 0.4-0.75 (p<0.05).

Conclusions
MR imaging is a sensitive modality to explore organophosphate induced brain damage. Delayed treatment with midazolam with or without scopolamine provides only transient neuroprotection with some advantage in adding scopolamine. Early imaging findings are found to be in correlation with clinical consequences of organophosphate poisoning and potentially could be used in the future to predict long term prognosis of poisoned casualties.
Results from voxel based analysis preformed on the T2 maps of the poisoned rats treated with ATOX, ATOX+MID or ATOX+MID+SCOP groups, compared with control animals. Highlighted regions represent regions with significant elevated T2 values (p<0.01). High T2 signal represents edematous changes.
Edge Density Imaging: Mapping the Anatomic Embedding of the Structural Connectome Within the White Matter of the Human Brain

J Owen¹, Y Chang¹, P Mukherjee¹
¹University California, San Francisco, San Francisco, CA

Purpose
The structural connectome (1) is a powerful construct that can be used to characterize the network topology of the human brain in health and in disease. The edges of the connectome traverse white matter to connect cortical and subcortical nodes, although the anatomical embedding of these network connections generally is overlooked in the literature. Characterization of the anatomical embedding of the structural connectome could elucidate the relative importance of different white matter tracts to the overall network architecture of the healthy brain, as well as in white matter diseases with complex spatial patterns of disconnection.

Materials and Methods
In this work, we introduce edge density imaging (EDI), a postprocessing technique for diffusion-weighted MRI data, which reveals the spatial embedding of the structural connectome by creating a map that represents the number of edges that pass through every white matter voxel. We use diffusion-weighted images acquired on a Siemens 3T TIM Trio MR scanner from 10 healthy adult subjects (each scanned twice). Using tractography (2) between gray matter regions defined by the FreeSurfer atlas (3), we can reconstruct the path that each edge of the connectome takes through the white matter.

Results
Our results demonstrate spatially ordered variations of edge density (ED) throughout the white matter, including a strong posterior ED bias. In the figure, we provide axial slices through the ED image as well tract density (TD) (4) and probability of crossing fibers (p(CF)) images (all images are averaged over subjects in MNI space) for comparison. As seen in the figure, the peri-atrial white matter emerges as the region with the highest ED. From a test-retest reproducibility analysis, we establish excellent to good reliability for our edge density calculations, and show consistent results using different cortical and subcortical parcellation schemes and scan acquisition parameters. We also demonstrate that ED yields complementary information to other previously described voxel-wise white matter parameters, including fractional anisotropy, TD, p(CF), fiber orientation dispersion and neurite density. We map the white matter regions that are enriched with pathways connecting rich club nodes and also those with high densities of intra-modular and intermodular edges, discovering that edges of the rich club and modules are not distributed evenly across the white matter. Specifically, we found that regions in the right superior parietal and left superior temporal white matter have greater number of rich club edges than complimentary, contralateral regions. Using edge betweenness centrality, we are able to identify regions involved in a large number of shortest paths, some of which are highly connected and others which are relatively isolated.

Conclusions
Overall, our findings reveal an intricate relationship between white matter anatomy and
connectome edges, thereby motivating the use of EDI in white matter disorders to better understand how brain network connections are disrupted in diseased states.
Effects of Head Impact Exposure on the Internal and External Capsule Regions of White Matter in High School Varsity Football Players

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¹Wake Forest School of Medicine, Winston-Salem, NC, ²Wake Forest School of Medicine, Winston-Salem, NC, ³Wake Forest University School of Medicine, Winston-Salem, NC

Purpose
Normal brain development demonstrates diffusion tensor imaging (DTI) changes in the internal capsule and the external capsule (1, 2) that progress along a maturational trajectory into adolescence and early adulthood. The purpose of this study is to evaluate the effects of nonconcussive cumulative head impact exposure related to high-school football on the microstructural development of these white matter regions using DTI. Our hypothesis is that white matter regions of the internal and external capsule may be particularly sensitive to the effects of nonconcussive head impact exposure.

Materials and Methods
Thirty-nine football players (age range 14-18 years) from a local high-school varsity football team with no prior history of concussion were instrumented with the Head Impact Telemetry System (HITs) during all practices and games. HITs records kinematic data from head impact sensors embedded in the helmet. All participants received pre and postseason MRI acquired on a 3T Siemens Skyra MRI scanner (Siemens Healthcare, Erlangen, Germany). T1-weighted (T1W) anatomical images were obtained using a three-dimensional magnetization prepared rapid gradient echo sequence. DTI data was acquired using a two-dimensional single-shot echo planar imaging sequence (2.2×2.2 x 3mm, b=0 and 1000, 15 diffusion directions). The biomechanical metric computed from the HITs data was the combined risk weighted cumulative exposure (RWECP) for each subject. This metric represents the collective risk of concussion over the course of the season3. Diffusion tensor imaging metrics including fractional anisotropy (FA), mean diffusivity (MD), linear anisotropy (CL), planar anisotropy (CP), and spherical anisotropy (CS) maps were computed in FSL. Johns Hopkins University white matter labels (4) were used to calculate the mean DTI metrics of the internal and external capsule white matter tracts for the pre and the postseason diffusion maps. Percent change in the diffusion metrics between pre and postseason was calculated and regression analysis was conducted to assess the relationship between RWECP and the DTI metrics.

Results
There was a statistically significant linear relationship between RWECP and change in FA [F(1,37)=5.51, p=0.02] and between RWECP and change in CS [F(1,37)=4.96, p=0.03] in the right external capsule. A significant linear relationship was observed between RWECP and change in CP [F(1,37)=6.38, p=0.01] in the posterior limb of the left internal capsule.

Conclusions
We demonstrate that high-school football results in measurable effects on white matter diffusion in regions undergoing developmental change during adolescence, even in the absence of clinical concussion. Our findings suggest that nonconcussive cumulative head impact exposure may...
affect the maturational trajectory of microstructural changes in the white matter regions of the internal and external capsule.

(Filename: TCT_P-60_ASNR-figure.jpg)

P-64

FMRI Connectivity Network Changes Associated with a Season of High School Football

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¹Virginia Tech - Wake Forest School of Biomedical Engineering and Sciences, Winston-Salem, NC, ²Wake Forest School of Medicine, Winston-Salem, NC

Purpose
The purpose of this study is to determine if cumulative head impacts in nonconcussed high-school football players have an effect on resting state functional magnetic resonance imaging (rsfMRI) connectivity networks.

Materials and Methods
Thirty high-school football players without history of prior concussion participated in this study. Six minutes of rsfMRI was obtained pre and postseason from each subject. Functional MRI data preprocessing was performed using FSL. For each subject, fMRI data was band-pass filtered at 0.01-0.1 Hz and registered to the same subject structural data. Independent component analysis (ICA) was performed for each scan. For 16 scans, ICA components were classified manually to
noise and signal. These data were used to train the FMRIB's ICA-based Xnoiseifier (FIX) classifier. Artifact removal and motion correction were performed using the FIX classifier. The cleaned data were normalized to the Montreal Neurological Institute (MNI) space. Group ICA (gICA) analysis resulted in 29 gICA maps. Dual regression was performed in order to obtain subject version of the group maps. Network analysis was performed using the FSLNETS toolbox. Brain networks were constructed by computing pairwise partial temporal correlations between ICA components. Significant changes between pre and postseason connectivity was evaluated using paired t-tests corrected for multiple comparisons (p-value <0.05).

Results
Seventeen networks were identified using glICA analysis. Analysis of the interconnectivity between the networks revealed significant changes in one of these paired connections (Figure 1). Interconnectivity increased after a season of football between the frontoparietal network and a network centered in the extrastriate cortex involved in visual stimuli processing (1).

Conclusions
Our findings indicate significant changes (p-value =0.042) in brain connectivity between frontoparietal and visual networks after a season of football with only subconcussive head impact. The results add to the growing body of literature showing significant changes in brain connectivity networks associated with mild traumatic brain injury (2, 3).

Figure 1. Significantly increased connectivity between frontoparietal network and extrastriate cortex network (post-season connectivity > pre-season connectivity)
(Filename: TCT_P-64_2.jpg)

P-65

**Grey Matter Correlates of Functional Outcomes in Combat Veterans With Mild Traumatic Brain Injury**

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\(^1\)Philadelphia VA Medical Center, Philadelphia, PA, \(^2\)Drexel University, Philadelphia, PA
Purpose
Mild traumatic brain injury (mTBI) is an emerging public health problem among modern U.S. military veterans, and is associated with poor psychosocial and neuropsychiatric outcomes such as post-traumatic stress disorder (PTSD). The clinical evaluation and management of veterans with mTBI remains challenging due to difficulties in establishing the diagnosis, selecting appropriate therapy, and identifying subjects at high risk of poor outcome. Reliable biomarkers therefore are sought to better understand the underlying pathologic process and eventually improve clinical management. We set out to determine whether quantitative measurements of gray matter thickness and concentration are associated with important short and long term functional outcomes in veterans at risk for having sustained mTBI during combat.

Materials and Methods
We performed a retrospective cross-sectional and cohort study of more than 85 post-9/11 combat veterans who were evaluated within a single large VA hospital system over a 5-year period. All veterans were administered a screening questionnaire designed to identify those at high risk for having sustained TBI during combat. Veterans who screened positive were referred for brain MRI and comprehensive clinical evaluation. Subjects with abnormal conventional baseline brain MRI were excluded from the study. Demographic, clinical, and military characteristics of each subject were collected from the medical record. Symptom severity was assessed in veterans with PTSD using the PTSD checklist-military version (PCL-M). Longitudinal measures were collected for each subject over as many as 4 years of clinical follow up. High resolution magnetization-prepared rapid gradient echo (MPRAGE) T1-weighted sequences were utilized for calculation of regional gray matter thicknesses and voxelwise gray matter concentrations according to standardized postprocessing pipelines. Linear regression analysis was performed across all subjects to assess the association of gray matter measurements with continuous variables. The association of binary categorical variables with gray matter measurements was assessed by comparing different population subsets in a group-wise fashion.

Results
Significant correlations were identified between gray matter measurements and functional outcomes within this population of veterans at high risk for having sustained m-TBI during combat. For example, there was a statistically significant (p<0.05) inverse correlation between thickness of the right caudal anterior cingulate cortex and post-traumatic stress disorder checklist (PCL) score among combat veterans with post-traumatic stress disorder (see Figure).

Conclusions
Despite a normal conventional brain MRI, quantitative baseline measurements of gray matter structure were associated with important functional outcomes in combat veterans at risk for having sustained m-TBI during combat. These findings improve our basic understanding of m-TBI by implicating specific neuro-anatomical substrates underlying key pathologic processes related to m-TBI. The findings therefore will help inform future studies of m-TBI.
Histologic Analysis of Retrieved Clots in Acute Ischemic Stroke: Correlation with Stroke Etiology and Gradient-Echo MRI

W Yoon, S Kim, H Kim
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Purpose
The purpose of this study was to elucidate the relationship between clot composition and stroke etiology following mechanical thrombectomy and investigate the effect of varied clot compositions on gradient-echo (GRE) MR imaging of clots.

Materials and Methods
Histopathologic analysis of retrieved clots from 37 patients with acute middle cerebral artery (MCA) occlusion was performed. Patients underwent GRE imaging before endovascular therapy. Retrieved clots underwent semi-quantitative proportion analysis to quantify red blood cells (RBC), fibrin, platelets, and white blood cells by area. Correlations between clot compositions and stroke subtypes and susceptibility vessel signs (SVS) on GRE imaging were assessed.

Results
Stroke etiology was classified as cardioembolism in 22 (59.4%), large artery atherosclerosis (LAA) in eight (21.6%), and cryptogenic in seven (18.9%). The clots from a cardioembolic occlusion had a significantly higher proportion of RBCs (37.8% versus 16.9%, p=0.031) and a lower proportion of fibrin (32.3% versus 48.5%, p=0.044) compared to those from LAA. The proportion of RBCs was significantly higher in clots with an SVS than those without (48.0% versus 1.9%, p<0.001), whereas the proportions of fibrin (26.4% versus 57.0%, p<0.001) and platelets (22.6% versus 36.9%, p=0.011) were significantly higher in clots with a negative SVS than those with a positive SVS.

Conclusions
The histologic composition of clots retrieved from cerebral arteries in acute stroke patients is different between cardioembolism and LAA. In addition, an SVS on GRE imaging is strongly associated with a high proportion of RBCs and low proportion of fibrin and platelets in retrieved clots.

Hyperintense vessels on T2-PROPELLER-FLAIR in acute MCA stroke patients: Prediction of arterial stenosis and perfusion abnormality.

S Ahn
Gangnam severance hospital, Seoul, Korea

Purpose
Fluid-attenuated inversion recovery (FLAIR) hyperintense vessels (FHV) in acute brain ischemia are thought to be associated with large arterial stenosis and represent leptomeningeal
collateral flow. We presumed that FHV's are more prominent on T2-PROPELLER-FLAIR than T2-FLAIR.

Materials and Methods
We retrospectively reviewed 35 patients with middle cerebral artery (MCA) territorial infarction who underwent magnetic resonance imaging (MRI). We compared the predictability of FHV's on both sequences for large arterial stenosis using McNemar's test. FLAIR hyperintense vessel scores were graded according to the number of FHV's in the MCA-Alberta Stroke Program Early Computerized Tomography areas. A paired Student's t-test was used to compare FHV scores between two sequences. The correlation of T2-FLAIR and T2-PROPELLER FLAIR with perfusion-weighted image (PWI) was assessed by kappa statistics. Sensitivity and specificity to predict the delayed perfusion area were compared by McNemar's test.

Results
T2-PROPELLER-FLAIR improved the sensitivity for large arterial stenosis, compared with T2-FLAIR (92% versus 70%, p=0.04), although the specificity was not superior (87% versus 100%, p=0.12). FHV scores were significantly higher on T2-PROPELLER-FLAIR than T2-FLAIR (3.50±2.79 versus 1.21±1.47, p<0.01). T2-PROPELLER-FLAIR was in better agreement with PWI than T2-FLAIR (k=0.64 and k=0.27, respectively). The sensitivity and specificity of FHV's on T2-PROPELLER-FLAIR for perfusion abnormality were 85% and 79% respectively.

Conclusions
FLAIR hyperintense vessels on T2-PROPELLER-FLAIR is a more sensitive predictor of large arterial stenosis than T2-FLAIR, and FHV's were observed in wider MCA territory in patients with acute MCA infarction. The area with FHV's on T2-PROPELLER-FLAIR is well matched with the delayed perfusion area.
Improved detection of acute neck vascular dissection with axial fat-saturated dual echo T2-weighted MR imaging

V. Daruwalla¹, J. Ti², T. Hijaz³, T. Gallagher⁴, A. Nemeth⁵
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Purpose
The diagnostic utility of axial fat-saturated T1-weighted MR images in the detection of acute neck vascular dissection has long been debated. Axial fat-saturated dual echo T2-weighted images may offer an alternative, better means to evaluate for acute carotid or vertebral artery dissection.

Materials and Methods
This retrospective study included 10 subjects ranging in age from 20 to 80 years: two with acute carotid artery dissection, three with acute vertebral artery dissection, and five age-matched controls. The subjects all underwent imaging with an MRI/MRA neck dissection protocol including axial T1-weighted fat-saturated and fat-saturated dual echo proton density/T2-weighted sequences. Subjects with acute dissection in these images also were confirmed by CTA. The subjects were randomized and evaluated independently by two experienced neuroradiologists. All of the images were reviewed for hyperintense signal along the courses of the major cervical arteries, suggesting the presence of methemoglobin in an intramural hematoma resulting from acute dissection. The location of each dissection was recorded. Both sets of sequences were read separately and in reverse order. The readers were blinded to the diagnoses, clinical information, MRA and CTA results. Sensitivity, specificity, and accuracy were calculated for both of the sequences. The kappa statistic was used to measure interobserver agreement.

Results
The study involved 10 subjects ranging in age from 20 to 80 years, of which two subjects were positive for acute carotid artery dissection and three for acute vertebral artery dissection. The other five subjects were negative for dissection and were used as age-matched controls. Sensitivity, specificity, and accuracy for the axial T1-weighted fat-saturated MR images in diagnosing carotid and vertebral dissection was 100%, 33%, and 69.2%, respectively. Sensitivity, specificity, and accuracy for the axial fat-saturated dual echo proton density/T2-weighted images were 92.9%, 80%, and 87.5%, respectively. The kappa statistic showed substantial agreement between the two neuroradiologists with \( \kappa = 0.80 \).

Conclusions
Axial fat-saturated dual echo T2-weighted images are more accurate and specific than axial fat-saturated T1-weighted MR images in detection of acute dissection in the major cervical arteries. The high sensitivity of axial T1-weighted fat-saturated images is due to a high number of false positives and an absence of false negatives.
Intracranial Granulocytic Sarcoma in Patients with Acute Myeloid Leukemia: Three Case Reports with Intraparenchymal Involvement.

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\textsuperscript{1}University of Minnesota, Minneapolis, MN

Purpose
Granulocytic sarcoma (GS) of the central nervous system (CNS) is a rare manifestation of young patients with acute or chronic myeloid leukemia and other myeloproliferative disorders. In this study, we present the imaging manifestations of intracranial granulocytic sarcomas in two patients with intraparenchymal masses and one patient with optic nerve, cerebellum and basal ganglia lesions.

Materials and Methods
Sixty-four patients with acute myeloid leukemia and imaging of the brain were analyzed retrospectively using the electronic medical records of our institution. Three patients demonstrated involvement of the brain parenchyma. CT and MR images were reviewed.

Results
1) 69-year-old female with acute myeloid leukemia (AML) relapse. Noncontrast CT images demonstrated a hyperdense dural-based mass lesion in the right temporal lobe with surrounding edema and mass effect. MR images revealed a 5.8 cm lobulated avidly enhancing dural-based mass lesion in the right temporal lobe with vasogenic edema and hypointense signal on T1- and T2-weighted images. Diffusion-weighted images demonstrated restrict diffusion. 2) 64-year-old female with AML relapse demonstrated a 2.4 cm extra-axial hyperdense mass in the left temporal lobe. MR images demonstrated T1 hyper- T2 hypointense signal intensity with multiple blooming foci on susceptibility-weighted images, consistent with intralesional hemorrhage. Postcontrast images revealed a solid dural-based component with dural tail sign, without restrict diffusion. Vasogenic edema was shown without mass effect. 3) 22-month-old male presented
with AML relapse. MR images revealed a right cerebellar enhancing lesion, left optic nerve enlargement and enhancement of the optic nerve sheath. One month later, he developed a 1.9 cm ill-defined T1 iso- T2 hyperintense lesion in the right basal ganglia. All lesions resolved on follow-up imaging 45 days after AML chemotherapy treatment.

Conclusions
Intracranial granulocytic sarcomas are rare presentations of acute myeloid leukemia and can be misdiagnosed if the clinical history of leukemia is not recognized. The most common manifestations are extra-axial hyperdense masses simulating meningiomas with or without vasogenic edema.

(Filename: TCT_P-40_AMLAbstractImages.jpg)

P-43
6:00AM - 3:00PM

Is Apparent Diffusion Coefficient (ADC) Value Measured on PACS Workstation Helpful in Prediction of High-Grade Meningioma?

S Hirunpat1, N Sanghan1, C Watcharakul1, K Kayasut1, N Ina1, P Hirunpat1
1Prince of Songkla University, Hat-Yai, Songkhla

Purpose
To determine whether apparent diffusion coefficient (ADC) measured on PACS workstation is helpful in prediction of high-grade meningioma (WHO grade II and III).

Materials and Methods
Twenty-eight patients (mean age, 57.5 years; age range 44-71 years) including nine men and 19 women with histopathologically confirmed meningiomas (20 benign, 7 atypical and 1 malignant)
between August 2010 and June 2014 were included in the study. All patients underwent preoperative standard brain imaging which routinely included diffusion-weighted imaging (DWI) obtained at B value = 1000 s/mm². Quantitative analysis of the ADC value of the tumor and mean normalized ADC ratios of the tumor compared with the contralateral normal white matter were calculated and analyzed.

Results
The mean ADC of atypical and malignant meningiomas (0.698 ± 0.06 x10^-3 mm²/s) was significantly lower (P value < 0.05) as compared with benign meningiomas (0.83 ± 0.37 x10^-3 mm²/s). The mean normalized ADC ratios (NADC) in the atypical and malignant type (0.895 ± 0.09) also were lower than the benign type (1.05 ± 0.05 x10^-3) but without statistical significance (P value=0.06). Using the mean ADC less than 0.8 as a predictor of high grade meningioma gives the sensitivity of 75% (95% CI=34.9-96.8), specificity of 65% (95%CI=40.8-84.6), PPV=46.2% (95% CI=19.2-74.9) and NPV=86.7% (95%CI=59.5-98.3).

Conclusions
The mean ADC measured conveniently on PACS of atypical and malignant meningioma was statistically significantly lower than benign meningioma and may be a helpful tool in prediction of high grade meningioma with considerable sensitivity and specificity.

P-38
6:00AM - 3:00PM
Location of Leptomeningeal Disease on MRI of the Brain in Patients Presenting to a Tertiary Referral Center.
G Millare¹, N Guha-Thakurta², L Chi³, L Ketonene⁴, D Suki², R Mayer⁵, J Weinberg⁴, M Debnam⁶
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Purpose
Current methods of diagnosing leptomeningeal disease (LMD) are insensitive. While cytological evaluation remains the gold standard for diagnosis, MRI often is used in the assessment of patients with suspected LMD. The purpose of this study was to determine if there are intracranial sites of disease predilection on MRI in patients with LMD.

Materials and Methods
Patients with cytologically proven LMD and who also had concurrent MRI brain study were evaluated. The presence of enhancement and T2/FLAIR signal hyperintensity in the cerebellar folia and sulci of the supratentorial compartment, and enhancement involving the cranial nerves, Meckel's cave, basal cisterns, pituitary stalk, and ependymal surface of the lateral ventricles was reviewed retrospectively. The time interval between the MRI examination and cytological analysis was ≤ 30 days. Student's t-test was used for statistical analysis.

Results
The study included 271 patients, 143 women and 128 men, age 6-90 (median 52 years). Leptomeningeal enhancement and T2/FLAIR signal hyperintensity in the sulci were unilateral or bilateral and involved the following number of patients, respectively: cerebellum (n=82,96), occipital lobe (n=67,92), temporal lobe (n=47,58), parietal lobe (n=50,75), and frontal lobe.
Cranial nerve involvement was unilateral or bilateral and present in the following number of patients: CN III (n=9), CNV (n=27), CN VII/VIII (n=45), Meckel's cave (n=31), basal cisterns (n=40), pituitary stalk (n=13), ependymal surface of lateral ventricles (n=47). The enhancement of the cerebellar folia was significantly greater than in the sulci of the parietal, temporal and frontal lobes (p<0.0002), and the enhancement in the sulci of the occipital lobes was significantly greater than the temporal and frontal lobes (p<0.03). The T2/FLAIR signal hyperintensity was significantly greater in the cerebellar folia and occipital lobes compared to the frontal, temporal and parietal lobes (p<0.02). Enhancement of CNVII/VIII was significantly greater than CN III (p<4.5 E-08), CNV (p<0.002), Meckel's cave (p<0.004) and the pituitary gland (p<1.3 E-05). The enhancement of the basal cisterns was significantly greater than CN III (p<5.3 E-06), CNV (p<0.03), and the pituitary gland (p<0.0001). The enhancement of the ependymal surface of the lateral ventricles was significantly greater than CNIII (p<6.9 E-08), CNV (p<0.003), Meckel's cave (p<0.008) and the pituitary stalk (p<2.9 E-06).

Conclusions
Leptomeningeal disease affects the brain and cranial nerves diffusely. Leptomeningeal disease, characterized by enhancement and T2/FLAIR signal hyperintensity, significantly involves the cerebellar folia and occipital lobes when compared to the remainder of the supratentorial compartment. CNVII/VIII, the basal cisterns, and ependymal lining of the lateral ventricles are involved significantly more often than the other cranial nerves and the pituitary stalk. Further study will be necessary to determine the etiology and significance of this pattern of disease involvement and to compare to other processes with leptomeningeal enhancement.

P-44

Magnetic resonance spectroscopy in low grade gliomas.

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Purpose
The purpose of this scientific paper is to analyze the contribution of magnetic resonance spectroscopy (MRS) in diagnosis and therapeutic monitoring of low grade gliomas highlighting the basic metabolic pattern and its variants and their impact on the management of this group of patients.

Materials and Methods
We prospectively analyzed magnetic resonance findings in 75 patients with low grade glioma (WHO grade II) confirmed by histopathological study presented at our institution between January 2012 and December 2014. All patients were studied in 1.5T Siemens Avanto with spectroscopy technique with two modalities: 3D CSI multivoxel, TE of 140ms, and monovoxel PRESS, TE of 35ms. The metabolic lectures included areas of normal brain and then compared with tumor and near tumor patterns. N-acetyl aspartate (NAA) levels, Ch and Cr, mI and Lip/Lac were analyzed, and particularly the Ch/NAA, NAA/Cr and mI/Cr ratios.

Results
We found a group of patients with diffuse/fibrillary astrocytoma (WHO grade II), 41 cases; oligodendrogliomas (WHO grade II), 28 cases; and oligoastrocytoma (WHO grade II), six cases. All patients had solitary supratentorial lesions, most located in the frontal and parietal lobes (59
tumors, 78.6%). Only two lesions were located in the brain stem and the remaining 14 were located in the remaining lobes or in the basal ganglia. The analyses of the obtained metabolic patterns were divided into two basic patterns. The first group comprised 21 patients, 20 with diffuse/fibrillary astrocytomas and one with oligoastrocytoma, a pattern which we call pseudo-normal readings with long TE. While the qualitative analysis impresses be a normal pattern it is not in the quantitative analysis of the peaks and especially indices. Comparison with normal brain declining Ch Ascend NAA, NAA index Ch/less than 1.1 and NAA/Cr ratio between 1.46 and 1.62 is observed. In 20 cases mI was observed in the readings with short TE (100% of astrocytomas) and no injury presented peak Lip/Lac. In the second group, 54 injuries, 100% had tumor-called classic pattern, with an evident decrease in NAA and rise of Ch inversion of the relationship between the two metabolites. Choline/NAA ratio was greater than 1.2 in all cases even if no injury cutoff exceeded 2.4. Most of these lesions showed values Ch/NAA between 1.53 and 1.57 (47 lesions, 87%). Choline/Cr ratio was less than 1.75 in all cases and only nine cases peak Lip/Lac was observed. All variables astrocytic lesions showed no mI peak observed in oligodendroglia and mixed lesions only in three.

Conclusions
MR spectroscopy has been used as a tool not only for diagnosis of probable tumor and discard differentials but also to separate high grade lesions from low grade. Values of Cho/Cr and Cho/NAA ratios of 1.36 and 1.78 respectively in the area adjacent to the lesions have a PPV of 97.6% and NPV of 100% for high-grade lesions suspicious. In our series data obtained modified the initial management in a small number of patients because it was decided to perform surgical resection or biopsy immediately in 62 of the 75 patients.

P-16
6:00AM - 3:00PM

Magnetic Resonance Spectroscopy of postpartum depression and the role for dorsolateral prefrontal cortex

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Purpose
Postpartum depression (PPD) is a mood disorder considered a subtype of major depressive disorder (MDD). A complex interaction between hormones, neurotransmitters, genetic and environmental factors should be involved in its etiology. In vivo proton magnetic resonance spectroscopy (¹H-MRS) is the only noninvasive technique to assess neurotransmitter dysregulation related to medial and dorsolateral prefrontal cortex (dPFC) and anterior cingulate gyrus (AGC) as part of the neuronal pathways involved in emotional processing. The aim of this study is to use ¹H-MRS to measure neurochemical changes in the dPFC of postpartum women to better understand PPD pathophysiology.

Materials and Methods
Two groups of postpartum women were studied. One with 36 women diagnosed with PPD and other with 25 healthy controls. All the women were subjected to a structured clinical interview, depression scales, and ¹H-MRS acquired in an Achieva 3T MRI scanner (Philips, The Netherlands). Single voxel MRS were processed with LCMRModel software, normalized by GM-
WM intra-voxel concentration, and analyzed by ANCOVA, controlling for confounding covariates in estimating the level of metabolite between groups.

Results
We identified reductions of glutamate complex (Glu) and N-acetylaspartate (NAA) in the dlPFC in the PPD group compared with controls. In AGC the use of progestagenic hormones reduced the absolute values of Glu and lead to increased levels of choline (Cho).

Conclusions
The reduced levels of Glu and NAA in the PPD group may be related to glutamatergic excitotoxicity hypothesis and axon-neuronal dysfunction, with subsequent reduction of glutamatergic synaptic metabolism in dlCPF region. This region is involved in important cognitive functions that are impaired in MDD frames. In the ACG, we identified reduction of Glu and increase of Cho which may also be related to glutamatergic excitotoxicity and increased neuronal membranes exchanges.

P-17

Morphometric Analysis and Diffusion Tensor Imaging Investigation in Brain of Neuropsychiatric SLE Patients

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Purpose
The aims of this study attempt to investigate the neuroanatomical segmentation and DTI alternations in neuropsychiatric SLE (NPSLE) patients by using morphometric analysis and diffusion tensor imaging (DTI) including the mean diffusivity (MD) and fraction anisotropy (FA).

Materials and Methods
In this study, 27 patients with NPSLE (mean age 41.4 years, M/F: 3/23) and 43 age-matched normal control (mean age 41 years, M/F: 11/32) were enrolled. The MRI was performed by Siemens Magnetom Aera 1.5T MR scanner. The imaging protocol included T1WI with 3D MPRAGE, T2WI and fast FLAIR with SPACE technique. The DTI images were obtained by the single-shot EPI sequence with diffusion gradients in 30 directions, voxel size: 2x2x2 mm. Multispectral MRI segmentation was processed with the SPM8 software package. The region-of-interest (ROI) masks encompass the frontal, temporal, parietal, occipital, limbic lobes 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 dividing the volumes of GM and WM by the whole brain volume (GM+WM+CSF) as a method for normalization. Diffusion tensor imaging analysis was performed by using DTI studio software. The quantification of the microstructural alternations for each region was acquired by averaging the FA, MD values within the ROI.

Results
In morphometric analysis, the volume fraction of whole brain parenchyma and global WM in NPSLE patients are significantly smaller than that of normal volunteer. Except the parietal lobe,
there is no significant change in volume fraction of GM between NPSLE patients and normal control. The FA of WM over the frontal, temporal, parietal, occipital, limbic lobes and sub-lobar region in NPSLE patients are significant lower than that of the normal volunteer, especially the parietal and occipital lobes (P<0.001). However, the NPSLE patients revealed that significantly increased MD is found in GM of limbic and temporal lobes, sub-lobar region, and WM of frontal, parietal and occipital lobes.

Conclusions
The brain atrophy in NPSLE patients is major due to volume reduction of WM. In NPSLE patients show decrease in FA of WM, this is not seen in GM. Those alternations express the different macro- and microstructural characteristics of WM and the correlation of cognitive function with neuropsychiatric symptom in NPSLE patients will be investigated.

P-27

MRI findings in Eastern Equine Encephalitis: The “Parenthesis” Sign

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Purpose
To describe distinct magnetic resonance imaging (MRI) findings in patients with eastern equine encephalitis (EEE) through two representative examples and review of the imaging literature.

Materials and Methods
We present two patients with EEE who were transferred to a tertiary referral center from outside hospitals. The first patient is an 87-year-old male with viral titers that returned positive for EEE who rapidly clinically declined and was pronounced dead on day 3 after transfer. The second patient, a 49-year-old male, presented with a 4-day history of "feeling unwell." Eastern equine encephalitis viral titers were found to be positive at an outside hospital. The patient's condition continued to worsen and he was pronounced dead 2 days after transfer. Both patients received gadolinium-enhanced MRI studies prior to their demise.

Results
In the first subject, MRI of the brain showed T2/FLAIR hyperintensity asymmetrically in the left temporal lobe and bilateral hippocampi, cerebral peduncles, midbrain, and brainstem. Linear areas of T2 hyperintensity also were seen in the external and internal capsules with relative sparing of the lentiform nuclei. There was no abnormal enhancement. The second patient's MRI demonstrated symmetric increased T2/FLAIR signal of the basal ganglia, thalami, insular cortex, and the central midbrain. In addition, as seen in the first subject, linear areas of increased T2 signal were seen in the internal and external capsules.

Conclusions
Single case reports of imaging findings in EEE exist in the literature with variable patterns of abnormality (1, 2, 3). We present two cases of EEE with distinct MRI findings. Both cases of EEE show the previously described predominance of T2/FLAIR hyperintensity in the basal ganglia and thalami as well as the less frequently mentioned linear hyperintensity of the external capsules (4, 5). Thus, we propose that this "( ) parentheses sign" on T2 or FLAIR imaging may, with some degree of specificity, distinguish EEE from other processes.
MRI-based Volumetric Analysis of Preoperative Growth Rates in Glioblastoma

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Purpose
To evaluate if the preoperative tumor growth rates of glioblastoma patients fit a linear model based on MRI-defined tumor volume. Linear radial growth is predicted by MRI-based mathematical models and used to define patient-specific metrics of response to therapy.

Materials and Methods
Twenty-four glioblastoma patients were identified retrospectively based on the following inclusion criteria, approved by the local IRB: histologic confirmation of GBM and at least 3 T1+contrast MRIs prior to surgical intervention. Tumor radius was computed by assuming a sphere of equivalent volume. As an alternative hypothesis, we compared an exponential growth model to the linear model. We examined interobserver variability and the effect of image resolution on tumor volume delineation. We recorded the use of steroids for each MRI data point.

Results
We observed an average coefficient of determination of 0.8717 with a standard deviation of 0.2226 for T1+contrast tumor volume growth rates. Interestingly, the exponential model provided a similar goodness of fit to the data. Four patients exhibited negative growth rates that was not directly attributable to steroid involvement between MRIs. Low resolution images were found to underestimate tumor radius by 1mm relative to the higher resolution images.

Conclusions
This is the first study, to our knowledge, to use three or more MRIs taken prior to surgical intervention to support the hypothesis that glioblastoma exhibits linear radial growth in the absence of therapy. Image resolution, steroid use, interobserver variability and alternative measures of tumor size were included as sources of uncertainty in our data. Although an exponential model was found to have a similar goodness of fit, linear radial growth is predicted by proliferation/invasion mathematical models and is used in patient-specific predictive metrics of response to therapy that are correlated with overall and progression-free survival.

NPH Post Shunt Improvement in Gait Metrics is correlated with Increased CSF Peak Flow Velocity

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Purpose

The relationship between cerebrospinal fluid peak flow velocity (CSF PV) through the cerebral aqueduct and gait performance is not characterized well in normal pressure hydrocephalus (NPH) patients who undergo ventriculoperitoneal shunting (VPS). Therefore, our goal was to establish this relationship and test the hypothesis that aqueductal PV is correlated with gait function in an NPH group.

Materials and Methods

Seven patients with idiopathic NPH who demonstrated gait improvement following spinal tap were studied retrospectively. Patients underwent MRI and gait evaluation [Functional Ambulation Performance (FAP) and Gait Time (GT) tests] before and after VPS. Aqueductal cross-sectional area (ACSA), PV, and total ventricular volume were obtained from semi-automatic segmentation of phase-contrast and magnetization-prepared rapid gradient-echo MRIs, while FAP and GT were obtained from neurological assessment. All mean changes pre- to post-VPS were tested using paired-sample t tests, and all correlations tested using Pearson's correlation coefficient.

Results

Mean PV increased 25% pre- to post-VPS (mean±standard deviation: 6.9±3.6 to 8.3±3.8 cm/s, \(p<0.01\)); ACSA decreased 24% (6.5±2.6 to 4.8±1.9 mm2, \(p<0.05\)), FAP increased 14% (73.3±15.9 to 82.1±13.3, \(p=0.05\)); total ventricular volume decreased 11% (140±27 to 124±25 cm3, \(p<0.01\)). GT decreased 14% (44.5±70.8 to 27.3±30.6 ms, \(p=0.3\)), but change was statistically insignificant. Mean PV increase strongly correlated with ACSA decrease (R=0.90, \(p<0.01\)), FAP increase (R=0.76, \(p<0.05\)), and GT decrease (R=0.91, \(p<0.01\)), as shown in Figure 1. Figure 1. Top (a): Pre- to post-shunt percent change in gait time versus absolute difference in peak flow velocity (PV; post-shunt – pre-shunt values) for each patient ("•"). Middle (b): Pre- to post-shunt percent change in Functional Ambulation Performance (FAP) score versus absolute difference in PV for each patient ("•"). Bottom (c): Pre- to post-shunt percent increase in peak flow velocity (PV) versus percent decrease in aqueductal cross-sectional area (ACSA) for each patient ("•").

Conclusions

Pre- to post-shunt increase in PV across all subjects, as shown in Figure 1c, is intriguing given evidence from prior studies. Moreover, increased PV's correlation with improved gait function necessitates further investigation with larger sample sizes in longitudinal studies. Along with the strong correlation between increased PV and decreased ACSA, these findings suggest a potentially complex and dynamic biophysical mechanism common to NPH patients following shunt placement. If future studies validate these initial findings, aqueductal PV could be used as a noninvasive biomarker of gait function that may improve NPH diagnosis.
Optimally-Discriminative Voxel-Based Analysis and High Angular Resolution Diffusion-Weighted Imaging Reveals Connectivity Abnormalities in Early Stage Lewy Body Spectrum Disease

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Purpose
The overarching goal is to examine the relationship of prodromal symptoms occurring prior to the onset of Lewy Body Spectrum Diseases (LBSD: Parkinson's disease, Parkinson's with dementia, Dementia with Lewy Bodies) with brain changes identified via multimodality imaging. Here, we use optimally discriminative voxel-based analysis to identify differences in fractional anisotropy (FA) in patients (N=12) with mild cognitive impairment of LBSD and Hahn & Yahr Stage ≤ II motor symptoms compared with healthy age-matched controls (N=5).

Materials and Methods
Fractional anisotropy maps were derived from whole brain high angular resolution diffusion-weighted imaging (HARDI) data. Comparisons were performed using optimally discriminative voxel-based analysis (1) following nonlinear registration to a group template (2). We used 2,000 permutations to derive statistical significance maps.

Results
We found decreased FA in mild cognitive impairment of LBSD patients relative to controls in the superior longitudinal fasciculus (SLF) (Figure 1A), corpus callosum (Figure 1B), pons (Figure 1C), cerebellum (Figure 1D) parieto-occipital white matter (Figure 1E), and uncinate fasciculus (UF) (Figure 1F). Significance is set at P <0.05 uncorrected. Decreases in FA have been reported in the pons, parietal occipital white matter, in the cerebellar hemispheres using constrained spherical deconvolution for tractography reconstructions (3), in the UF and SLF in Parkinson's with depression (4), UF and corpus callosum in apathy (5), pons in REM sleep disorder. In our current sample (N=25), patients were more likely to suffer depression (P=0.0003), apathy (P=0.0002) and REM sleep disorder (P = 0.048).

Conclusions
This is the first study to report the use of optimally discriminative voxel-based analysis and HARDI in the identification of connectivity abnormalities in LBSD. Results are consistent with the diffusion literature and the prodromal symptoms distinguishing LBSD patients from the controls in our sample. Results are uncorrected and should be interpreted with caution. Higher order analysis using Apparent Fibre Density is planned with a larger cohort size as recruitment progresses.
Qualitative Assessment of Psychological Comorbidities In Patients With Cutaneous Vascular Malformations and Anomalies

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Purpose
The quality of life of patients with cutaneous vascular malformations and anomalies (CMV-A) can be affected negatively by psychological comorbidities, which may be associated with noncompliance. Our purpose was to assess our distribution of various subtypes of CMV-A and qualitatively assess the psychological stressors along with their impact on compliance to treatment.

Materials and Methods
Retrospective analysis of psychological complaints and compliance to treatment of all patients with CMV-A assessed in neurointerventional clinic during period 2009-2014. Patient's demographics and lesion(s) characteristics were extracted. Psychological complaints related to anxiety, low mood, stress, fear of negative appearance and level of satisfaction with appearance were recorded. Compliance was defined as adherence to the treatment plan. No formal grading questionnaire was used. Fisher's exact test was used to identify the psychological complaints significantly associated with each vascular lesion and with lack of compliance.

Results
Among a total of 75 patients assessed, 49 (65.3%) were females, age range 2-78 years (mean 30.2). Venolymphatic malformations were the most common, n=46 (61.3%). Forty-seven (62.66%) patients had lesions on face and/or neck. All except one patient older than 7 (n=71, 94.6%) had a psychological complaint. These included fear of negative appearance (n=53, 70.6%), dissatisfaction with appearance (n=46, 61.3%), low self-esteem (n=35, 46.6%), anxiety (n=16, 21.3%), stress (n=13, 17.3%), bullying (n=5, 6.6%) and low mood (n=4, 5.3%). Fear of negative appearance (n=53, 70.6%) was more frequent in the 6-18 (n=15, 20%) and 18-50 (n=32, 42.6%) year age groups (p=0.009). Twenty-three (31%) patients were noncompliant. Patients with low self-esteem had a significantly higher rate of noncompliance 15 (20.2%, p=0.0381).

Conclusions
Our cohort of CVM-A revealed a majority of patients with low flow vascular malformations located in face and/or neck. We found a high prevalence of multiple psychological comorbidities and noncompliance. Low self-esteem was significantly associated with noncompliance.
Purpose

Use of proton MR spectroscopy (1H-MRS) in multiple sclerosis (MS) lesions is hindered by the fact that most lesions are under its >1cc spatial resolution, resulting in partial volume effects from neighboring tissue and cerebrospinal fluid (CSF). Here we apply an absolute quantification workflow with stringent partial volume correction to study <1cc lesions of early relapsing-remitting MS. The goals were to: 1) compare nonenhancing lesions to prelesional tissue in terms of N-acetylaspartate (NAA), creatine (Cr), choline (Cho) and myo-inositol (mI) concentrations; and 2) to test if lesional and prelesional metabolism correlates with T1 hypointensity.

Materials and Methods

Ten patients (32 months post-diagnosis) were scanned at 3T with 3D 1H-MRS (VOI 10×8×4.5=360 cc, TE/TR=35/1800 ms, 480 voxels, 0.75 cc each). Lesion masks were generated on FLAIR MRI and were coregistered to CSF, gray and white matter (GM, WM) masks. New FLAIR lesions appearing at a 6-month follow up were coregistered to the preceding timepoint, creating a "ghost" mask of the forthcoming lesion. The T1 hypointensity contrast ratio (CR) was calculated for each lesion or prelesional tissue. The 1H-MRS grid was voxel shifted to maximize region-of-interest (ROI) lesion content. Only ROIs with lesion content>40%, CSF<30% and GM<20% were analyzed. Their concentrations were obtained using phantom replacement after normalization for intravoxel lesion and CSF content.

Results

A statistically significant correlation between CR and metabolism was observed only for NAA (Figure 1). No correlations were observed, however, when prelesional tissue was excluded from the analysis. Prelesional tissue metabolism was significantly different from lesions only in NAA (p=0.002). N-acetylaspartate was lower, while Cho, Cr and mI were higher in lesions compared to these patients' average global WM values, reported in reference 1.

Conclusions

The metabolic profile of <1cc lesions in early disease is similar to what is reported for larger lesions and advanced MS. Prelesional tissue exhibited lesion-like metabolism for all glial markers, but in contrast, had higher NAA. These findings substantiate the view that glial activation is present prior to lesion formation and does not exacerbate thereafter. Active inflammation, however, brings about axonal injury, which persists in established lesions.
Recognition of Ophthalmic Artery Variants on CT Angiography (CTA)

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Purpose
Ophthalmic artery serves as an important collateral vascular pathway in patients with significant carotid vascular disease. Familiarity with the anatomy and variations of the ophthalmic artery also is important for assessing paraclinoid aneurysms and for planning middle meningeal and ophthalmic artery interventions. With the increased usage of CT angiography in the management of patients with suspected intracranial vascular lesions, ophthalmic artery variants should be identified and reported in order to facilitate patient diagnosis and management.

Materials and Methods
We utilized multiplanar CT angiography (CTA) and digital subtraction angiography (DSA) to delineate the normal course of the ophthalmic artery and its variants, and illustrate the embryological origins of several ophthalmic artery variants. CT angiography was performed after intravenous administration of 80 cc of Omnipaque 350 contrast on a 64-slice multidetector CT (MDCT) with 0.625 mm slice thickness followed by creation of 3D/MIP coronal and sagittal reformats.

Results
In this poster, we describe the CTA appearance of the following variants: 1. Origin of the ophthalmic artery from the middle meningeal artery (Figure 1: Small arrow - Ophthalmic artery, Large arrow - Middle meningeal artery). 2. Intradural origin of the ophthalmic artery from the supraclinoid ICA. 3. Low cavernous carotid origin of the ophthalmic artery (Figure 2: Small...
Variations in the relationship of the origin of the ophthalmic artery with the optic strut. The ophthalmic artery arises from the internal carotid artery at the point where it leaves the cavernous sinus in 83% of patients and courses through the optic canal (Hayreh et al). In 6.5% of cases, the origin is intradural but not more than 1 mm from the dural entry. In 7.5%, it arises within the cavernous sinus and in 2% within the dura itself. Variants include: 1. Ophthalmic artery origin from the middle meningeal artery: a. Ophthalmic artery arises from the middle meningeal artery and enters the orbit via the superior orbital fissure. b. Communicating branch between the ophthalmic and middle meningeal artery that may pass through the superior orbital fissure or through accessory foramina in the orbital wall lateral to the superior orbital fissure (Foramen of Hyrtl or meningo-orbital foramen). 2. Ophthalmic origin from the cavernous segment of ICA - from the inferolateral trunk (Remnant of the dorsal ophthalmic artery). 3. Origin of middle meningeal artery from the ophthalmic artery.

Conclusions
Recognition of anatomical variations of the ophthalmic artery can play an important role in the assessment and planning of interventions for paraclinoid aneurysms, middle meningeal artery embolizations for meningiomas or dural arteriovenous fistula, ophthalmic artery interventions including intra-ophthalmic chemotherapy for retinoblastoma and intra-ophthalmic thrombolysis for retinal artery thrombosis and assessment. Many variants of the ophthalmic artery can be detected on CT angiography and can help guide management decisions.
Relationship between NET Gene Polymorphism and Brain Volume in Major Depressive Disorder: A Voxel-Based MRI Study

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Purpose
The selective norepinephrine reuptake inhibitor is effective in the treatment of major depressive disorder (MDD), which suggests that there may be a relationship between MDD and the dysfunction of the norepinephrine transporter (NET). There are two NET polymorphisms, T-182C in the promoter region and G1287A in exon 9. We investigated the relationship between the brain volume and the polymorphism of the NET gene in MDD using a voxel-based morphometry (VBM) analysis.

Materials and Methods
Thirty patients with first-episode MDD and 48 healthy subjects (HS) matched for age and gender underwent 3D high-resolution T1-weighted images. All subjects were divided into 4 groups according to the polymorphism of either NET T-182C or NET G1287A genotypes (NET T-182C: TT or C-carriers, NET G1287A: GG or A-carriers) in both the MDD and HS groups. The genotype-diagnosis interaction effects on brain morphology were evaluated with VBM.

Results
The analysis of the genotype (NET G1287A)-diagnosis interaction demonstrated that the reduction of the left prefrontal cortex (PFC) volume between MDD and HS was significantly larger for GG individuals than for A-carrier individuals (FDR-corrected p < 0.05, T value = 4.29, MNI = [-15, 18, 56]). For the analysis of the NET T-182C genotype, there was no significant interaction effect in any brain regions.

Conclusions
In MDD patients, there was the relationship between the PFC volume and the polymorphism of NET G1287A gene. Because it is known that either too low or too high levels of norepinephrine impair the PFC function, the levels of norepinephrine, which is dependent on the polymorphism of G1287A gene, may affect the PFC volume in MDD.

P-35

Reliability of Estimating Enhancing Brain Tumor Volume Using a Widely Available Commercial Software Package

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Purpose
To determine medical imaging technologist (MIT) reliability when measuring enhancing tumor volumes (EHV) of proven glioblastoma multiforme (GBM) using semi-automated segmentation method on a commercial software platform (Philips IntelliSpace V6 – ISP6, Philips Healthcare). Volumetric measurements may be more sensitive in early detection of progression and poor response to treatment in GBM than linear measurement methods. Routine volumetric analysis of EHV is challenging due to software training needs and specialized skills development. A technique that is reliable and accessible via commercial software integrated into imaging practice is required. We recently introduced a 3D laboratory for postprocessing of images using ISP6. This pilot study assessed the outcome of this process to routinely provide EHV.
Materials and Methods
Contrast-enhanced 3D T1-weighted MPRAGE in 15 patients with proven GBM were studied. The ISP6 first generated the EHV with the final volume produced after manual correction by three MITs (M, D, A). They individually blindly assessed all tumors with one (M) performing the measurements twice. The tumor volumes ranged from 1.9 to 91.2 cubic centimeters. Intraclass correlation coefficient (Stata, StataCorp LP, Texas, USA) was used to measure the reliability between three MITs. The intra-observer agreement (M) was assessed using the Bland-Altman method (Stata, StataCorp LP, Texas, USA).

Results
The intraclass correlation coefficient for three MITs were 0.96 [95% CI (0.91 – 0.98)]. The bias (mean of differences) for the intra-observer agreement is 0.113 and the 95% confidence limits of agreement is -2.83 to +3.05 suggesting the differences are within three units.

Conclusions
This study suggested very high reliability between different MITs and also very good intra-observer agreement using this method. The intra-observer agreement is better with larger volume tumors than smaller ones. The study suggests that this method can be used routinely in clinical practice. Follow-up study using larger sample size is suggested to further evaluate this method, particularly with reference to the smaller volume tumors.

P-15

Resting State Functional Connectivity and Age Predict Individual Brain Tumor Patient Mortality

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Purpose
Resting state functional magnetic resonance imaging (rs-fMRI) is a powerful technique for studying whole brain neural connectivity and has significantly expanded our understanding of functional brain activity of normal and patient populations. Here rs-fMRI data and clinical measures from brain tumor patients are used in a machine learning analysis to predict mortality within 1.5 years after a brain scan.

Materials and Methods
Resting state fMRI scans from 70 brain tumor patients (36 M, mean age = 50.4 years, see Table 1) were acquired on GE MR750 3T scanners with a gradient echo EPI sequence. Data were preprocessed using AFNI (1) and FSL (2) which included slice-timing correction, motion correction, spatial normalization and smoothing. The resultant registration to standard MNI space was satisfactory. The subjects were new-onset brain tumor patients with no other malignancy. Patients were represented by their functional connectivity [measured using independent component analysis (ICA) derived functional network ROIs (3)] and demographic measures (age, gender), in a linear SVM classifier to predict mortality within 1.5 years. Prediction accuracy was estimated with leave-one-out cross-validation (LOOCV) on the entire dataset.

Results
Mortality classification was very successful, achieving 87% accuracy (p-value < 1×10-11) with a
linear SVM algorithm. Examining the weights of the classification model revealed the influential features or predictors of mortality to be: age, and connectivity of several networks (Figure 1).

Conclusions
Machine learning applied to rs-fMRI offers an appealing framework in which to develop and evaluate software tools for clinical tasks like predicting primary outcomes of tumor patients. This work shows that rs-fMRI provides a rich source of data that is useful in clinical applications, allowing successful single brain tumor patient mortality prediction.

Table 1. Brain tumor patient characteristics.

<table>
<thead>
<tr>
<th>Tumor Grade (if known)</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent 3yr. survival time</td>
<td>17 patients</td>
<td>7 patients</td>
<td>14 patients</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>71%</td>
<td>21%</td>
</tr>
</tbody>
</table>

Figure 1. The most influential predictors of mortality: connectivity of ROIs and age.

P-55

Shades of Grey: Quantifying the Threshold for Identification of Early Ischemic Changes in Acute Ischemic Stroke

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Purpose
The presence of early ischemic changes (EIC) on an acute stroke head CT is a relative contraindication for the administration of IV rtPA. The degree of hypodensity required to exclude a patient from treatment has not been quantified or standardized. We aim to develop a quantified method for determining the severity of EIC, which may lead to better patient selection in acute reperfusion therapies after stroke.

Materials and Methods
We identified acute ischemic stroke patients from a prospective stroke registry and excluded patients with brainstem stroke, onset to CT time > 12 hours, poor quality images, or lack of ischemia on either initial or follow-up scan. A board certified neuroradiologist selected a region of interest (ROI) and recorded Hounsfield Units (HU) in four areas for each CT scan: ischemic gray (IG), ischemic white (IW), nonischemic gray (NG), and nonischemic white matter (NW). Using contralateral nonischemic tissue as a reference, we calculated a HU ratio for each
permutation of ischemic versus contralateral nonischemic area. We then compared the HU ratios of IV rtPA-treated patients to those patients who were untreated due to significant early ischemic change.

Results
We identified 39 patients, 25 treated with IV rtPA and 14 who were untreated due to significant EIC. All patients had confirmed stroke on neuro-imaging. The groups had similar baseline characteristics except for a higher incidence of smoking (previous/passive/present) in the EIC group (p=0.013). The mean HU for areas of IG was significantly higher in the IV rtPA than EIC group (29.53 versus 25.02, p=0.023). The ratio of NG/IG was significantly different (EIC 1.56 versus IV rtPA 1.30, p=0.002), as was the ratio of NW/IG (EIC 1.13 versus IV rtPA 0.90, p=0.002). The coefficients of variation for the ratios ranged from 0.163 (NG/IG, EIC) to 0.331 (NW/IW, EIC).

Conclusions
The HU ratios of normal to ischemic tissue, particularly involving ischemic gray area, vary significantly between IV rtPA and EIC groups. In the future, calculating these ratios (and comparing to a set standard range) may help determine treatment for a patient. Limitations include small sample size, reliance on follow-up imaging to determine stroke location, and retrospective design. This study is ongoing, drawing data from a large prospective stroke database to identify the most predictive HU ratio for validation and testing as a decision making tool.

P-58

Simple penumbra map according to CBF grades based on CT perfusion in stroke patients due to the middle cerebral artery occlusion

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Purpose
To investigate if penumbra map according to cerebral blood flow (CBF) grades based on CT perfusion (CTP) was useful for distinguishing salvageable brain tissue from ischemic core in stroke patients due to the middle cerebral artery occlusion (MCAO).

Materials and Methods
Volume scanning (VS) with the area detector CT (ADCT) was performed with injecting nonionic contrast medium 40ml at a rate of 4mL/s in acute stroke patients with the MCAO. CT perfusion of the whole brain used 1 s single rotation intermittent dataset scans acquired at 80kVp. Color maps of CTP (Figure 1) were produced and time-density curve (TDC) (Figure 1) was generated in all voxels. According to the time to peak (TTP) and the peak value at that time, PV divided by TTP (PV/TTP) was calculated at all voxels and PV/TTP was regarded as possible CBF. Comparing the affected side (a) with the contralateral side (c) at symmetrical voxels, CBFa divided by CBFc was regarded as relative CBF (CBF%) (Figure 1). Additionally, CBF grade 1 was defined as CBF% of less than 0.2, grade 2 as CBF% of 0.2 or more and less than 0.6 and grade 3 as CBF% of 0.6 or more.

Results
Cerebral blood volume (CBV) or TTP map produced from standard CTP application was unable
to distinguish penumbra from ischemic core. Time to peak or MTT maps overestimated probable penumbra area, which was wider than real infarcts on day 3. In our penumbra map in the affected hemisphere, core was displayed in red and penumbra in yellow, which was compatible to real infarcts of CT scans on day 3 (Figures 2 and 3).

Conclusions
Simple penumbra map derived from PV/TTP was useful for showing ischemic core and penumbra.

CT angiography, CT perfusion and Time-density Curves from A

- Affected side pos: PVa/TTPa
- Contralateral side PVc/TTPc
- Relative CBF (CBFa / CBFc)

(Filename: TCT_P-58_Fig1CTPTDCCBF.jpg)
(Filename: TCT_P-58_Fig2noinfarct.jpg)
Siriraj Thai Language Paradigm for Functional MRI: A Pilot study in Normal Volunteers

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Purpose
To create a language paradigm in Thai for functional MRI (fMRI) study of Thai people.

Materials and Methods
Ten normal Thai native speakers with right handedness from Edinburgh's score underwent fMRI study by using created Thai version of language paradigm (SiTP1). The SiTP1 consisted of block paradigms of word generation (WG) from Thai letters, verb generation (VG) from nouns, naming pictures (NP), and sentence completion (SC). The fMRI studies were performed by using BOLD techniques under 3T MR machine. Individual and group analysis of the images from each paradigm was done by using SPM8 to get the activated areas and lateralization index (LI).

Results
There were five males and five females (22 to 37 years old). Eight of 10 were post-graduate students, one was a residential training fellow and the other one had grade 12 education. In group analysis from whole brain calculation, the LI from WG was left lateralized (LI = 0.7). The VG and SC paradigm gave ambiguous result (LI = 0.13 and -0.11 respectively), whereas the NP paradigm gave weakly right lateralization (LI = -0.26). When calculating frontal or parietal lobe, all paradigms gave strong left LI. Comparison of LI between frontal lobe and parietal, temporal or whole brain from each paradigm were significantly different (p<0.05). When analyzing activation in frontal lobe only, no significant difference was found between each paradigm except between VG and NP (p=0.016).

Conclusions
There was good lateralization of the signal from fMRI when using the created Thai paradigm. Regional calculation from frontal lobe gave the best result. The result supported possibility of using it as alternative tool to identify the dominant hemisphere in Thai patients.
Purpose
Primary intracranial neoplasms that invade the skull base are uncommon and not emphasized in literature. These tumors can be described based on their presenting location in the anterior,
middle or posterior cranial fossa. This distinction can guide surgical management and offers the greatest potential for complete tumor resection while minimizing morbidity from neurological injury.

Materials and Methods
We retrospectively review 10 cases of intracranial tumors that invade the skull base. All 10 patients underwent CT and MRI with and without intravenous contrast material administration. We present illustrative case examples of primary intracranial neoplasms that invade the skull base highlighting their location, extension and imaging features.

Results
Skull base invasion by primary intracranial tumors is based on their presenting location. The majority of these intracranial tumors are located near the skull base. In the anterior cranial fossa these include esthesioneuroblastoma, ganglioglioma and meningioma. In the middle cranial fossa these include pituitary adenoma, craniopharyngioma, meningioma and trigeminal schwannoma. In the posterior cranial fossa these include acoustic schwannoma, glomus tumor and endolymphatic sac tumor. Combination of CT and MRI findings is essential for evaluation of tumor characteristics and extent of bony involvement.

Conclusions
Primary intracranial neoplasms that invade the skull base are a rare entity. The diagnosis and surgical management of skull base lesions are a challenge due to their anatomical complexity. A thorough knowledge of their presenting location and imaging features will facilitate optimal surgical management.

P-05
Small invasive growth of contrast enhancing gliomas associate with seizure presentation


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Purpose
Patients with low grade gliomas commonly present with epileptic seizures. Although the biological mechanisms that underlie tumor-associated seizures are unclear, we hypothesize that tumors with invasive growth kinetic and small volumetric size is associated with seizure incidence at presentation. This association may explain why non-grade IV glioma patients are more likely to present with seizures.

Materials and Methods
A total of 353 patients with contrast enhancing gliomas WHO grade II (N=13), III (N=28), and IV (N=312) were studied. We incorporated diagnostic T1+contrast and T2/FLAIR MRIs into a mathematical growth model to calculate a ratio of migration (D, mm2/yr) and proliferation (ρ, 1/yr) rates of tumor growth. We examined the association between the relative invasiveness ratio (D/ρ, mm2), volumetric size from T1GD, location and seizure presentation.

Results
When stratifying patients by histologic grade, grade III seizure presenting (SP) patients exhibited
higher average D/ρ (p=0.012, t-test) than nonseizure presenting (NSP) patients. Grade III and grade IV SP patients exhibited volumetrically smaller sized tumors than (Grade III p = 0.012 t-test. Grade IV p < .0001, Mann-Whitney) NSP patients. When examining the association between seizure presentation and tumor location (temporal, parietal, and frontal lobes), smaller, more invasive tumors were associated with SP patients. This indicates small invasive growth was a characteristic found across different locations and grades.

Conclusions

The association of high D/ρ and small tumors with SP patients suggests that patients with an invasive growth pattern (high D/ρ) may be more likely to present with seizures than nodular tumors (low D/ρ). We interpret this association to imply that more infiltrative tumor growth is more likely to produce a seizure due to tumor cell invasion along white matter tracts. In contrast, nodular growth may predominately push against, rather than invade along white matter tracts, leading to less disruption of neuronal tracts and decreased seizure incidence.

P-61

Small Traumatic Subdural Hemorrhages: Is routine ICU admission necessary?

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Purpose

With advancing technology, the sensitivity of computed tomography (CT) for the detection of subdural hematoma (SDH) continues to improve. In some cases, the finding is limited to one or two images of the CT exam. At our institution, all patients with a SDH require intensive care unit (ICU) admission, regardless of size. In this report, we tested the hypothesis that patients with a relatively normal initial clinical exam and a finding of a small traumatic SDH in their presenting CT exam do not require the intensive monitoring offered in the ICU and can be managed on a normal hospital floor.

Materials and Methods

This is a retrospective study of patients evaluated and treated at a Level I Trauma Center for acute traumatic intracranial hemorrhage (ICH) between 2011-2014. The clinical and imaging profile of 97 patients with traumatic SDH were studied.

Results

Of the 97 patients, 26 (30%) underwent neurosurgical intervention, 26 (30%) had calvarial fractures, 47 (48%) had additional intracranial hemorrhages, 31 (32%) of the patients had significant co-morbidities and 10 (10.3%) of the patients expired. The size of SDH correlated with the presenting Glasgow Coma Scale (GCS) score, the length of time in the ICU, the number of repeat imaging, and the number of neurosurgical interventions. The size of SDH also correlated with degree of midline shift and basal cistern effacement.

Conclusions

While patients with larger traumatic SDH have significant morbidity and mortality, those with smaller SDH and higher GCS scores showed no evidence of decline during their hospital stay. These patients may not need to be admitted to the ICU on a routine basis. This change in management can have tremendous cost saving implications on patients and hospitals and decrease the number of unnecessary in-hospital consultations.
Susceptibility Etching: A Review of 9 Cases

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1Massachusetts General Hospital, Boston, MA, 2Massachusetts General Hospital, Harvard Medical School, Boston, MA

Purpose
"Susceptibility etching" consists of susceptibility effect, lining the supratentorial gray white junction with variable involvement of susceptibility effect in the posterior fossa, the corpus callosum, and the deep white matter. This "etching" corresponds to various coagulation abnormalities. The goal of this study is to evaluate "susceptibility etching" in its various imaging appearances and correlate it with coagulation abnormalities. 1. To illustrate the MR spectrum of "susceptibility etching" artifact in adults with coagulation abnormalities. 2. To discuss "susceptibility etching" distribution and location. 3. To review the typical clinical history, epidemiology, symptomatology, and prognosis in relation to "susceptibility etching."

Materials and Methods
We reviewed nine cases of patients with "susceptibility etching" and correlated this imaging finding with their coagulation profile values. We reviewed PT, PTT, fibrinogen values, D-dimer values, and platelet counts. We reviewed additional clinical parameters in the nine cases including clinical history, gender, clinical outcomes as well as cognitive and motor deficits. We catalogued "susceptibility etching" as well as involvement of susceptibility effect in additional locations in the brain, which were variable and included the deep white matter, cerebral cortices, posterior fossa and brainstem.

Results
Three of the patients passed away within a few days of the MR imaging demonstrating "susceptibility etching," one patient developed subcortical dementia and five patients were lost to long term follow up, of which three had various motor and memory problems at the time of imaging. Seven of the nine patients had variably reduced platelet count, ranging from mildly reduced to severely decreased (ranging from 36,000 platelets/mcL to 133,000 platelets/mcL) and all who were tested had a significantly elevated D-dimer (ranging from 957 mcg/L to >10,000 mcg/L). A strong correlation between "susceptibility etching" and coagulation abnormalities, specifically in relation to elevated D-dimer, was noted. The fibrinogen values also were variably elevated, likely due to fibrinogen's role as a marker as an acute phase reactant.

Conclusions
After a review of nine patients with "susceptibility etching," we found a correlation with coagulation abnormality. The location of "susceptibility etching" is intriguing and may provide insight to the pathophysiology of intravascular coagulopathy in the brain. The involvement of the gray white matter junction may relate to the sudden reduction of vascular caliber in this region (1). This "etching" effect may correspond to microvascular thromboemboli lodged into an area of sudden vascular caliber reduction, in the setting of coagulation abnormalities.
Susceptibility-weighted imaging and diffusion-weighted imaging findings in Central Nervous System Monomorphic Post-Transplant Lymphoproliferative Disorder

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Purpose
To evaluate advanced MRI features of monomorphic central nervous system post-transplant lymphoproliferative disorder (CNS PTLD).

Materials and Methods
IRB approval was obtained to perform a retrospective review of the brain MRI characteristics in patients with pathology proven CNS monomorphic PTLD. In particular, the presence and pattern of enhancement, presence of susceptibility effect, presence of vasogenic edema, and minimum ADC values within the lesions were evaluated.

Results
A total of six patients with available MRI exams were identified, including two with multiple lesions in the CNS, and four with single lesions in the CNS. The majority of the lesions were in a cerebral lobar subcortical distribution. Among the cases that received intravenous contrast, most lesions demonstrated peripheral enhancement, while a few demonstrated diffuse enhancement. All lesions contained areas of susceptibility effect that correspond to hemorrhage and associated vasogenic edema, which often was rather extensive. The lesions generally demonstrated restricted diffusion, ranging from 0.38 to 0.73 x 10^-3 mm^2/s.
Conclusions
The presence of cortical and subcortical lesions with heterogeneous enhancement, areas of restricted diffusion, and susceptibility effect may suggest the presence of CNS PTLD, in the appropriate clinical setting.

P-39 6:00AM - 3:00PM

The Effect of Contrast Leakage Correction on DSC Perfusion MRI in Predicting Angiographic Vascularity of Meningiomas

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Purpose
To investigate the effect of mathematic contrast leakage correction on dynamic susceptibility contrast-enhanced (DSC) perfusion MRI in predicting angiographic vascularity of meningioma. Materials and Methods
Consecutive 32 patients with meningiomas who had preoperative DSC PWI and catheter angiography were included retrospectively. Based on the degree of angiographic vascularity which classified with a 4-point grading scale, the meningiomas were dichotomized into high vascularity and low vascularity groups. Cerebral blood volume (CBV), leakage-corrected CBV and leakage coefficient K2 were measured in enhancing tumors and normal appearing white matter (NAWM). The CBV and corrected CBV were normalized by dividing the values in the enhancing tumors to those of NAWM. The correlation between angiographic vascularity and CBV or corrected CBV was assessed with the Spearman rank correlation coefficient. The CBV and corrected CBV of the two meningioma groups were compared with a two-sample t test. The diagnostic performance of CBV and corrected CBV in differentiating between high and low vascularity meningiomas was assessed with receiver operating characteristic (ROC) curve analysis.

Results
Angiographic vascularity correlated positively with CBV (Spearman's rho = 0.840; P <.001) and corrected CBV (Spearman's rho = 0.891; P <.001). The high vascularity meningiomas demonstrated significantly higher CBV and corrected CBV compared with low vascularity meningiomas. In differentiating between low vascularity and high vascularity meningiomas, the area under the curve was 0.964 for CBV, and was 0.991 for corrected CBV.

Conclusions
Dynamic susceptibility contrast-enhanced perfusion MRI can serve as a noninvasive, quantitative tool for assessing angiographic vascularity of meningiomas. Its diagnostic performance is slightly improved with mathematic leakage correction.

P-28 6:00AM - 3:00PM

The Effect of Hypoxia on Cerebral Arterial Calibre and Flow Velocity - An MRI Study
Purpose
It is believed that one of the processes responsible for maintaining oxygen delivery in high altitude climbers is an increase in cerebral arterial flow velocity. Cerebral arterial dilatation has long thought to play no part in maintaining cerebral oxygenation. Recent studies have disputed this theory and suggest that cerebral vasodilatation also contributes to the maintenance of oxygen delivery in hypoxic conditions. In addition, studying these cerebrovascular effects also might provide new insights into the pathophysiology of acute mountain sickness (AMS) and high altitude cerebral edema (HACE). The aims of this study were to document changes in middle cerebral artery (MCA) caliber, flow and calculated oxygen delivery in response to normobaric hypoxia over a 22-hour period.

Materials and Methods
Subjects (n=12) underwent 3T MRI scanning (GE HDxt, Milwaukee USA) at baseline (FiO2=21%) and at 2, 4, 6, 11 and 22 hours of continuous normobaric hypoxia (FiO2=12%, approximately equivalent to an altitude of 4,400m). A 3D time of flight MRA was performed to enable measurement of MCA cross-sectional area and diameter (Figure 1). A sagittal 2D-phase contrast MRA was performed to enable estimation of the MCA flow velocity (Figure 2). Arterial oxygen saturation (SaO2) was measured after each scanning session using a near infrared finger pulse oximetry probe. Blood samples were obtained at baseline, 11 and 22 hours to provide measurements of hemoglobin (Hb). Blood oxygen content was calculated as the product of the SaO2 and Hb. Middle cerebral artery flow was calculated as the product of the MCA area and flow velocity. Oxygen delivery was calculated as the product of the blood oxygen content and MCA flow velocity. Paired t-test was used to assess the significance of changes in the variables at each time point against the baseline. Significance was set at <0.05.

Results
Ten subjects completed the 22-hour study and two subjects dropped out due to symptoms after 11 hours. Middle cerebral artery flow and diameter trends are displayed in Figures 3 and 4, respectively. Mean MCA flow velocity significantly increased by 21.1% between baseline and 2 hours (47.5 cm/s to 57.5 cm/s, p<0.05) before gradually decreasing towards baseline levels. A similar trend was observed for mean MCA flow (4.5 ml/s at baseline and 5.5 ml/s at 2 hours, p<0.05). Mean MCA diameter appeared to increase between baseline and 6 hours by 3.9% (3.10mm to 3.22mm) before decreasing, although this rise was not statistically significant (p=0.09). Blood oxygen content decreased from 20.2 ml O2/dl blood at baseline to 18.3 ml O2/dl blood at 22 hours (p<0.001), whereas cerebral oxygen delivery did not alter over the 22 hours.
Conclusions
This study confirms findings from other studies that hypoxia causes an increase in MCA flow velocity. This in turn contributes to an increase in MCA flow, which maintains oxygen delivery despite a drop in blood oxygen content. It also was observed that the rise in MCA diameter approached significance. A repeat study with a larger number of subjects may lead to a reappraisal of the effects of MCA diameter on maintenance of cerebral oxygenation.

![Cross section used to obtain measurements](Fig 1: Orthogonal MPR of a 3D time of flight MRA used to measure MCA diameter and cross-sectional area)

![Segittal 2D MRA with region of interest circled the MCA (red) to estimate MCA R velocity](Fig 2: Segittal 2D MRA with region of interest encircling the MCA (red) to estimate MCA R velocity)

![Mean MCA Flow](Fig 3: Box plot (2.5-97.5 percentile) displaying the changes in MCA flow with time)

![MCA Diameter](Fig 4: Box plot (2.5-97.5 percentile) displaying the changes in MCA diameter with time)

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P-14

The Effect of Hypoxia on Resting-State Functional Connectivity in the Human Brain

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Purpose
It is believed that one of the processes responsible for maintaining cerebral oxygen delivery in subjects ascending to high altitude is an increase in cerebral flow. Despite maintaining oxygen delivery, many climbers are prone to developing acute mountain sickness (AMS) or high altitude cerebral edema (HACE), the mechanisms of which remain poorly understood. Symptoms can include headache and gastrointestinal symptoms, but also cognitive and behavioral changes. As there are changes in cerebral blood flow (CBF) in response to hypoxia, we postulate that this may result in changes in the brain's resting-state functional connectivity and, therefore, could be studied using the blood-oxygen level dependent (BOLD) contrast utilized by resting-state fMRI (rs-fMRI).

Materials and Methods
Subjects (n=12) underwent 3T MRI scanning (GE HDxt, Milwaukee USA) at baseline (FiO2=21%) and at 2, 4, 6, 11 and 22 hours of continuous normobaric hypoxia (FiO2=12%, approximately equivalent to an altitude of 4,400m). T1 FSPGR followed by BOLD fMRI sequences were acquired at rest. Imaging data were analyzed in FSL v5.05 using standard preprocessing, including motion correction smoothing, high-pass filtering, and affine registration. Dual regression was used to create per-subject, per-time point volumes that could be analyzed for longitudinal effects, using the 10 ICA-generated networks as described by Smith et al. Baseline volume was subtracted from each hypoxic time point, producing five volumes per subject. An F-test was computed to test for any nonzero hypoxic changes from baseline. Inference was performed with threshold-free cluster enhancement (TFCE). Family-wise-error corrected whole-brain TFCE inferences were obtained using a permutation test with 5000 permutations with further Bonferroni correction for considering 10 components. The Lake Louise questionnaire was used to assess for AMS.

Results
Ten subjects completed the 22-hour study while two subjects dropped out due to symptoms after 11 hours. Ten subjects, including the two early retirees, developed AMS at differing time points. Increased connectivity (p<0.05) due to hypoxia has been found in a small area within the medial occipital pole (Figure 1). These areas belong to the components that include maps 120 and 220 (as described by Smith et al). These maps correspond to medial, occipital pole, and lateral visual areas. The explicitly visual behavioral domains correspond most strongly to these maps, and paradigms cognition–language–orthography and cognition–space correspond to the occipital pole and lateral visual maps, respectively. Figure 2 shows the mean of hypoxic change with respect to baseline at different time points in the entire significant cluster.

Conclusions
A small area of significant increase in BOLD signal activity was demonstrated in response to hypoxia within the 'visual maps'. A global increase in connectivity on rs-fMRI to fully account for the cognitive and behavioral changes associated with AMS was not seen. These results may suggest that alternative pathophysiological processes contribute to these symptoms.
The Role of Cerebral Oedema in the Development of Acute Mountain Sickness - A MRI Study

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Purpose
Acute mountain sickness (AMS) of varying severity can develop in individuals following rapid ascent to high altitudes with low atmospheric oxygen levels, with the potentially fatal high altitude cerebral edema (HACE) developing at the extreme end of the spectrum. The precise mechanism by which AMS occurs currently is poorly understood. One of the proposed theories is that AMS may be due to an increase in intracranial pressure as a result of cerebral edema. Edema has been noted to be particularly prominent within the corpus callosum. However, the evidence for the association of cerebral edema and AMS (especially in the less severe end of the spectrum) is sparse. In light of these observations, we aimed to study the development of cerebral edema in response to normobaric hypoxia over a 22-hour period, and its association with AMS.

Materials and Methods
Subjects (n=12) underwent 3T MRI scanning (GE HDxt, Milwaukee USA) at baseline (FiO2=21%) and at 2, 4, 6, 11 and 22 hours of continuous normobaric hypoxia (FiO2=12%, approximately equivalent to an altitude of 4,400m). Diffusion-weighted images (B=0, B=1000) were acquired at each time point, from which apparent diffusion coefficient (ADC) maps were calculated to assess for edema. Region of interest measurements of ADC values were performed on the ADC maps in several areas of the brain white matter. The Lake Louise questionnaire was used to assess for AMS. Paired t-test was used to assess the significance of changes in the mean ADC value. Logistic regression with a single random intercept variable for subject was used to assess the association between the ADC values and the development of AMS. Significance was set at <0.05.

Results
Ten subjects completed the 22-hour study and two subjects dropped out due to symptoms after 11 hours. Ten subjects developed symptoms associated with AMS by 22 hours. Compared to the baseline, a significant increase in the ADC value was observed in the splenium of the corpus callosum (Figure 2) at 11 and 22 hours (20.3 x 10^-4 mm^2/s to 22.1 x 10^-4 mm^2/s and 21.9 x 10^-4 mm^2/s, respectively; p<0.01). Similarly, there was a significant rise in the ADC value from baseline in the genu of the corpus callosum (Figure 3) at 22 hours (16.9 x 10^-4 mm^2/s to 18.5 x 10^-4 mm^2/s, respectively; p<0.05). The increase in ADC values within the corpus callosum was noted to occur in all subjects. No significant changes in ADC values were observed elsewhere. No significant association between a rise in ADC value in the corpus callosum or AMS was observed.

Conclusions
This study suggests that exposure to normobaric hypoxia results in edema within the corpus callosum. This predilection for the corpus callosum also has been noted in previous studies. However, the rise in ADC value within the corpus callosum was independent of the presence of AMS. Although a repeat study with a larger number of subjects may be needed to detect significance in varying ADC values elsewhere within the brain, the findings also may suggest that alternative, parallel pathophysiological processes contribute to AMS.
Three-Dimensional Printed MRI-based Brain Molds and Individualized Tissue Sectioning Apparatuses Minimize Tissue Distortion and Slicing Error for Improved MRI-Histopathologic Co-Registration in Brain Cancer Patients

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Purpose
Precise coregistration of brain tissue and in vivo imaging is critical for validation of imaging biomarkers used to detect brain tumor invasion (1). Tissue distortion during fixation and slicing can complicate coregistration.
Materials and Methods
Three brain cancer patients who underwent brain-only autopsies were included in this analysis. To minimize tissue distortion, a clinically acquired MRI was used to generate 3D-printed molds for use during fixation. To obtain representative axial cuts, an individualized tissue sectioning apparatus (ITSA) was designed from a high resolution clinical scan and the slice profile of 6.5mm images (Figure 1). Using a layer resolution of 0.40mm, printing cost for the combination of the fixation mold and slicing ITSA was approximately $61 and printing duration was approximately 38 hours for the mold and 22 hours for the ITSA. After sectioning, the thickness of each slice was measured to assess consistency. Finally, coregistration error was assessed by coregistering photos of each slice to the corresponding MRI slice and measuring the distance between landmarks such as gyri and sulci in each image (2).

Results
Whole brain coregistration mean error in the x,y plane was 6.26mm for Subject 1, 8.12mm for Subject 2, and 8.16mm for Subject 3. Differences were highest at the dorsal and ventral poles of the brain, farthest from the center of the ITSA. There was increased error in the left hemisphere due to greater freedom for the knife to move at the top of each slot and significant disease progression between images.

Conclusions
We present a novel method for preserving the shape of a brain during fixation and for slicing it in the same orientation as clinically acquired in vivo imaging. We find that landmarks align well after slicing. 3D printed brain cages and slicing molds provide affordable means for preventing tissue distortion and precisely slicing brain tissue for coregistration with imaging acquired prior to death.
TOWARDS PRECISION NEUROIMAGING: STANDARDIZATION OF DTI OF A MULTICENTER TRAUMATIC BRAIN INJURY STUDY

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Purpose
Each year, an estimated 1.7 million Americans sustain traumatic brain injury (TBI), often resulting in devastating neurological disabilities. Transforming Research and Clinical Knowledge in TBI (TRACK-TBI) is an NIH-funded study that began in 2014 with the goal of enrolling 3000 patients at 11 sites to create a large, high quality database that integrates clinical, imaging, proteomic, genomic, and outcome biomarkers to establish more precise methods for TBI diagnosis and prognosis. Diffusion tensor imaging (DTI) has shown promise in prior single-center studies and a major objective of TRACK-TBI is to validate its utility. A critical need for a multicenter imaging study is to minimize the inter-site variability of quantitative biomarkers. To our knowledge, DTI standardization previously has not been attempted across this number of sites and across all three major MR vendor platforms. In this work, we present our approach to, and initial results from, harmonization of a high angular resolution 3T DTI protocol across 13 scanners at 11 academic medical centers using a novel diffusion phantom as well as a traveling human volunteer.

Materials and Methods
Diffusion MRI was acquired from a prototype 3D-printed isotropic diffusion phantom developed at the National Institute of Standards and Technology (NIST) and from the brain of a travelling volunteer on 13 3T MR scanners representing all three major vendors (4 GE, 2 Philips, and 7 Siemens) at 11 different sites using 8- or 12-channel head coils. The diffusion phantom was scanned at b=0, 500 and 900 s/mm² with 1.1mm in-plane resolution and 5mm slices, using three orthogonal directions. Human brain DTI was performed with b=1300 s/mm² in 64 directions at 2.7-mm isotropic resolution, with eight b0 volumes. Diffusion tensor imaging analysis was performed in FSL, including brain extraction, motion and eddy current correction and calculation of FA, MD, AD and RD. Tract-Based Spatial Statistics (TBSS) was used to register the white matter skeletons across scans. Means and the coefficient of variation (CoV) across scanners were calculated for each DTI metric from 15 major white matter tracts in the JHU DTI-81 atlas.

Results
For the NIST diffusion phantom, the CoV of MD across the 13 scanners was less than 3.5% for a range of diffusivities from 0.4-1.1x10-6 mm²/s. For the volunteer, the CoVs across scanners of the 4 DTI metrics, each averaged over the entire white matter skeleton, were all less than 5%. In individual white matter tracts, large central pathways such as the corpus callosum, the cingulum, corona radiata, and the superior longitudinal fasciculus also showed good reproducibility with the CoV consistently below 5%. However, other tracts showed more variability with the CoV of some DTI metrics ranging up to 10%.

Conclusions
Initial results suggest the feasibility of standardizing DTI across 3T scanners from all three major MR vendors in a large scale neuroimaging research study. Further technical development is needed to improve reproducibility in certain white matter tracts.
(Filename: TCT_P-63_PalaciosEM_PhonomResults.jpg)
DTI Global Metrics

![Bar charts showing DTI global metrics with CoV: 4.2% for FA, CoV: 3.4% for AD, CoV: 8 x 10^-4 for MD, and CoV: 6 x 10^-4 for RD.](Filename: TCT_P-63_PalaciosEM_HumanResults.jpg)
Transient MR-Angiography changes associated with morphological alterations in status epilepticus: a short case series.

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Purpose
Status epilepticus (SE) is a clinical entity characterized by one continuous, unremitting seizure lasting longer than 5 minutes, or recurrent seizures without regaining consciousness between seizures for greater than 5 minutes. In the peri-ictal phase MR may show sign of hyperperfusion in the seizure focus and adjacent areas.

Materials and Methods
We observed four patients affected by SE both in the post-ictal and in the delayed time with MR, diffusion-weighted MR imaging (DW MRI) and MR angiography (MRA) and we correlated imaging with EEG results to find possible impairments of cerebral circulation and correlate them with morphological alterations.

Results
In this case series on patients without previous records of epileptic seizures, MR was proved useful in the identification of transient DWI and FLAIR signal abnormalities suggestive for hyperperfusion, of the thalamic involvement in the seizure genesis or propagation and of the hippocampal sparing, as well as in the differential diagnosis with pathological conditions causing seizures. Delayed MR scans were diriment for the exclusion of cerebral damage due to cytotoxic edema. While MRA provided interesting diagnostic information, abnormalities consistent with hyperperfusion having been observed, in none of the patients a satisfying topographic match between MR and EEG for the localization of the epileptogenic focus was observed.

Conclusions
Further studies on larger samples and with different imaging techniques (e.g., perfusional MR or CT perfusion), could provide a more accurate relation between pre and postictal CBF modifications, its adequateness, and the implication of these data in the prognostic and therapeutic process of patients affected by epilepsy.

P-12
Use of Color-coded T1-weighted magnetic resonance plaque imaging for predicting distal embolism during carotid artery stenting

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Purpose
Distal embolism during carotid artery stenting (CAS) can sometimes result in serious ischemic complications. To prevent such complications, a sufficient understanding of carotid plaque histology before CAS is required. In this study, color-coded T1-weighted magnetic resonance
Plaque imaging with nongated spin echo (SE) method were used to calculate approximate volumes of carotid plaque components. Associations of these components with distal embolism during CAS then were assessed.

Materials and Methods

During the period from September 2011 to September 2014, T1-weighted MR plaque axial image with nongated SE method were obtained for 30 consecutive lesions that underwent CAS in our hospital. On the basis of T1-weighted MR plaque axial images, color-coded MR plaque images were constructed with proprietary software, and the approximate volume of each histological component (hemorrhage, lipid/necrosis, and fibrous) was calculated. Incidence of distal embolism during CAS was assessed by MR diffusion-weighted images (DWI) after CAS. Patients were classified as DWI-positive or -negative, and values for the hemorrhage component, lipid/necrosis component, vulnerable component (hemorrhage+lipid), and total plaque volume were compared between groups.

Results

Carotid artery stenting was performed using filter wire for distal protection in all cases. Seventeen (56.7%) lesions were classified as DWI-positive and 13 as DWI-negative. All 17 DWI-positive lesions were asymptomatic. Total plaque volume did not differ significantly between groups (p=0.06). The volumes of the hemorrhage and lipid/necrosis components were larger in the DWI-positive group (p=0.01 and 0.04, respectively), as was vulnerable plaque volume (p=0.03). The cutoff value for vulnerable plaque was 272 mm³ (AUC: 0.73).

Conclusions

Color-coded T1-weighted MR plaque imaging with nongated SE method was useful in understanding the condition of carotid plaque. Use of the color-coded MR plaque image to assess vulnerable plaque components allowed prediction of distal embolism during CAS.

P-19

Utility of Advanced Neuroimaging Techniques in Predicting Structural and Functional Integrity of Brain Tissue in Pseudoencephalocele in a Patient with Gorham’s Disease

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Purpose

To present a rare case of Gorham's disease affecting skull base bones causing left temporal pseudoencephalocele. To illustrate the value of rs-fMRI, DTI and MR perfusion in establishing the structural and functional integrity of the brain tissue in pseudoencephalocele.

Materials and Methods

High resolution T1-weighted spoiled gradient recalled echo (SPGR), diffusion tensor imaging (DTI), resting-state functional MR imaging (rs-fMRI) and dynamic susceptibility contrast (DSC) MR perfusion were acquired with a 3T Siemens Skyra magnet using clinically available sequences. The diffusion acquisition included 30 directions. Color coded, directional, fractional anisotropy maps were generated from DTI data and superimposed on the anatomical T1-weighted images (with Invivo, Dynasuite Neuro 3.0 workstation). The rs-fMRI was collected for 7 min with a TR of 2 sec. Preprocessing of the rs-fMRI included motion correction, regression of
the mean signal from normal appearing white matter and cerebrospinal fluid, band-pass filtering from frequencies 0.01-0.1, and smoothing with a 6mm fwhm gaussian kernal. A region of interest (ROI) was generated on the SPGR encompassing the inferior left temporal lobe which had herniated. The mean time series extracted from this ROI was used to generate a correlation map with all other voxels in the brain. Clusters of at least 35 continuous voxels with a p-value < 0.05x10^-5 were considered significant.

Results
The DTI suggested high anisotropy and craniocaudal white matter orientation (blue in Figure 1) in the herniated brain tissue. The rs-fMRI analysis found several regions showing functional connectivity with the displaced temporal pole. This included, most notably, the contralateral temporal pole (Figure 2). MR perfusion revealed preserved perfusion of the herniated brain and symmetric and normal perfusion of the rest of the left temporal lobe.

Conclusions
Advanced imaging including DTI and rs-fMRI suggest relatively preserved structural and functional connectivity of the herniated left temporal lobe.
Purpose
Digital subtraction angiography (DSA) is the best method of evaluating carotid cavernous fistulas. Digital subtraction angiography, however, has the disadvantage of being an invasive procedure. CT angiography (CTA) which is noninvasive, has been shown to provide more
information about the size and location of fistulas. This study compared CTA and DSA in elucidating the size and location of carotid cavernous sinus fistula before embolization.

Materials and Methods
We retrospectively reviewed the CT angiography image findings and DSA. Nine patients with carotid cavernous fistula (Direct and indirect CCF) were examined (six women, three men, age 31 – 96 years). All patients underwent pre and postcontrast-enhanced CTA and DSA. Interval between CTA and DSA ranged from 2 days to one week. CT angiography through the circle of Willis was performed (collimation 1mm, pitch 0.5; and index, 1mm, matrix 512x512, FOV 20x20cm). Two neuroradiologists rated detectability of the fistula tract as "good," "moderate," or "poor" in each axial, coronal, and sagittal source images. The χ² test was used to compare the imaging modalities with respect to their ability to detect fistula.

Results
CT angiography did not differ significantly from DSA as a whole. Source images of CTA proved useful in identifying fistulas before an invasive DSA study was undertaken. Axial and sagittal reformatted images were superior to coronal reformatted images to identify the fistula. However, differences in performance among reconstruction methods depended upon the segmental location and size of fistula along the internal carotid artery.

Conclusions
CT angiography source imaging has proved itself as useful as DSA for detecting CCFs.

P-52

Visualizing Tissue Structure with NODDI.

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Purpose
Advanced diffusion MRI models such as Neurite Orientation Dispersion and Density Imaging (NODDI) recently have been developed to overcome DTI limitations. NODDI provides multiple compartmental fractions for a richer description of tissue microstructural properties. In this work we present the use of a single color-coded map to represent the information derived with NODDI.

Materials and Methods
A two-shell NODDI protocol was implemented on 3T Siemens Skyra (30 directions at b=1000 s/mm² and 60 directions at b=2000 s/mm²) and 3T Philips Achieva (35 directions at b=711 s/mm² and 60 directions at b=3000 s/mm²) and applied to a group of multiple sclerosis patients and tumor patients (low and high grade gliomas), respectively. Diffusion datasets were fitted to the NODDI model in MATLAB. NODDI decomposes the signal of a voxel into three compartment: neurites, extra-neurite and isotropic Gaussian diffusion. We created a single RGB color-coding map of the three compartment model (red for extra-neurite, green for neurites, and
blue for isotropic Gaussian diffusion), in which the relative contributions of the different microstructural compartments could be appreciated easily.

Results
The NODDI Color Map provides a simple and effective way to visualize the relative weight of each compartment. In multiple sclerosis NODDI color map enables better visual assessment of the underlying microstructural changes in normal appearing white matter as well as within lesions. In brain tumors, the NODDI color map better illustrates the tumor extension and different components within apparently homogeneous lesions on FLAIR: cystic/necrotic and infiltrative tumor components correspond to areas of increase in isotropic (blue) and extra-neurite (red) diffusion components, respectively. The information added might help biopsy sampling and treatment planning.

Conclusions
NODDI color maps represent a feasible and useful way to visualize the information provided by NODDI analysis in a practical single image summarizing brain microstructural complexity in normal appearing white matter as well as in brain pathology.
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<th>FLAIR</th>
<th>NODDI color map</th>
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<td><strong>LOW GRADE GLIOMA</strong></td>
<td><img src="image1.jpg" alt="FLAIR Image" /></td>
<td><img src="image2.jpg" alt="NODDI Image" /></td>
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<tr>
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<td><img src="image4.jpg" alt="NODDI Image" /></td>
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P-08  6:00AM - 3:00PM

Volumetric Evaluation of the Thalamus in Patients with Lobe Temporal Epilepsy

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Purpose
Epilepsy is a chronic neurological disorder characterized by a predisposition to generate spontaneous seizures. It is a prevalent neurological disease that affects about 50 million people worldwide. In adults, the temporal lobe epilepsy (TLE) is the most common form of pharmacologically intractable epilepsy. The thalamus is a key brain structure in many neural circuits. In the literature, there is evidence that the thalamic region and the thalamus-temporal network may be altered in patients with TLE; however, still lack information related to the network and its possible changes. So, the aim of this study was to evaluate, using magnetic resonance imaging, the thalamic volume in patients with TLE and hippocampal sclerosis.

Materials and Methods
This is a retrospective study using magnetic resonance images obtained from a group of 64 patients, of whom 34 are women, 38 are lesion in the right hippocampus, and the mean age 40.91 (± 10.09). The control group consisted of 91 healthy volunteers (HV), 41 female, mean age equal to 41.37 years (± 17.33). T1-weighted images were segmented, and the thalamus volume was calculated using the FreeSurfer version 4.5 software. The groups were compared using Kruskal-Wallis test and the normalized volume.

Results
When compared ipsilateral normalized thalamus volume (median=0.46%) versus the contralateral (median=0.50%), right (median=0.48%) and left (median=0.50%) thalamus volumes of HV, we found a significant difference at p≤0.05 (p=0.04).

Conclusions
We found a significant volume reduction in ipsilateral thalamus that can indicate a possible damage. In futures studies, more information should be added using other quantitative techniques of magnetic resonance.

P-09  6:00AM - 3:00PM

White Matter choking sign and its variants in Characterization of Focal Cortical Dysplasia-Neuropathological correlation

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Purpose
To describe two new signs called "White Matter Choking Sign" and "White Matter Choking Extended sign" useful for diagnosis of focal core dysplasia (FCD).
Materials and Methods
One hundred sixty-five patients in age group of 6-44 years with refractory epilepsy, who underwent epilepsy surgery, were included in the retrospective study imaged using both TLE and ETLE (extra temporal lobe epilepsy) protocols on a 3T MRI system with a 3D T1, 3D T2, 3D T2 FLAIR for detection of occult dysplasia. The data were viewed and postprocessed to generate 3D corticographs of normal, abnormal areas and correlated with multimodal imaging (DTI, inter-ictal, ictal VEEG, ictal SPECT, inter-ictal FDG PET and pathology).

Results
Results: Three patterns emerged in our series of histopathologically proved FCD. The FCDS analyzed were as follows: 1B(56), IIA(33), IIB(27), III(39). 1. White Matter Choking sign. Sudden truncation or choking of subcortical white matter with blurring of interface (White Matter Choking sign) positively has correlated with Focal cortical dysplasia in 82%. 2. Cortical laminar architectural abnormality. 3. White Matter Choking Extended sign. WM choking sign underlying a cortical laminar architectural abnormality has positively correlated with type IB and Type IIA- 92%.

Conclusions
White Matter Choking sign and White Matter Choking Extended sign offer optimal sensitivity and specificity for MRI detection of FCD type I and IIA and characterization of FCD.
White Matter Choking Sign in Depth
Bottom of the Sulcus FCD
Purpose
There has been increasing interest in the role of imaging modalities to identify residual disease post-treatment in locally advanced head and neck cancer (LAHNC). Technetium 99m-ethylenedicysteine-deoxyglucose (99mTc-EC-DG) is a glucose analogue radiopharmaceutical imaged with SPECT. Based on the hypothesis that 99mTc-EC-DG is not incorporated by inflammatory cells and thus has the potential to differentiate between post-treatment inflammation and active residual cancer earlier than other imaging techniques, we performed a pilot study to evaluate the preliminary diagnostic accuracy of 99mTc-EC-DG at 4 weeks postchemoradiotherapy in patients with LAHNC.

Materials and Methods
Patients with LAHNC were imaged with 99mTc-EC-DG SPECT at baseline pretreatment and at 4 weeks after treatment completion. The gold standard for comparison was a composite measure of pathological, clinical, and radiologic responses up to 6 months post-treatment. Preliminary estimates of the sensitivity, specificity, positive predictive value, and negative predictive value of 99mTc-EC-DG for predicting treatment response at 4 weeks were obtained.

Results
Nine patients with LAHNC underwent imaging with 99mTc-EC-DG SPECT at baseline and at 4 weeks post-treatment. At 4 weeks post-treatment, five patients had no radiological evidence of disease, whereas four patients did not have significantly decreased uptake, indicative of residual disease. Among these five patients, all were free of disease after 10 weeks by gold standard assessments (true-negative). Among the four patients with uptake at 4 weeks, two were found to have disease at 10 weeks (true-positive), and two had no evidence of disease at 10 weeks (false-positive). Thus, 99mTc-EC-DG SPECT at 4 weeks had a sensitivity of 100.00% (95% CI: 19.3% to 100.00%), a specificity of 71.4% (95% CI: 29.3% to 95.5%), a positive predictive value of 50.0% (95% CI: 8.3% to 91.7%), and negative predictive value of 100.00% (95% CI: 48.0% to 100.00%).

Conclusions
The period of 4 to 12 weeks following chemoradiotherapy is the optimal period for surgical management of residual disease for patients with LAHNC. This "safe window" corresponds to the period between resolution of acute tissue injury and the onset of chronic tissue injury that
impairs wound healing. PET18-FDG has been used, but due to its uptake by inflammatory cells, its utility is limited before at least 10 weeks post-treatment. Therefore, early prediction of benefit from chemoradiotherapy in LAHNC is an unmet need. The results of this study suggest that imaging with 99mTc-EC-DG SPECT may fill this gap. Most impressive, at 4 weeks post-treatment, when inflammation and mucositis are common, six patients had no uptake by 99mTc-EC-DG SPECT, and were indeed found to not have residual negative. Nevertheless, further evaluation through a larger trial is necessary to confirm the clinical utility of 99mTc-EC-DG SPECT for predicting early response to chemoradiotherapy in patients with LAHNC.

P-74

Application of Dynamic Contrast Enhanced MR Imaging Parameters for Distinguishing between Squamous Cell Carcinomas and Malignant Lymphoma of the Oropharynx

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Purpose
The purpose of this study was to investigate the usefulness of histogram analysis of dynamic contrast-enhanced MR imaging (DCE MRI) parameters for the differentiation of squamous cell carcinoma (SCC) and malignant lymphoma of the oropharynx.

Materials and Methods
Pretreatment DCE MRI was performed in 21 patients with pathologically confirmed oropharyngeal SCC and six patients with malignant lymphoma. Dynamic contrast-enhanced MRI parameter maps including volume transfer constant (Ktrans), flux rate constant (kep), and extravascular extracellular volume fraction (ve) were obtained on the basis of the Tofts model. Enhancing tumors were segmented manually on each slice of parameter maps and data were collected to obtain a histogram for the entire tumor volume. The Wilcoxon signed rank test and receiver operating characteristic (ROC) analysis were used to compare histogram parameters of each DCE-derived variables between oropharyngeal SCC and malignant lymphoma.

Results
Histogram analysis of Ktrans and ve maps revealed that mean, median, mode, 10th and 90th percentile values of SCC were higher than those of malignant lymphoma. Among them, the median, mode, and 10th percentile value of Ktrans were significantly higher in SCC than in lymphoma (P = 0.013, 0.008, and 0.006, respectively), and the mode, skewness, and kurtosis of ve were significantly higher in SCC than in lymphoma (P = 0.023, 0.013, and 0.008). On ROC analysis, kurtosis of ve had the best discriminative value for distinguishing between oropharyngeal SCC and lymphoma (area under the curve, 0.865; cut-off value, 2.60; sensitivity, 83.3%; specificity, 90.5%).

Conclusions
Our preliminary evidence using histogram analysis of DCE parameters based on the whole tumor volume suggests that it might be useful to differentiate SCC from malignant lymphoma of the oropharynx.

P-71
Computed Tomography Dacryocystography: has the new era of lacrimal system evaluation arrived?

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Purpose
The aim of this study is to demonstrate the ability of CT to assess completely the lacrimal apparatus, both its membranous portion as the bone structure that involve.

Materials and Methods
We revised dacryocystography CT scans performed in our department, using multi-detector devices (16 and 64 channels). Patients of both sexes were included with wide age range (from 5 to 70 years). Some tests were performed after catheterization of the lacrimal ducts (similar to conventional dacryocystography), while others were performed with contrast instillation. We included postoperative evaluations, carried out to evaluate the permeability of dacryocystorhinostomy.

Results
The analysis of our cases allowed us to identify the presence of obstructions of the lacrimal system, high level obstruction (lacrimal ducts) in some cases, and low level obstruction (lacrimal sac and nasolacrimal duct) in others. We evaluated two patients in the postoperative period of dacryocystorhinostomy, one with patent ostium and another with recurrence of epiphora due to rhinostomy incompatible with the position of the lacrimal sac.

Conclusions
CT dacryocystography is a method to assess the lacrimal system in its entirety, with the same efficacy as conventional dacryocystography. It has a role in diagnosing the presence of lacrimal obstruction and in the characterization of the level of such obstruction. It is also an excellent method for postoperative evaluation and when facial lesions secondarily affect the lacrimal system. The use of low dose protocols will permit an even safer use of this technique.
Contrast-Enhanced MRI as a Predictive Imaging Tool in Squamous Cell Cancer of the Oropharynx and Oral Cavity: Results from the UCLA patient-based Pathology & Radiology Head and Neck Database (UPP&R HAND Study).

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Purpose
Human papilloma virus (HPV) positivity, expression of epidermal growth factor receptor (EGFR), and perineural invasion are prognostic factors for survival of patients with squamous cell cancers of the head and neck. However, determination of marker expression currently is reliant on invasive procedures such as tumor biopsy or excision. Using a cross-sectional pathology and imaging database we aimed to define imaging features that can noninvasively predict the presence of these molecular markers via contrast-enhanced magnetic resonance imaging (CE MRI) in a cohort of patients with squamous cell cancer of the oropharynx and oral cavity.

Materials and Methods
We established the UCLA patient-based Pathology & Radiology Head and Neck Database (UPP&R HAND) that comprises data on patient epidemiology, pathology, imaging, and outcome of all patients seen at the UCLA Johnson Comprehensive Cancer Center between 2007 and 2012.
with head and neck cancers. All pathological specimens were assessed blinded to the imaging results. All imaging studies were evaluated blinded to the findings of histopathology and genetic profiling. Binary logistic regression models were employed to screen for imaging predictors of HPV positivity and perineural invasion.

Results
Overall, 1045 patients had a diagnosis of head and neck cancer, of which 442 had a diagnosis of oropharyngeal or oral cavity squamous cell cancer. Of these, 80 patients (26 women, 54 men, median age 58 years, range: 21-79) had both pertinent imaging and pathology data. EGFR staining was positive in 100%, HPV staining was positive in 46%, and perineural invasion was present in 78%. Homogeneous contrast enhancement (Risk Ratio (RR): 24.6, 95% confidence interval (CI): 1.1-539.9, p=0.04) and T1 tumor signal (RR: 28.8, CI: 2.2-383.3, p=0.01) were both significant predictors of HPV positivity, while there was no significant association between T2 tumor heterogeneity and HPV status (p=0.29). Perineural invasion was associated significantly with the maximal tumor diameter in CE MRI (RR: 5.7, CI: 1.6-20.2, p=0.007), and with the lymph node N staging (RR: 0.6, CI: 0.3-1.0, p=0.05).

Conclusions
These results demonstrate an association between key pathologic features and CE MRI results in patients with squamous cell cancer of the oropharynx and oral cavity, indicating that CE MRI may serve as a noninvasive imaging tool to predict the presence of these molecular features in patients with head and neck cancers.

P-70

6:00AM - 3:00PM

Correlation of Contrast Enhanced MR Imaging and Intravenous Fluorescein Angiography Focusing on Retino-choroidal Enhancement on Contrast Enhanced FLAIR and T1-Weighted MRI

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Purpose
The purpose of our study is to correlate the retinochoroidal (RC) enhancement on contrast-enhanced FLAIR (CE FLAIR) and contrast-enhanced T1WI (CE T1WI) and findings of intravenous fluorescein angiography (IVFA) and to evaluate whether the RC enhancement on CE FLAIR and CE T1WI is consistent with the leak of fluorescein on IVFA that suggest retinal-blood barrier (RBB) breakdown.

Materials and Methods
From December 2010 to March 2013, MRI (CE-T1WI, CE-FLAIR) and IVFA were performed in 50 patients (mean age 61±15, M:F=33:17). Intravenous FA was performed to evaluate various eye diseases including nonproliferative diabetic retinopathy (NPDR, n=11), proliferative diabetic retinopathy (PDR, n=7). In all patients, CE FLAIR imaging was acquired as a last sequence and time delay after contrast injection was ranged as 7 - 8 minutes. One patient had an artificial eyeball, therefore, 99 eyes were evaluated. In our study, T1WI and CE FLAIR revealed two layers of eyeball as inner high and outer low signal intensity. We considered the layer with inner high signal intensity as RC layer and the layer with outer low signal intensity as sclera. We
evaluated RC enhancement on CE T1WI and CE FLAIR and subtraction image of FLAIR (FLAIR-Sub). A radiologist reviewed all MRI data and evaluated RC enhancement by visual and semiquantitative assessment with 8-steps calibrated color coding map by using image J. One ophthalmologist assessed IVFA and evaluated the location and source of fluorescent leak. The side and location of leak on IVFA was correlated with RC enhancement on CE T1WI, CE FLAIR and FLAIR-sub under the consensus between radiologist and ophthalmologist. We considered fluorescent leak on IVFA as gold standard, and we evaluated the sensitivity, specificity, PPV, NPV, and accuracy of CE T1WI, CE FLAIR, and FLAIR-Sub, respectively.

Results
Leak of fluorescent on IVFA was found in 22 eyeballs and RC enhancement was detected in 16 eyeballs on CE-FLAIR and seven eyeballs on CE T1WI. Most common sources for leak of fluorescent were neovascularity in RC layer. In most patients, CE FLAIR was superior to CE T1WI for detection and demonstration of RC enhancement corresponding to fluorescent leak. In eight cases of PDR, CE T1WI did not reveal RC enhancement, however, CE FLAIR revealed RC enhancement in seven eyeballs. In one negative case of PDR, MRI was performed 366 days before IVFA. There were several false positive MRI cases in that only CE FLAIR revealed RC enhancement not corresponding to leak on IVFA. Most of false positive MRI cases were NPDR (n=7). Sensitivity, specificity, PPV, NPV and accuracy were 73%, 87%, 59%, 89%, and 83% for CE FLAIR, 76%, 86%, 59%, 92%, and 83% for FLAIR-Sub, and 32%, 97%, 78%, 83%, and 83% for CE T1WI.

Conclusions
The RC enhancement on CE FLAIR was consistent with the leak of fluorescent on IVFA. CE FLAIR could detect 76% cases of RBB breakdown and was better than CE T1WI for detection of RBB disruption.
Correlations between T2-values and Clinical Symptoms in TMJ Disorder Patients

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¹Osaka University Graduate School of Dentistry, Suita, Osaka

Purpose

Previous research indicated that T2-values measured within the articular disk of the temporomandibular joint (TMJ) were significantly larger in patients than those in healthy volunteers. However, it is still unknown whether and how this finding relates to actual clinical symptoms in patients. The purpose of this study was to reveal any prospective association.

Materials and Methods

Twenty-nine patients with temporomandibular disorders were enrolled in this study. All subjects were examined using a 1.5T MR imaging scanner (Signa HDxt 1.5T; GE Healthcare, Milwaukee, Wisconsin) equipped with a TMJ surface coil. An 8-echo spin-echo sequence for measuring T2-values was performed using a closed mouth position, and T2-values of the articular disk and the retrodiscal tissue were measured using an independent workstation (Advantage Workstation, Version 4.4; GE Healthcare). We administered visual analog scale questionnaires (VAS) to patients in order to evaluate subjective pain experience in the TMJ region at rest, when the mouth was opened and/or closed, and while eating. Additionally, we assessed the degree of interference in daily life with 0 indicating "no pain" or "no interference" and 100 indicating "the worst pain possible" or "maximum interference". Patients subsequently were divided into four groups according to their VAS scores (0 group, 1-25 group, 26-50 group, or 51-100 group, respectively).

Results

The T2-values of the articular disk and the retrodiscal tissue in the two upper VAS groups (26-50 and 51-100) were significantly higher than those in the lowest VAS group for all mouth states both for subjective pain experience and the amount of interference in daily life.

Conclusions

We found a strong correlation between T2-values of the articular disk and the retrodiscal tissue of the TMJ and clinical symptoms in TMJ disorder patients. We propose that T2-values may prove to be a valuable clinical diagnostic in treating this disorder.
Purpose
To determine the role of dynamic contrast-enhanced (DCE) MRI in differentiating between carotid space paraganglioma and schwannoma.

Materials and Methods
We retrospectively reviewed records of patients with histologically verified carotid space tumors who had undergone DCE MRI between June 2008 and July 2014. The data were evaluated for tumor T2 signal characteristics and enhancement pattern. The dynamic data were analyzed for quantitative parameters using extended Toft’s model (Ktrans, Kep, Ve and Vp) and semiquantitative parameters based on time-intensity curve [AUC (area under curve), peak enhancement, wash-in, wash-out, SER (signal enhancement ratio) and TME (time for maximum enhancement)]. Only a qualitative data analysis was conducted due to the low sample size and exploratory nature of the study.

Results
Patients with a diagnosed paraganglioma (P group, n=2) and patients with a diagnosed schwannoma (S group, n=4) were included. All tumors were hyperintense on T2W imaging and show avid enhancement, but only one patient with paraganglioma had flow voids. The structural images appeared to be insufficient to confidently diagnose the tumor type. Patients in the P group had very high peak enhancement and a short TME, which was distinctly different from the other four tumors. The Ktrans and Ve values were nearly 0 in these cases. Peak enhancement, wash-in and wash-out were fast in paraganglioma, indicating high arterial and venous shunting.

Conclusions
Dynamic contrast-enhanced MRI potentially could be used to assist differentiating between carotid space paraganglioma and schwannoma. Both quantitative and semiquantitative (time intensity curve) parameters appeared to support its diagnosis but a larger study is needed to validate the preliminary results from this study.
P-77  
6:00AM - 3:00PM

Esthesioneuroblastoma: Re-evaluating the Paradigm of Intracranial Extension and Cyst Formation.

R Dumont Walter¹, J Arzeno¹, M Palma Diaz², W Hsu¹, A Sepahdari¹
¹Univ. of California, Los Angeles, Los Angeles, CA, ²UCLA Department of Pathology & Laboratory Medicine, Los Angeles, CA

Purpose
Esthesioneuroblastoma is an uncommon malignant neuroectodermal tumor arising from the nasal cavity. Classic teaching regarding imaging characteristics of these lesions includes the formation of cysts at margin of the brain-tumor interface, although the true prevalence of this finding is controversial.

Materials and Methods
We assessed the prevalence of esthesioneuroblastoma using the UCLA patient-based Pathology & Radiology Head and Neck Database (UPP&R HAND). UPP&R HAND comprises data on patient epidemiology, pathology, imaging, and outcome of all consecutive patients seen at the UCLA Johnson Comprehensive Cancer Center between 2000 and 2013 with head and neck cancers. All pathological specimens were assessed blinded to the imaging results; all imaging studies were evaluated blinded to the findings of histopathology. Binary logistic regression models were employed to assess imaging predictors of intracranial tumor extension.

Results
Thirty-one esthesioneuroblastoma patients (13 women, 18 men, median age: 55 years, range: 12 - 79 years) had both pertinent imaging and pathology data. Eighteen patients (58.1%) had evidence of intracranial extension. Only four of these 18 patients (22.0%) demonstrated cyst formation at the brain-tumor interface. Hyam tumor grades were reported for 16 patients. Twenty-eight patients were still alive (80.0%) at the time of analysis; the three patients that died all had intracranial extension and intermediate grade tumors (Hyam grade II/III). There was a trend toward higher tumor grade with the presence of intracranial extension (Odds Ratio: 9.6, 95% confidence interval: 0.75 - 123.5, p = 0.08). The intracranial portion of tumors with cysts measured significantly larger than those without cysts (mean ± SD: 33.5 mm ± 10.6 versus 10.9 mm ± 7.8, p=0.0003).

Conclusions
To our knowledge, this is the largest reported esthesioneuroblastoma patient cohort including both imaging and corresponding pathology data. The results from this cohort suggest that cyst formation at the brain-tumor interface is an uncommon imaging finding in patients with esthesioneuroblastoma. We observed a trend toward significance between higher tumor grade and the presence of intracranial extension. The relationship between tumor size and apparent cyst formation suggests a possible mechanism of cerebrospinal fluid trapping as the cause of this radiological sign.

P-72  
6:00AM - 3:00PM
Purpose
To investigate differences in dynamic contrast-enhanced (DCE) MRI parameters according to the status of HPV and EGFR biomarkers in patients with oral cavity and oropharyngeal SCC by histogram analysis.

Materials and Methods
We retrospectively analyzed pretreatment DCE MRI performed in a total of 22 consecutive patients with oral cavity and oropharyngeal SCC, and parameter maps of Ktrans, Kep, and ve were obtained. The histogram parameters of Ktrans, Kep, and ve were calculated from the entire enhancing tumor volume, and compared between the subgroups based on HPV and EGFR biomarker status.

Results
The cumulative histogram parameters of Ktrans and Kep showed lower values in the HPV-negative and EGFR overexpression group than in the HPV-positive and EGFR-negative group, which was statistically significant for the mean (P = 0.009), 25th, 50th, and 75th percentile values of Ktrans and the 25th percentile value of Kep according to HPV status, in addition to the mean value of Ktrans (P = 0.047) and Kep (P = 0.004) according EGFR status. No significant difference in ve was found according to HPV and EGFR status.

Conclusions
Dynamic contrast-enhanced MRI is useful for the assessment of tumor microenvironment associated with HPV and EGFR biomarkers before treatment in oral cavity and oropharyngeal SCC patients.

P-73

MRI Predictiability of The Presence of Pathologic Nodal Disease in Squamous Cancer of The Head and Neck.

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\textsuperscript{1}Queen's University, Kingston, Ontario

Purpose
MR imaging (MRI) in patients with head and neck cancer may trigger surgery that is associated with a significant morbidity. We report predictability of MRI in adequately diagnosing pathologic lymph nodes at our center.

Materials and Methods
Twenty-four patients were identified between Jan 2011 and Dec 2013 for a chart review. Eligible patients had a squamous cell carcinoma, underwent neck surgery within 100 days of the MRI scan.
Results
Twenty-one out of 24 patients were male with median age of 63 years. Primary sites included oral cavity and oropharynx (58%), skin and unknown primary (26%), larynx and nasopharynx (16%). Fifty-four percent had a new diagnosis. MR imaging stated necrosis in 88% and extracapsular extension (ECE) in 8%. Seventy-one percent of MRI studies suggested positive nodal disease, 8% were equivocal and 21% negative. Eighty-seven percent underwent neck dissection (70% ipsilateral, 17% bilateral). Thirteen percent had biopsy. Fifty percent of patients had pathologically positive (P+) lymph nodes (LN). Median number of LN was 10 and P+ LN ranged from 1 to 7. Extracapsular extension was stated in 67% of MRI studies and number in 21. The specificity of MRI neck for detecting P+ LN was 58%, whereas sensitivity was 100%. Thirty-nine percent of MRI studies had an accurate estimate of the number of P+ nodes. Forty-eight percent overestimated the number.

Conclusions
MR imaging is highly sensitive in predicting pathological nodal disease with a moderate level of specificity. MR imaging may overestimate the number of positive nodes. Extracapsular extension and necrosis correlate well with pathology. There is a likely role of standardized pathology and radiology reporting.

P-66

Residual Cervical Thymus: A Normal CT Finding That May Be Present Throughout Patients' Lives

A Prabhu1, H Kale1, B Branstetter1

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Purpose
Although the thymus is centered in the mediastinum, there is often a cervical component that can be seen in children and young adults. The frequency of radiologically evident residual cervical thymus in older adults is not known. The purpose of our study was to determine the proportion of adults that have residual cervical thymus visible on contrast-enhanced neck CT.

Materials and Methods
We retrospectively identified 700 patients who had undergone contrast-enhanced CT scans between February 2013 and August 2013. We categorized the patients by decade of life and calculated the proportion in whom residual cervical thymic tissue could be detected. Location of the tissue focus, greatest axial diameter, and distance above the manubrium were recorded. A multivariate model was used to determine whether age or sex predicted likelihood of identifiable cervical thymus, size of residual thymus, or distance of residual thymus above the sternum.

Results
Of the 700 patients, 157 (22.4%) had residual cervical thymus. The mean (±SD) distance of the residual thymus extension above the manubrium was 13.4 mm ± 7.26. The mean size of the residual cervical thymus was 12.5 mm ± 4.11. The frequency of residual thymus decreased exponentially with age (Figure 1). There was a statistically significant relationship between age and size of residual cervical thymus (p = 0.02). Most of the cervical thymic tissue was found in the left paratracheal region.
Conclusions

Residual cervical thymus may be present at any age, although the frequency decreases with increasing age.

![Graph demonstrating the relationship between age decade and presence of cervical thymus on CT. Circular markers are raw data. Dark line is best-fit logistic regression. Thin lines are 95% confidence intervals. Third decade of life indicates patients aged 20-29.](TCT_P-66_Figure1_abstractrevised.gif)

Retrospective Review of Anatomical Considerations in Dacryocystorhinostomy

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\(^1\)University of California, Davis, Sacramento, CA, \(^2\)University of California Davis Medical Center, Sacramento, CA

Purpose

Dacryocystorhinostomy (DCR) is a common procedure for the treatment of nasolacrimal duct obstruction by creating a fistula between the lacrimal fossa (sac) and middle meatus with reported failure rate between 5-10%. Anatomical variation surrounding the nasolacrimal fossa and scarring from adjacent structures (e.g., middle turbinate) postoperatively has been implicated in the failure rate. The relationship of the middle turbinate to the nasolacrimal fossa is unknown in the normal population. The purpose of this study is to determine the prevalence and a
reproducible method to measure the overlap between the middle turbinate and nasolacrimal fossa.

Materials and Methods
Retrospective review of 50 normal sinus CTs by two independent reviewers measured the AP dimension of the nasolacrimal fossa and its overlap with the ipsilateral middle turbinate (reformatted axial plane parallels to the mid orbits) at the inferior margin of the nasolacrimal fossa.

Results
Fifty patients (30 female and 20 male, mean age 46.9 years) were included. Eighty-two percent (41 out of 50) patients had overlap of the lacrimal fossa with the middle turbinate. Average nasolacrimal size was 6.1 ± 1.1 mm right and 6.1 ± 1.0 mm left. Overlap was 2.2 ± 2.9 mm right and 2.0 ± 2.7 mm left. Concordance between the two independent readers was very high, yielding chi-squared of >0.99 for each variable.

Conclusions
The prevalence of the lacrimal fossa (sac) and middle turbinate overlap is common amongst the normal population however with wide variability. The degree of overlap is currently not characterized preoperatively and may be an important risk factor for failure to investigated. We offer a simple and reproducible metric for future prospective studies evaluating causes of DCR failures and possible preoperative imaging.
Temporomandibular joint magnetic resonance evaluation before and after osteotomy in patients with mandibular laterognathism

A Wolosker¹, M Pereira², H Yamashita², L de Abreu Junior³, K Nishiyama², M Borri⁴
¹MD, PhD-Sao Luiz Hospital-Fleury Group- Federal University of Sao Paulo, Brazil, Sao Paulo, Brazil, ²Federal University of Sao Paulo, Sao Paulo, Brazil, ³Fleury Group, Sao Paulo, Brazil, ⁴Sao Luiz Hospital-Fleury Group-Federal University of Sao Paulo, Brazil, São Paulo, Brazil

Purpose
The objective of this study was to evaluate internal derangement signs of temporomandibular joint using magnetic resonance imaging (MRI), before and after sagittal split osteotomy in patients with mandibular asymmetry.
Materials and Methods
The experimental study consisted in temporomandibular joint (TMJ) MRI evaluation of 20 patients, with mandibular asymmetry who underwent orthognathic surgery (saggital split osteotomy). The study was made before and after surgery. We also evaluate two clinical parameters: pain and joint sounds (clicking/crackle). The images were analyzed by two radiologists, in consensus, and McNemar test and marginal homogeneity test were applied to compare the findings.

Results
Bone changes (p=0.450), disc displacement (p=0.155) and joint effusion (p=0.773), showed no statistical difference before and after surgery. However, the mandibular excursion demonstrated improvement statistically significant (p=0.04) after surgery. Pain decreased after surgery (five patients reported pain before surgery and none after surgery). The joint sounds showed statistically significant improvement (p=0.004): it was present in 12 TMJ (33.3%) before surgery and in 4 TMJ (11.1%) after surgery.

Conclusions
This study suggests that there was no statistically significant differences in TMJs evaluated by MRI in patients with mandibular laterognathism before and after surgery. However, there was improvement in the mandibular excursion, joint sounds and pain, after surgery.
Figura 2: MRI of TMJ shows anteriorly displaced disk.
Figura 1: MRI of TMJ with cortical thinning
The Utilization of Dual Energy CT in the Differentiation between Inspissated Sinus Secretions and Fungal Infection

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\textsuperscript{1}Vancouver General Hospital, Vancouver, British Columbia, \textsuperscript{2}Vancouver General Hospital, Vancouver, AK
Purpose
To evaluate the potential of dual energy CT in the differentiation between inspissated sinus secretions and fungal infection.

Materials and Methods
Surgical samples were acquired directly from theatre and imaged ex vivo using dual energy CT. Samples were received and imaged according to their clinical priority. Dual energy CT characteristics were assessed on MMWP workstations. Hounsfield units, monoenergetic spectra and dual energy index (DEI) values were assessed for each sample. Preliminary studies were performed on six samples.

Results
Results demonstrated that significant differences exist between the DEI values of sinus secretions (range -0.00132 to 0.000543) inspissated secretions (-0.00267) and fungal mycetoma (0.0152). In particular the difference between fungal mycetoma and inspissated secretions is important with both diagnostic and therapeutic implications.

Conclusions
Dual energy CT demonstrates important differences between fungal mycetoma and inspissated secretions. This warrants further investigation to clearly delinate useful parameters for clinical integration into decision making and patient care.

Monday
6:00AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exposition Hall A (Level 1)

Scientific Poster-Print - Interventional (P)
P-82

Angiographic Anatomy and Targeted Surgical Dissection Technique of Swine Rete Mirabile

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¹The University of Chicago, Chicago, IL, ²Univeristy of Chicago, Chicago, IL

Purpose
Swine rete mirabile has been a very popular experimental target for the preclinical evaluation of liquid embolic agents due to its complex vascular network assimilates nidus of arteriovenous malformation. Thus, angiographic and histopathologic findings of acute and chronic responses to various embolic agents have been established relatively well. However, as far as authors know, the detailed descriptions on its angiographic anatomy and targeted surgical dissection technique for the safe and easy harvest of swine rete mirabile have not been reported. We have described angiographic anatomy of swine arch vessels and focused dissection technique for the safe uninjured recovery of swine rete mirabile.

Materials and Methods
Fourteen Domestic (200-250 lbs) Swine were enrolled in this study. Angiographies were performed under general anesthesia. 5F Berenstein catheter was used for obtaining angiography
and 014 Microcatheter was used to obtain super selective angiography. Surgical dissection of skull base to obtain rete mirabile was performed after euthanatized animals.

Results
Angiography was obtained in all animals and interpreted. All animals show rete mirabile supplied by ascending pharyngeal artery. Rostral to rete, bilateral ACAs, MCAs and basilar system were all identified. Communication channels between rete and external ophthalmic branch of the internal maxillary artery through the orbital fissure (arteria anastomotica of Daniel, dawes and Prichard) as well as ramus anastomoticus also were demonstrated. Surgical dissection technique has been modified during the project to streamline harvesting the rete. Our currently established technique is decapitate swine head through the plane of occiput and C1 vertebral body, then approach via ventrally to remove tongue and oropharynx, then dissect through posterior pharyngeal wall identifying bilateral tympanic bullae and basisphenoid bone, then carefully remove basisphenoid bone about one and half inch above the rostal end of the tympanic bullae to fully expose the rete. We found there is no necessity to dislocate or remove mandible or nasopharynx for the targeted surgical dissection of the Swine rete.

Conclusions
We have described angiographic anatomy of Swine carotid arteries and rete mirabile as well as targeted surgical dissection technique for its safe unharmed recovery.

P-83 6:00AM - 3:00PM
Clinical Presentation and Outcomes of Indirect Carotid Cavernous Fistulas: A Single Center Experience

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\textsuperscript{1}University of Michigan Medical Center, Ann Arbor, MI

Purpose
To present our experience with the presentation, endovascular therapy, and outcomes of patients with indirect carotid cavernous fistulas.

Materials and Methods
We retrospectively reviewed the clinical and operative records, imaging, and postoperative course of patients with indirect carotid cavernous fistulas.

Results
In total, 34 patient cases were identified. There were 11 males and 23 female. The average age was 64 years. Thirty-two of 34 patients (94\%) presented with eye redness/proptosis, 22/34 (65\%) presented with changes in vision, and 1/34 (3\%) presented with intracranial hemorrhage. Six of 34 patients (18\%) had lesions with cortical venous reflux (CVR) and 28/34 (82\%) had lesions without CVR. A higher proportion of patients with CVR had no significant past medical history (50\% versus 14\%) and presented with intracranial hemorrhage (17\% versus 0\%). A higher proportion of patients without CVR had a history of diabetes (21\% versus 0\%), hypertension (64\% versus 17\%), and presented with eye redness/proptosis (100\% versus 67\%). Endovascular treatment was used in 29/34 cases with a total number of 31 procedures. Follow up was available in 28/29 patients who were treated with endovascular therapy. All treated cases with CVR (5/5) either had complete angiographic obliteration of their fistula or cure of CVR immediately after their final procedure and at an average follow up of 7.7 months. Twenty-two of 23 patients
(96%) without CVR had improved or cured symptoms at an average follow up of 41.3 months. One of 23 (4%) patients had incomplete therapy and their symptoms worsened over time. There was a significant neurologic complication in 1/31 procedures (3%).

Conclusions
Indirect carotid cavernous fistulas most commonly present with eye redness, proptosis, and visual changes. Patients having lesions with CVR may be less likely to have a characteristic clinical presentation and medical comorbidities. Endovascular therapy has a high success rate in curing CVR and improving patient symptoms while having low rates of significant neurologic complications.

P-86

Malignant CTA Profile is Highly Predictive of Death or Disability in Patients Undergoing Endovascular Therapy for Acute Ischemic Stroke

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¹Christiana Care Health System, Newark, DE

Purpose
Triage of patients with acute ischemic stroke to endovascular therapy remains challenging. To date, there are no published randomized controlled studies that prove benefit of mechanical thrombectomy over intravenous tissue plasminogen factor (IV tPA) alone. Futile recannulation represents a subset of acute ischemic stroke patients that have already infarcted the distal territory and will have no benefit (and potentially harm) by revascularization. The purpose of this study was to determine if CT collaterals could identify this subset prospectively and, thereby, avoid an invasive and costly procedure.

Materials and Methods
In this poster we present Alberta Stroke Program Early CT Scores (ASPECTS), CT collateral scores and 90 day clinical outcomes for all patients that underwent mechanical thrombectomy for acute ischemic stroke [secondary to middle cerebral artery (MCA) occlusion] during a 2-year period at a large stroke center. Patients had a mean National Institute of Health (NIH) Stroke Score of 17.9, and were either not eligible for IV tPA or did not have significant clinical improvement after administration of IV tPA. Collateral scores were determined using 20 mm MIP reconstructions, independently reviewed and then a single CTA collateral grade agreed upon by two CAQ neuroradiologists. We then compared the nonmalignant and malignant CTA groups in terms of modified Rankin Score (mRS) at 90 days.

Results
Sixty-two patients were analyzed in this study and 6.5% of the patients presented with a malignant pattern on CTA. A poor functional outcome, defined as a mRS of five or six, was noted in 100% of patients with a malignant pattern on CTA. Given the small sample size this did not meet statistical significance. No clinical significance was noted in the other subgroups CTA collateral grades.

Conclusions
One hundred percent of patients with a malignant CTA collateral pattern with acute MCA occlusion had mRS of five or six at 90 days. Although we have a small sample, this study
suggests patients presenting with a malignant pattern on CT angiography should be considered carefully prior to endovascular therapy.

**P-84**

6:00AM - 3:00PM

**Mechanical thrombectomy with Solitaire stent and forced arterial suction thrombectomy (FAST) with Penumbra reperfusion catheter: Which device is fast and effective?**

M Rho¹, C Han¹, E Chung¹, H Hong¹

¹Kangbuk Samsung Hospital, Sungkunkwan University School of Medicine, Seoul, Korea, Republic of

**Purpose**

Mechanical thrombectomy with many devices has improved recanalization rates when compared to clot disruption with a wire and microcatheter alone. Among the many devices, the Solitaire stent retriever and forced arterial suction thrombectomy (FAST) with Penumbra reperfusion catheter were introduced recently. The aim of this study was to compare our immediate recanalization rates with these two available mechanical devices and switch technique of these devices.

**Materials and Methods**

A retrospective review from March 2010 to September 2014 was performed on patients who underwent mechanical thrombectomy for large vessel occlusion. Cases where IATPA and/or balloon angioplasty and/or stenting performed without mechanical thrombectomy were excluded from the study. Recanalization rates were assessed immediately postprocedure by follow-up angiography. TIMI and TICI scores were used to quantify the extent of recanalization and the residual clot burden.

**Results**

Seventy procedures were performed on 68 patients using Solitaire-FR (SOL):44 and FAST:26. Thirteen cases underwent thrombectomy using both FAST and Solitaire devices. The M:F ratio was 1:1.06. The most common vascular territory involved was the M1 of middle cerebral artery (MCA) 45.7% (32/70) followed by internal carotid artery (ICA) 27.1% (19/70), basilar top and posterior cerebral artery 15.7% (11/70), M2 of MCA 5.7% (4/70), ICA/MCA, MCA/ACA tandem lesion 5.7% (4/60). The demographic data between two groups were similar without statistical difference (Table 1). The puncture to recanalization time was 61 minutes (SOL: 57 and FAST: 71). Additional procedures were performed in 35% (21/60) of the cases [SOL: 13.6% (6/44) and FAST: 57.7% (15/25)]. The number of Solitaire stent passes was 1.6 (range 1-6) in solitaire only cases, but the number of FAST was 2.5 (range 1-3) in FAST only cases. Complete recanalization was achieved in 65.7% (46/70) [SOL: 75% (33/44) and FAST: 50% (13/26)]. The rate of complete recanalization was significant for the Solitaire group versus the FAST group without statistical significance (>0.05) (Table 2). Clinical outcome was not significant statistically (Table 3).

**Conclusions**

The study reveals a higher rate of angiographic recanalization using the Solitaire-FR device, requiring a lesser number of passes and other rescue procedures as compared to FAST. Thus, Stent retrievers (Solitaire-FR) are advantageous in faster device delivery and quick flow restoration. In difficult cases, switch technique from Solitaire stent to the FAST was more
effective than visa versa. However, future prospective randomized large trials are required to confirm these early results.
<table>
<thead>
<tr>
<th></th>
<th>Solitaire (n=44)</th>
<th>FAST (n=26)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>65.2 (13.0)</td>
<td>68.9 (7.7)</td>
<td>0.19</td>
</tr>
<tr>
<td>Male</td>
<td>16 (36.4%)</td>
<td>15 (57.7%)</td>
<td>0.13</td>
</tr>
<tr>
<td>Initial NIHSS (mean±SD)</td>
<td>16.2±6.0</td>
<td>17.0±6.0</td>
<td>0.59</td>
</tr>
<tr>
<td>Occlusion site</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICA</td>
<td>12 (27.3%)</td>
<td>7 (25.9%)</td>
<td>0.88</td>
</tr>
<tr>
<td>M1</td>
<td>22 (50%)</td>
<td>10 (38.5%)</td>
<td>0.49</td>
</tr>
<tr>
<td>M2</td>
<td>3 (6.8%)</td>
<td>1 (3.8%)</td>
<td>0.99</td>
</tr>
<tr>
<td>ICA/MCA, MCA/ACA tandem lesion</td>
<td>3 (6.8%)</td>
<td>1 (3.8%)</td>
<td>0.99</td>
</tr>
<tr>
<td>Basilar/PCA</td>
<td>4 (9.1%)</td>
<td>7 (26.9%)</td>
<td>0.10</td>
</tr>
<tr>
<td>Intravenous tPA</td>
<td>28 (63.6%)</td>
<td>16 (61.5%)</td>
<td>0.93</td>
</tr>
<tr>
<td>Occlusion site (left)</td>
<td>18 (40.9%)</td>
<td>11 (42.3%)</td>
<td>0.89</td>
</tr>
<tr>
<td>Onset to arterial puncture time (min, SD)</td>
<td>251 (253)</td>
<td>244 (177)</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Table 1. Baseline demographic and clinical characteristics of the patient
<table>
<thead>
<tr>
<th></th>
<th>SOL (n=44)</th>
<th>FAST (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puncture to recanalization (min, SD)</td>
<td>57±47</td>
<td>71±49</td>
</tr>
<tr>
<td>Onset to recanalization (min, SD)</td>
<td>308±190</td>
<td>315±186</td>
</tr>
<tr>
<td>Number of pass (n)</td>
<td>2.1±1.5</td>
<td>2.5±1.6</td>
</tr>
<tr>
<td>One device only</td>
<td>n=38</td>
<td>n=11</td>
</tr>
<tr>
<td>Recanalization rate (TIMI 3)</td>
<td>27/38 (71.1%)</td>
<td>7/11 (63%)</td>
</tr>
<tr>
<td>Recanalization rate (TICI 2b-3)</td>
<td>30/38 (78.9%)</td>
<td>7/11 (63%)</td>
</tr>
<tr>
<td>Additional rescue treatment</td>
<td>6/44 (13.6%)</td>
<td>15/25 (57.7%)</td>
</tr>
<tr>
<td>Total recanalization rate (TIMI 3)</td>
<td>30 (68.2%)</td>
<td>14 (53.8%)</td>
</tr>
<tr>
<td>Total recanalization rate (TICI 2b-3)</td>
<td>33 (75%)</td>
<td>13 (50%)</td>
</tr>
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</table>

**Table 2. Recanalization Rate Comparison**
Purpose
This study aimed to report clinical outcomes and immediate and long term angiographic results of stent-assisted coil embolization by using retrievable stent (Solitaire AB) for the treatment of wide-necked intracranial aneurysms.

Materials and Methods
From January 2011 to September 2014, a total of 156 patients harboring 162 aneurysms were treated with stent-assisted coiling by using Solitaire AB stent. Thirty-five patients (22.4%) presented with acute subarachnoid hemorrhage. Stent was removed after the procedure in 36 patients (23.1%) and repositioned during the procedure in eight patients (5.1%). Bailout stenting

<table>
<thead>
<tr>
<th></th>
<th>SOL (n=44)</th>
<th>FAST (n=112)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day NIHSS</td>
<td>12.8±9.3</td>
<td>13.5±9.1</td>
</tr>
<tr>
<td>90 day mRS (≤ 2)</td>
<td>12 (27.3%)</td>
<td>9 (34.6%)</td>
</tr>
<tr>
<td>90 day mortality</td>
<td>8 (18.2%)</td>
<td>7 (26.9%)</td>
</tr>
<tr>
<td>Symptomatic hemorrhage</td>
<td>4 (9.1%)</td>
<td>5 (19.2%)</td>
</tr>
<tr>
<td>Asymptomatic hemorrhage</td>
<td>1 (2.3%)</td>
<td>1 (3.6%)</td>
</tr>
</tbody>
</table>

Table 3. Clinical Outcome Comparison
was performed in 27 patients (17.3%). Clinical and angiographic outcomes were evaluated retrospectively. Angiographic outcomes were assessed using the Raymond classification.

**Results**

Immediate angiographic results were complete occlusion in 106 aneurysms (65.4%), neck remnant in 52 (32.1%), and aneurysm remnant in four (2.5%). Of 121 patients with an unruptured aneurysm, three thromboembolic complications and three periprocedural intracerebral hemorrhages (ICH) occurred; two (1.7%) of these patients had severe disability at 3 months. The remaining 119 patients (98.3%) showed good recovery. Of 35 patients with ruptured aneurysms, two procedure-related ICHs and two thromboembolic complications occurred; 22 patients (62.9%) had a favorable outcome. Overall, the rate of procedure-related complications was 6.4% (10/156). Follow-up angiography more than 1 year after the coil embolization was obtained in 42 patients with 43 aneurysms. Of these, recanalization was observed in five aneurysms (11.6%); 34 aneurysms (79.1%) unchanged; and four aneurysms (9.3%) showed progressive thrombosis.

**Conclusions**

In our experience, removal and reposition of the Solitaire stent allowed for reducing thromboembolic complications and making the coiling procedure faster and easier in selected patients. Considering the good clinical outcome with the low rates of both procedural complication and recurrence, Solitaire stent-assisted coil embolization seems to be safe and effective in the treatment of wide-neck intracranial aneurysms.

**P-88**

6:00AM - 3:00PM

**Outcomes of Staged or Simple Angioplasty in Severe Carotid Artery Stenosis at Higher Stroke Risk**

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¹Saitama Medical University, International Medical Center, Hidaka, Saitama, ²Saitama Medical University International Medical Center, Saitama, Hidaka-shi

**Purpose**

Cases with severe carotid artery stenosis with unstable plaque and impairments of cerebrovascular reserve are thought to be higher stroke risk. Purpose of the present study was to assess the safety of the staged or simple angioplasty for the patients with severe carotid artery stenosis.

**Materials and Methods**

Forty-eight consecutive patients underwent staged or simple angioplasty (PTA), with 53 procedures. The primary outcome was a composite of death, stroke, or myocardial infarction at 30 days and during the follow-up period. We also performed studies in which preprocedural factors were associated with results, especially studies with flow velocities changes measured by doppler ultrasound examinations before and after the angioplasty.

**Results**

Thirty-one cases (33 procedures) underwent CAS followed by staged angioplasty, mean intervals between PTA and CAS were 53.4 days. Post PTA stenosis including post CAS was observed in five patients (10.1%), and four of them underwent angioplasty, again. Primary outcomes were
observed in two cases. One case was ischemic stroke and the other was cardiac complication. Changes in flow velocities were associated significantly with appearance of high intensity spots in postinterventional diffusion-weighted MRI. There were no significant differences in other baseline characteristics. Conclusions In cases of higher stroke risks, assessments of the CVR and plaque vulnerability were essential and staged or simple angioplasty seemed to be safer than conventional CAS.

P-81

Post-procedural Visual Hallucinations after Endovascular Therapy for Intracranial Dural Arteriovenous Fistulas

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Purpose
The purpose of this study is to investigate clinical features of visual hallucinations after endovascular therapy in patients with intracranial dural arteriovenous fistulas (iDAVF).

Materials and Methods
Five patients who experienced abnormal visual hallucinations after endovascular embolization for iDAVF between August 2011 and November 2014 were included in this study. There were four males and one female with a mean age of 68 years (age range: 62-72). We evaluated the clinical features of visual hallucinations and pre and postprocedural radiologic findings on modalities including MRI, CT, angiogram and cerebral perfusion study.

Results
All visual hallucinations were described as realistic and lacked additional neurological alterations except for one case accompanied by sensory aphasia. The symptom was recognized on POD0 in three cases, POD1 in one case and POD2 in one case. It diminished within 30 minutes to 2 months without any clinical sequelae. All patients had arteriovenous shunts at the transverse or sigmoid sinuses and cortical veins dilatation or reflux. Transvenous coil embolization was performed in three cases and transarterial embolization by Onyx was performed in two cases. Increased blood flow and electroencephalogram abnormality in tempororo-occipital region were detected in one case.

Conclusions
Transient visual hallucinations after endovascular therapy for iDAVF occasionally are seen in cases of transverse or sigmoid sinus fistulas with cortical veins dilatation or reflux. The condition is thought to be triggered by increased blood flow and epileptiform reactions after successful endovascular therapy.

P-89a

Pre or postoperative transarterial embolization of middle meningeal artery in subdural hemorrhage: Clinical experience and literature review

B Kim¹, H CHANG¹, E Kim¹
Purpose
There are no established treatment standards for recurrent subdural hematoma (SDH). In this study, we discussed the efficacy of middle meningeal artery (MMA) embolization in preventing recurrence of SDH.

Materials and Methods
We performed superselective angiography of MMA in 12 patients who suffered from recurrent SDH or SDH with risk factor. After angiography, we performed particle embolization of MMA.

Results
In all cases, there were diffuse abnormal vascular stains that seemed to represent the vascularities in the outer membrane of SDH. In all the patients, there were no recurrences or enlargements of SDH after the embolization of the MMA.

Conclusions
Middle meningeal artery embolization may be an effective adjuvant treatment modality for preventing the recurrence of SDH.

P-85

Prognostic Indicators In Patients Considered for Mechanical Thrombectomy

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1Ochsner Clinic Foundation, New Orleans, LA

Purpose
Ochsner Clinic Foundation in New Orleans, LA is a certified comprehensive stroke center and a major referral center for stroke therapy including a hub and spoke type of telestroke system with over 30 referral sites. The purpose of this study is to determine the strongest prognostic indicators of clinical outcome in patients who are under consideration for mechanical thrombectomy (MT).

Materials and Methods
Sixty-eight consecutive patients who presented with stroke signs, underwent CT perfusion/CT angiography, demonstrated M1 or M2 occlusions, and had a brain MRI during admission were analyzed retrospectively from 1/1/12-7/1/14. Patients with intracranial hemorrhage at presentation, tandem lesions, or high grade carotid stenosis were excluded. Infarct volumes were measured on diffusion-weighted images using specific software (Terarecon) with a semi-automated region of interest selection technique under the supervision of a board certified neuroradiologist. Several proposed risk factors were analyzed by retrospective chart review. Discharge and follow-up modified Rankin Scale (mRS) and the National Institute of Health Stroke Scale (NIHSS) also were found on chart review and were used as clinical endpoints. Evaluation was performed using stepwise forward multivariable linear regression. A logistic regression was used to analyze the probability of death.

Results
The strongest statistically significant predictors of low NIHSS and mRS were infarct volume (p=0.001) for discharge NIHSS; MT during admission (p<0.001) and obesity (p<0.05) for discharge mRS; MT during admission (p<0.001), atrial fibrillation (AF) (p=0.03),
hyperlipidemia (p=0.02), prior stroke (p=0.007) for follow-up NIHSS; and MT during admission (p<0.001) for follow-up mRS. The strongest statistically significant predictors of high NIHSS and mRS were infarct volume (p=0.001) and hemorrhagic conversion (p=0.001) for discharge NIHSS; infarct volume (p<0.001) and hemorrhagic conversion (p<0.001) for discharge mRS; infarct volume (p=0.01) and age (p=0.007) for follow-up NIHSS; and hemorrhagic conversion (p=0.005) and infarct volume (p=0.002) for follow-up mRS. All patients combined, infarct volumes ranged from 2 to 553 mL with an average of 94.5 mL. In patients who were treated with MT the infarct volumes ranged from 2 to 235 mL with an average of 59.4 mL and in patients not treated with MT the infarct volumes ranged from 2 to 553 mL with an average of 138.9 mL. The strongest indicator of death at discharge was infarct volume (p=0.03).

Conclusions

Infarct volume was found to be the strongest predictor of a poor prognosis at discharge. The strongest predictor of positive prognosis upon follow up was found to be MT during admission. Poor outcomes correlate with older age. Clinical factors predicting positive outcomes include: obesity, prior stroke, AF, and hyperlipidemia. Further research with larger sample sizes will allow comparison of risk factors between intervention and nonintervention groups, facilitating better identification of patients who are likely to benefit most from MT.

P-89 6:00AM - 3:00PM

Proposal for a collateral flow grading system in posterior circulation stroke: a single-center experience

S Marziali1, f garaci2, V Da Ros3, f di giuliano4, p stanzione5, g simonetti4, r floris4
1fondazione policlinico tor vergata, roma, italy, 2Università degli Studi di Roma “Tor Vergata, Rome, roma, 3University Hospital of Rome, Rome, Rome, 4fondazione policlinico tor vergata, roma, Italy, 5Università degli Studi di Roma “Tor Vergata, roma, Italy

Purpose

Collateral score in anterior circulation stroke has been investigated deeply as a reliable predictor of clinical outcome; on the contrary only few reports on collateral score in posterior circulation (pc) stroke exist. We reported our preliminary experience on the use of a CT angiography (CTA)-based collateral score grading system in patients with acute vertebro-basilar occlusion (AVBO).

Materials and Methods

Pretreatment noncontrast CT (NCT), CTA and CTA-source images (CTA-SI) of patients with AVBO treated by mechanical thrombectomy preceded or not by intravenous thrombolysis within 24 hours of symptom onset were analyzed retrospectively. PcASPECTS was calculated on NCT and CTA-SI whereas a CTA collateral brainstem score (CTAcbs) was created using six decreasing (and worsening) points of vessel opacification within the occluded territory. All above-mentioned scores and stroke risk factors were correlated to 3 months clinical outcome with a modified Rankin Scale ≤ 3 considered as a favorable outcome. The Fisher test and Mann-Whitney test were used for statistical analysis.

Results

Fifteen patients were recruited for analysis. Interobserver reliability in the final CTAcbs was excellent (p=0.001). Successful recanalization (TICI 2b-3) was achieved in 10/15 (63%). A
favorable outcome was observed in six patients (40%). CTAcbs was related significantly to clinical outcome: in particular patients with lower scores were more likely to have 3 months favorable outcome (p=0.003). Location of the thrombus at the distal part of basilar artery and hypertension were related to unfavorable outcome (p=0.03; p=0.03) whereas smoke habit was significantly more frequent in patients with favorable outcome (p=0.02). No statistical correlation was found between NCT pc-ASPECTS or CTA-SI pc ASPECTS and final outcome.

Conclusions
Our preliminary single-center experience showed that patients with good pc collateral score had better chance of 3 months favorable outcome. The proposed CTAcbs seems to be an easy and reliable tool for selection of patients candidate to endovascular therapy.

P-87

Stent-Based Thrombectomy for Acute Ischemic Stroke in Octogenarians and Nonagenarians

W Yoon¹, T Heo¹, S Kim¹
¹Chonnam National University Hospital, Gwangju, Korea, Republic of

Purpose
The safety and efficacy of endovascular therapy for acute ischemic stroke in patients 80 years or older remains unknown. This study reports the outcomes of stent-based thrombectomy as first-line endovascular therapy for treatment of acute stroke in octogenarians and nonagenarians.

Materials and Methods
We retrospectively reviewed data from 221 consecutive patients who were treated with mechanical thrombectomy using the Solitaire stent. Successful revascularization was defined as a modified TICI grade ≥2b. Good outcome was defined as a 90-day modified Rankin Scale score of 0–2. Futile revascularization was defined as an mRS 3-6 despite successful revascularization. Patients were divided into two groups: 80 years of age and older (group I; n = 40) and less than 80 years of age (group II; n = 181). Clinical and radiologic outcomes were analyzed and compared between group I and II.

Results
The median baseline NIHSS score was not significantly different between two groups (14 versus 12). The median procedure time was longer in group I (39 versus 30 minutes, P=0.029) and good outcome was more common in group II compared with group I (27.5% versus 48.6%, P=0.015). Futile revascularization was significantly more common in group I compared with group II (68.8% versus 45.2%, p=0.015). There were no significant differences in the rates of successful revascularization (80% versus 85.6%), symptomatic hemorrhage (5% versus 3.3%), and mortality (12.5% versus 8.3%) between two groups.

Conclusions
Our study suggests that stent-based thrombectomy with a Solitaire stent can achieve a high rate of revascularization and a low rate of complication and mortality in octogenarians and nonagenarians. However, futile recanalization was still more common in octogenarians compared with younger patients after stent-based thrombectomy in our study. Careful patient selection for mechanical thrombectomy may reduce the futile recanalization and improve clinical outcome in octogenarians with acute stroke.

I Orosz¹, V Trinh¹, R Harris¹, J Qiao¹, B Salehi¹, C Geannette¹, H Ullman¹, N Salamon¹
¹UCLA, Los Angeles, CA, David Geffen School of Medicine at UCLA, Los Angeles, CA

Purpose
To illustrate a potential pitfall of the FDG-PET for the diagnosis of focal cortical dysplasia.

Materials and Methods
We retrospectively reviewed 23 patients (mean age 14.5 years, sd 1.3) with pathology proven FCD Type IIA/B in the frontal lobe with subtle MRI findings. Two neuroradiology fellows, who were blinded to the known locations of FCD evaluated preoperative PET/MRI coregistration image to identify the zone of hypometabolism. Results of the raters' evaluation were categorized into three: A; both negative, B: discordant and C: both positive. Locations of FCD were subdivided into three groups: 1, lateral frontal; 2, superior frontal; and 3, orbital frontal. The degree of FDG-PET hypometabolism was measured separately using the lesion's standardized uptake value (SUV).

Results
FDG-PET visual assessment was correlated with the locations of the FCD in the frontal lobe. Raters were able to identify 70% of lateral frontal FCD (n=10). For superior frontal FCD (n=8), only 12.5% was detected. Orbital frontal FCD (n=5) was identified in 80%. In SUV analysis, the lesions in the superior frontal lobe had a significantly less hypometabolism with cut-off SUV of 17000 Bq/mL. Raters were able to identify lesions when SUV is lower than 17000 Bq/mL.

Conclusions
Subtle FCD TypeIIA/B located in the superior frontal lobe region and with SUV over 17000 Bq/mL showed false negative result in PET/MRI coregistration. Understanding this potential pitfall will be important for presurgical evaluation and require different approach using other modality such as SPECT or magnetic source imaging.
Altered Structural Connectivity in 4 Year Old Children Born Very Preterm with White Matter Injury

B Morgan¹, J Young¹, W Lee², M Mai¹, M Shroff³, M Taylor³
¹Hospital for Sick Children, Toronto, Ontario, ²Hospital for Sick Children, Toronto, ON, ³The Hospital for Sick Children, Toronto, Ontario

Purpose
White matter injury (WMI), such as punctate white matter lesions, is common following very preterm (VPT) birth and has the potential to impact white matter maturation and later neurocognitive outcomes (1). In a cohort of VPT children, we examined the long term effects of WMI detected from MRI at birth on white matter development at 4 years of age.

Materials and Methods
Sixty-direction diffusion data and a T1 anatomical scan were acquired in 26 VPT-born (mean gestational age: 28.87 weeks, 13 males), now 4-year-old children using a Siemens 3T Tim Trio MRI. Seven subjects were identified as having WMI from a T1 acquired at birth. For each subject, probabilistic tractography was performed using BEDPOSTX and PROBTRACTX (2, 3) and a structural connectivity matrix was computed, which counted the number of fibers projected between the caudate, putamen, thalamus, frontal pole, motor and occipital cortices (bilaterally),

(Filename: TCT_P-94_Pic1.jpg)
creating a 12x12 matrix. A multivariate partial least squares (PLS) analysis (4) was performed to explore the relationship between structural connectivity patterns and the presence/absence of WMI at birth. This provided a 12x12 connectivity matrix that details which pattern of connections differentiates subjects with and without WMI. Statistical significance of these contributions can be calculated using bootstrap ratios, which approximates a z-score. A threshold of $|z|>2.3$ was applied to single out the most significant contributions. The analysis was designed such that a negative z-score represents lower connectivity in the group with WMI.

Results
The included figure illustrates the pattern that maximally differentiates the presence or absence of WMI. The color-bar depicts the bootstrap ratios. For example, the connection of the right thalamus to the right frontal cortex significantly contributes to the differentiation between subjects with and without WMI. Notably, there appears to be a pattern of reduced connectivity of the thalamus and putamen to the frontal regions in subjects with WMI.

Conclusions
Reduced numbers of fiber projections between bilateral thalami and the left putamen to the frontal cortex at 4 years of age may indicate alterations of white matter tract development in the presence of WMI at very preterm birth. Neural components fundamental to the maturation of networks, such as projection neurons, subplate neurons, and oligodendrocyte precursors are suggested to be compromised by WMI (5). Our findings may provide evidence for selectively vulnerable connections between the subcortex and frontal cortex to WMI, perhaps due to the fact that they are last to develop of the networks explored.
Can FDG-PET find epileptogenic tuber in Tuberous sclerosis complex?

Y Hirata¹, A Yogi¹, E Karavaeva¹, B Ellingson¹, N Salamon¹
¹David Geffen School of Medicine, University of California - Los Angeles, Diagnostic Radiology, Los Angeles, CA

Purpose
Noninvasive approach to define epileptogenic focus in tuberous sclerosis complex (TSC) is challenging. The purpose of this study is to evaluate if standardized uptake value (SUV) calculation in FDG-PET can detect epileptogenic tissue in TSC.

Materials and Methods
Seven patients (mean age, 5 years) who underwent tuberectomy between February 2009 and September 2013, were selected. All patients had pre-operative FDG-PET and MRI. Epileptogenic tubers (n =13) were defined by multimodality evaluation using EEG, magnetoencephalogram, and intra-operative electrocorticography and these were compared with nonepileptogenic tubers (n =100). All tubers were segmented into three regions for calculation of SUV: within the tubers, 2 mm outer margin of tubers, and 4 mm outer margin of tubers using AFNI (Analysis of Functional NeuroImaging). Six parameters were analyzed: intralesion SUV; SUV at the 2 mm and 4 mm margins; combined SUV of the 2 mm and 4 mm margins; combined SUV of the intralesion and the 2 mm margin; and a combined SUV of all three regions. A Man-Whitney test was performed to compare the differences in these six parameters between the epileptogenic and nonepileptogenic tubers. We also classified tubers in Frontal, Parietal, Temporal, and Occipital lobe and analysis was made in each lobe.

Results
In all six parameters, epileptogenic tubers in temporal lobe showed significantly lower mean SUV compared to nonepileptogenic tubers (p < 0.003). No statistical significance was obtained in the epileptogenic tubers found in the other lobes.

Conclusions
Standardized uptake value analysis of FDG PET showed significantly lower value in only temporal lobe epileptogenic tissues.
Temporal tuber: tuber itself

mean SUV

epileptogenicity (0:non-epi, 1:epi)

(Filename: TCT_P-96_SUV_tuber.jpg)
Comparing 4th generation Iterative Reconstruction Technique and Standard Filtered Back Projection for Effects on Image Quality and Radiation Exposure with Multi-detector Pediatric Head CT Examinations.

A Thomas¹, J Egelhoff¹, R Towbin¹, J Curran¹, J Miller¹, R Southard¹, H Hu¹
¹Phoenix Children's Hospital, Phoenix, AZ

Purpose
Compare the effects on image quality and radiation exposure for multidetector pediatric head CT examinations performed using standard filtered back projection with those using a 4th generation iterative reconstruction (IR4) technique.

Materials and Methods
We retrospectively reviewed 126 head CT exams performed with standard filtered back...
projection and 158 pediatric head CT exams performed with iDose4 level 2, an IR4 developed by Philips Healthcare. All exams were obtained on a 256-slice Brilliance iCT scanner (Philips Healthcare). Cases were stratified into four age categories based on the patient's age in years (0-1.5, 1.5-7.0, 7-13, and over 13). A single axial slice through the basal ganglia at the level of the foramina of Monro was reviewed for each exam. Circular regions of interest measuring 0.6 +/- 0.05 cm² were drawn in the mid right thalamus (gray matter) and the right frontal white matter. This allowed for quantification of mean Hounsfield Units (HU) and standard deviation (SD) for gray matter (GM) and white matter (WM), which were used in standard equations to calculate our objective parameters. Objective parameters of image quality compared between the two techniques were signal to noise ratio (SNR) for GM, SNR for WM, and contrast to noise ratio (CNR) between GM and WM. CTDIvol (value calculated by the CT scanner) and effective dose (ED) were used as quantitative parameters for dose comparison between the two techniques. Equations used were: ED = k (CTDIvol), SNRGM = mean HU GM/SD GM, SNRWM = mean HU WM/SD WM, and CNR = (mean HU GM - mean HU WM)/ ((SD GM)² + (SD WM)²)⁰.⁵. The k used for calculating ED is an established age dependent variable coefficient.

Results
Comparisons of SNR of GM in the age group of 0 to 1.5 years showed statistically significant improvement for IR4 (p<0.05). The remaining age groups had no statistically significant differences between the two imaging techniques for SNR of GM. Differences in SNR of WM and CNR gray-white were statistically insignificant between the two imaging techniques in all four age groups. The radiation dose parameters of ED and CTDIvol were significantly lower for IR4 across all age groups (p<0.01). There was 25.9% average CTDIvol dose reduction for all pediatric patients scanned with IR4.

Conclusions
Compared to standard FBP, the IR4 technique utilized in this study demonstrates statistically significant dose reduction for all pediatric patients undergoing head CT examinations while maintaining, and in some instances, improving objective image quality.
Figure 1: Bar plot of average and standard deviation of effective dose (ED) between projection (FBP) and iDose$^4$ (IR4) as a function of age groups. In each age group, the effective dose between FBP and IR4 are statistically significant (p<0.01). (Filename: TCT_P-104_Figure1.JPG)
Purpose
While cavernous angioma after cranial irradiation has been documented (1, 2) there are no reports on its development after high dose chemotherapy with autologous peripheral blood stem cell transplantation. We present a patient with desmoplastic/nodular medulloblastoma associated with anhidrotic ectodermal dysplasia who developed cavernous angioma 2 years after high dose chemotherapy with peripheral blood stem cell transplantation.

Materials and Methods
A 1-year-old boy with ingravescent vomiting was admitted to our institute. He presented with a
large head, depressed nasal bridge, low-set ears, thick lips with peg-shaped teeth, hypohidrosis, sparse hair, thin atrophic skin, scaly dermatitis with frontal bossing, and a bulging anterior fontanel. Neuroradiological examination revealed multiple cerebellar masses with heterogeneous enhancement and speckled calcifications and severe obstructive hydrocephalus.

Results
He underwent surgery. The histological diagnosis was desmoplastic/nodular medulloblastoma and he underwent postoperative multiple drug chemotherapy with autologous peripheral blood stem cell transplantation. The outcome was favorable and he did not undergo radiotherapy. After 2 years intracranial hemorrhage at right temporo-parietal lobe was detected at his regular radiological check-up and he again underwent surgery. The histological diagnosis was cavernous angioma. Image Findings: (A, B) Computerized tomography revealed large posterior fossa masses with speckled calcifications and obstructive hydrocephalus. (C, D) After high dose chemotherapy, right temporo-parietal hemorrhage was observed.

Conclusions
To our knowledge this is the first report of anhidrotic ectodermal dysplasia-associated desmoplastic/nodular medulloblastoma and cavernous angioma. It may be the first report of secondary cavernous angioma after chemotherapy with autologous peripheral blood stem cell transplantation.
Diffusion Tension Imaging in Very Preterm and Term Born Children at 4 Years of Age

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¹Hospital for Sick Children, Toronto, Ontario, ²Hospital for Sick Children, Toronto, ON, ³The Hospital for Sick Children, Toronto, Ontario

Purpose
Very preterm (VPT) children born at less than 32 weeks gestational age (GA) are at risk for altered white matter (WM) maturation, which has been detected in the neonatal period and throughout later development (1). We used diffusion tensor imaging (DTI) to examine structural differences of white matter tracts between VPT and term-born children at 4 years of age, a period of rapid WM development.

Materials and Methods
Sixty-direction diffusion data were acquired in 30 VPT children (17 males, mean scan age: 4.2 years) born at mean (SD) gestational age of 28.8 (1.45) weeks and nine term-born children (5 males, mean scan age: 4.6 years) on a 3T Siemens Trio MR scanner with a 12-channel head coil. Using FSL's tract-based spatial statistics (2), each subject's DTI data were non-linearly co-registered to create a cohort-specific fractional anisotropy (FA) template. A mean FA skeleton was generated on the average FA image and a threshold of 0.25 was applied to represent the center of major white matter tracts. FSL Randomise (3) was used to evaluate differences between groups and significance was determined using threshold-free cluster enhancement.

Results
Fractional anisotropy values for the VPT children were reduced consistently (p<0.05) compared to term-born children at 4 years of age within major white matter tracts. Affected regions included the body of the corpus callosum as well as bilateral areas of the cortical spinal tract, superior longitudinal fasciculus, inferior longitudinal fasciculus, thalamic radiation, and fronto-occipital fasciculus.

Conclusions
Very preterm-born children were found to have widespread, significant reductions in FA compared to term-born children within major white matter tracts. Consistent with previous literature, this finding is evidence for lasting effects of prematurity on white matter development. Disrupted white matter properties at 4 years of age provides insight on altered neurodevelopment that may have important implications in relation to the poorer cognitive and motor outcomes experienced in this population.
**P-105**

6:00AM - 3:00PM


E Carabelli\(^1\), P Shah\(^2\), S Faro\(^3\), D Middleton\(^4\), F Mohamed\(^4\)

\(^1\)Temple University School of Medicine, Philadelphia, PA, \(^2\)Temple University, Philadelphia, PA, \(^3\)Temple University School Of Medicine, Philadelphia, PA, \(^4\)Temple University, Philadelphia, PA

**Purpose**

The purpose of the study was threefold: to propose a new method for drawing regions of interest (ROIs) in the cervical spinal cord; to establish normal diffusion tensor imaging (DTI) parameters for gray and white matter regions; and to determine the influence of gray matter DTI values on white matter DTI values.

**Materials and Methods**

The study consisted of 10 subjects (2 males, 8 females, mean age of 9.7 years) without clinical or imaging evidence of spinal cord injury or pathology. Subjects underwent two identical scans using a 3.0T Siemens Verio MR scanner (Siemens, Erlangen, Germany) with a 4-channel neck matrix and 8-channel spine matrix coils. The protocol consisted of conventional T1- and T2-weighted structural scans and axial DTI scans based on the iFoV sequence. VAT also has been applied to reduce in-plane distortions. Manual shim volume adjustments were performed prior to data acquisition. High resolution axial DTI images were acquired to cover the entire cervical spinal cord. The imaging parameters included: 3 averages of 20 diffusion directions, 6 b0 acquisitions, \(b = 800\) s/mm\(^2\), voxel size = 0.8 x 0.8 x 6 mm\(^3\), axial slices = 40, TR = 7900 ms, TE = 110 ms, and acquisition time = 8:49 min. Three ROIs were hand-drawn on each axial slice of each scan between the C1 and C7 levels (11-15 slices per subject). Whole cord ROI was drawn using the B0 and fractional anisotropy (FA) images. A single voxel width was avoided between the ROI margin and the cerebrospinal fluid (CSF) to avoid contamination. Slices were excluded if there was significant distortion. The whole cord ROI then was segmented and grouped into pure gray and pure white matter ROIs. Each voxel was designated as either gray matter or white matter using an anatomical atlas, B0, FA, and T2 GRE images. The DTI values then were compared within each subject and at each cord level across all ten subjects.

**Results**

There was a statistically significant difference in the functional anisotropy and axial diffusivity (AD) values between whole cord and gray matter ROIs. Similarly, there was a significant difference when comparing gray matter FA and AD values to white matter values. White matter FA values were greater than whole cord values at every level, but were not statistically significant. For AD, white matter values were significantly greater than whole cord values. There were no significant differences between gray matter, white matter and whole cord radial diffusivity (RD) values.

**Conclusions**

Fractional anisotropy and AD values are consistently higher in white matter than gray matter.
regardless of the cord level. Whole cord DTI ROI analysis does not accurately quantify pure white matter or pure gray matter disease that affects fractional anisotropy or axial diffusivity. These findings suggest that accurate representation of gray matter and white matter values for FA and AD requires segmentation. Furthermore, the consistent differences between gray and white matter values in FA and AD suggest that it may be possible to use an automated process to segment out the gray and white matter. Finally, if RD is the only parameter of interest, this study suggests that the whole cord analysis may yield the same results as segmented ROI analysis.

(Filename: TCT_P-105_ASNRI mage.gif)

P-90

Disrupted Anatomic Connectivity in the 22q11.2 Deletion Syndrome

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Purpose
The 22q11.2 deletion syndrome (22q11DS) is an uncommon genetic condition with a significantly increased rate of schizophrenia relative to the typical population (1). Although the neural substrates of schizophrenia are characterized incompletely, emerging evidence suggests that aberrant large-scale cerebral connectivity plays an important role (2, 3). Anatomical connectivity in 22q11DS is poorly understood.

Materials and Methods
We investigated differences in anatomical connectivity between 48 subjects with 22q11.2 deletion syndrome and 370 typically developing individuals. For all subjects, mean cortical thickness was estimated for 68 regions of interest in FreeSurfer. Multivariate analyses of covariance patterns were performed using hierarchical clustering and graph theoretical models (4).

Results
There were statistically significant differences in anatomical correlational patterns between groups ($\chi^2 = 4422.4$, p-value <0.0001). In the typically developing group, four distinct clusters were identified that generally followed lobar anatomy. In contrast, weaker anatomical relationships were observed in the 22q11DS group. Network models confirmed these finding and also discovered that the 22q11DS group had significantly decreased global connectivity statistics (clustering coefficient, betweenness, modularity, and small worldness) relative to typically developing subjects as determined via permutation tests using 1000 replicates.

Conclusions
Like schizophrenia, 22q11DS demonstrates significant global reductions in cerebral anatomical connectivity.
Effectiveness of Perfusion Imaging for Grading Pediatric Brain Tumors

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Purpose
To prospectively evaluate the effectiveness of perfusion MRI (pMRI) and diffusion MRI (DWI/ADC) measurements in distinguishing slow-growing low grade (LG) from fast-growing high grade (HG) pediatric brain tumors. Determination of brain tumor grade using pMRI is based largely upon studies performed in adult patients. Brain tumors in children differ significantly from adult lesions in their sites of origin, histological features, clinical presentation, biological composition, genetics, and proclivity to disseminate in the central nervous system (CNS). Therefore, testing the utility of pMRI and DWI values as biomarkers for grading pediatric brain tumors is essential.

Materials and Methods
Following IRB approval, 40 children with signed parental consent and assent (for children 7 years of age and older) who presented with new brain lesions were recruited prospectively. MR imaging exams with severe artifact, lesions too small for accurate diagnosis or those that did not fall under a WHO category were excluded. Thirty-four children with untreated tumors remained (16M/18F, ages 0-23 years). Perfusion imaging was added to the routine clinical MRI. Diffusion-weighted imaging (DWI) and ADC images were part of the routine clinical exam. Surgically resected tumors were classified as LG (WHO I/II) or HG (WHO III/IV). Pilocytic astrocytomas (PA) and pilocytic optic-pathway gliomas (OPG) were grouped together, but separately from other LG lesions since PA and OPG behave differently than other LG lesions. Nontumor (NT) lesions also were evaluated. Using serial imaging, stable and nonresectable lesions were classified as LG, whereas rapidly enlarging lesions were classified as HG. Based on these criteria the distribution was comprised of HG (n=4), LG (n=18), PA+OPG (n=8), and NT (n=4). Perfusion metrics including normalized (nRCBV), and standardized (sRCBV) relative cerebral blood volume and normalized cerebral blood flow (nRCBF) were calculated using IB Neuro (Imaging Biometrics LLC, Elm Grove, WI). Scanner-derived apparent diffusion coefficient (ADC) values were calculated from diffusion tensor imaging (DTI). Regions of interest were identified using best available anatomical images and mean values for each parameter were recorded. Statistical analysis included the Mann-Whitney t-test with alpha=0.5. (GraphPad Software, LaJolla, CA).

Results
A representative case is shown in Figure 1a. Graphs of sRCBV and ADC are shown in Figure 1b-d. sRCBV is statistically different for HG versus LG (p=0.022), but not for nRCBV or nRCBF. Apparent diffusion coefficient can distinguish HG from PA+OPG (p=0.012) and HG from LG (p=0.035); however, when sRCBV and ADC are combined, there is greater statistical
power for distinguishing these tumor categories (HG vs LG: p=0.0029; HG vs PA+OPG: p=0.0095).

Conclusions
The results of this study represent the first step toward developing an imaging biomarker that will allow us to subclassify pediatric brain tumors and tailor therapy to each child.
Gender Differences in Maturation of Cerebellar Peduncles in the Pediatric Age Group with Diffusion Tensor Imaging at 3T

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Purpose
Age-related changes in normal cerebral white matter tracts and the cerebellar peduncles have been described using diffusion tensor imaging (DTI) (1). Gender differences are present in the normal maturation of the cerebral white matter tracts (2). However gender differences in maturation of the cerebellar peduncles have not been described so far. In this study, we compare age-related changes in the superior, middle and inferior cerebellar peduncles in normally developing boys and girls from infancy to late childhood.

Materials and Methods
Participants were selected from an ongoing longitudinal imaging study of development in healthy children with written consent. Diffusion tensor imaging was acquired on 3T Philips scanner using a single-shot EPI sequence (b = 1000 s/mm², resolution = 2 mm isotropic; 61 noncolinear diffusion directions). After preprocessing using FSL (FMRIB, Oxford, UK), white matter regions of interest were obtained using JHU DTI based white matter atlas (ICBM-DTI-81 white-matter labels atlas). Voxel-based analysis of the fractional anisotropy (FA) values on DTI data were obtained at the superior, middle and inferior cerebellar peduncles and the anterior and posterior limbs of the internal capsules (ALIC and PLIC) using DIPY software. A general linear model on log transformed data was used to investigate the differential trajectories in FA between boys and girls. A model that contains the main effect of gender, log transformed age and the interaction between the two main effects was fitted.

Results
There were 46 children (16 boys, 30 girls), mean age 44.9 months (1.3 to 99.5 months). Diffusion tensor imaging FA values in all regions were lowest in early infancy and increased with age, most rapidly until about 2 years of age. Fractional anisotropy values in all age groups were highest in the posterior limb of the internal capsule followed by the superior cerebellar peduncle. Fractional anisotropy values in all observed regions were lower in girls, as compared to boys in infancy and early childhood. There was a steeper increase in the FA values in the superior, middle and inferior cerebellar peduncles in girls compared to boys. The FA value curves in girls and boys intersected at around 30 months of age, after which the FA values in the cerebellar peduncles were higher in girls. The interaction test between gender and log transformed age was statistically significant in the middle (p=0.02) and inferior cerebellar peduncle (p=0.04) and approached statistical significance in the superior cerebellar peduncle (0.06). There was a steeper increase in the FA values for girls compared to boys. There was a significant interaction (p=0.01) in the PLIC. Fractional anisotropy values in girls were steeper compared to boys.
Conclusions
The FA values in the cerebellar peduncles are lower in girls in infancy and early childhood. However, there is a steeper increase in the FA values in the cerebellar peduncles in girls as compared to boys, with higher FA values in later childhood. This is in line with previous studies highlighting earlier maturation of the cerebral white matter in girls as compared to boys.

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**Interhypothalamic Adhesion in Asymptomatic Children**

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Purpose
With our routine use of high resolution MRI techniques, we increasingly have observed a thin band of tissue spanning the third ventricle anterior recess and connecting the hypothalami, described as an interhypothalamic adhesion (IHA) in recent publications (1, 2). Historically, hypothalamic anomalies are associated highly with symptoms referable to a hypothalamic hamartoma, midline congenital disorder, hypothalamic-pituitary dysfunction, or seizures – with
very few asymptomatic patients reported (1-5). The purpose of our study is to further characterize these anomalies and determine any clinical significance.

Materials and Methods
The Children's Hospital Colorado database was searched for patients identified with isolated hypothalamic anomalies not attributable to a hypothalamic hamartoma, neurofibromatosis, or malignancy. This resulted in a cohort of 57 patients ranging in age from 5 days to 20 years. Their records were reviewed for presentation and symptoms. Images were reviewed by two pediatric neuroradiologists.

Results
In all cases, the IHA 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, or extend below the tuber cinereum. Of the 57 individuals, 40 had no symptoms referable to hypothalamic pathology, other significant structural anomalies, or any evidence of an underlying genetic disorder. The remaining 17 individuals had developmental delays and global deficits too severe to localize to a single abnormality (11 individuals), endocrine abnormalities (4 individuals), or nonlocalizable seizures (2 individuals).

Conclusions
Interhypothalamic adhesions in our series of patients were observed incidentally through the routine acquisition of high-resolution T1 imaging. No referable symptoms were identified in the majority of the study group. As the described anomaly is subtle and primarily apparent on isotropic T1 imaging, it very likely is under recognized. However, as high resolution MRI techniques become more routinely employed, IHAes are likely to be increasingly identified. In the appropriate patient population lacking associated symptoms, the described hypothalamic anomalies are most likely incidental and should not be misdiagnosed as hypothalamic hamartomas.
Interhypothalamic Adhesion: Incidence and Associations

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Purpose
Interhypothalamic adhesion (IHA) is a recently described structure that bridges the hypothalamus across the midline through the third ventricle. The purpose of this study is to further characterize this structure, evaluate its incidence in the pediatric population, and identify clinical associations.

Materials and Methods
We conducted a retrospective review of pediatric brain MRI studies on 1550 consecutive patients performed in 2012-2013 on a single 3T MRI scanner at a tertiary pediatric hospital. Locations of the IHA were collected and categorized. Signal intensity of the IHA was compared to normal appearing gray and white matter on both T1WI and T2WI. Medical records of patients with IHA were reviewed and were assessed for weight, height, and BMI and compared to the appropriate CDC clinical growth charts. Indications for and MRI findings also were categorized.

Results
We identified IHA in 35 of 1550 patients (2.3%) that displayed clear MRI evidence of an IHA in more than one plane. Signal intensity of the IHA was more consistent with gray matter than white matter. We classified IHA into several types by virtue of their locations in the third ventricle, anterior, mid, and posteroinferior (see Figure 1). There were a significant proportion of patients with <5% weight (10/34, 29%) and <5% height (8/35, 23%). There was a clinical association of subtype 3 with decreased pituitary function (3 of 3 patients).

Conclusions
The etiology and significance of IHA remains unclear. We identified short stature and underweight in 29% and 23% patients with IHA. In other patients IHA may represent an anatomical variant. Further investigation into its clinical significance is warranted.
Is Ultrafast Spin Brain MRI More Sensitive Than Head CT For Evaluation of Intracranial Abnormalities?

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Purpose
Noncontrast head CT (NCCT) is often the first imaging that a patient will receive for evaluating intracranial pathology. The resolution of soft tissue injuries is lower than MRI. The aim of this study is to determine if ultrafast spin brain MRI (UFS MRI) is superior or equivocal to noncontrast head CT for evaluation of intracranial pathology.

Materials and Methods
IRB approval was obtained. Electronic medical records at a children's hospital were examined retrospectively. The software system Display Of Radiological Information Software (DORIS) was used to search radiology reports for patients who received UFS MRI between June 2013 and January 2014. MR imaging sequences used in the ultra fast spin protocol were axial T2 HASTE, coronal T2 HASTE, sagittal T1 fl3d, axial T2-star epi, axial DWI. Axial FLAIR/EPI was also in the past, but is no longer part of the current protocol. Data were collected from patients who had received NCCT up to 7 days prior to UFS MRI. Indication for studies, age, gender, and study findings were evaluated.

Results
Of 149 records, 14 patients (9%) received NCCT within 7 days prior to UFS MRI. Five were female, nine were male. Age ranged from 7 days to 16 years old with mean of 3.8 years. Time between studies ranged from 2 hours to 7 days with mean of 72 hours. Findings on UFS MRI differed from NCCT in two patients (14%) showing acute infarct and a Chiari I malformation not seen on NCCT. All findings on NCCT were seen on UFS MRI.

Conclusions
Data suggest that UFS MRI is equivocal or superior to NCCT for evaluating intracranial pathology.
largely unknown. This study examines the impact of preterm birth on cerebellar volume in a longitudinal cohort of very preterm neonates (<33 week GA).

Materials and Methods

As part of a larger prospective study, 25 (17M) infants born between 28-33 weeks GA (29.1±1.6) were scanned within 2 weeks of birth (30.5±1.6), and at term equivalent age (41.5±2.2). A subset of these infants, 21 (14M), were scanned again at 4 years of age (3.9 years ±0.1). Infants were imaged during unsedated sleep using a neonatal head coil (SREE Inc.) and a 1.5T GE MRI (Signa Excite) at birth and term, or 3T Siemens MRI (Trio) at 4 years. High resolution anatomical scans (1mm iso, T1w FSPGR or MPRAGE) were segmented manually using Aquarius iNtution software (Terarecon) by two trained viewers. Linear models were used to analyze i) cerebellar growth for each of the time windows, and ii) the impact of gestational age at birth on cerebellar volume as a percentage of total brain volume (Z-scored) at term (adjusted to 40 weeks) and at 4 years. Sex was included as a potential covariate in both models.

Results

Consistent with existing literature (3, 4), cerebellar growth rate accelerated rapidly during late gestation (2.05ml/week at term versus 1.29 at preterm period, Figure A). However, by 4 years of age, cerebellar growth had slowed dramatically (0.52 ml/week, Figure B). Gestational age at birth has a significant correlation with cerebellar volume as a percentage of predicted total brain volume at term age (Figure C), but not at 4 years of age (Figure D). Volumes did not differ between the sexes.

Conclusions

These findings indicate that early cerebellar development, specifically volumetric growth, is influenced significantly by prematurity. Infants born earlier in the third trimester have smaller cerebellums than infants born later in this very preterm period. However, by 4 years of age, cerebellar volumes appear to be less sensitive to degree of prematurity.
A. Cerebellar Growth - Neonatal

Growth Rate - Term
2.05 ml/wk ± 0.43
(p < 0.001)

Growth Rate - Preterm Birth
1.29 ml/wk ± 0.14
(p < 0.001)

B. Cerebellar Growth vs Age at...

C. Volume vs Age at Birth (@ Term age)

r = 0.412 (p < 0.041)

D. Volume vs Age at Birth

r = 0.233 (p < 0.309)

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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 pediatric TSC patients.

Materials and Methods
A total of 23 patients (mean age, 5.4 years old) with 581 tubers were selected retrospectively. All patients underwent pre-operative multimodality evaluation including MRI, FDG-PET, and magnetic source imaging. Epileptogenic tuber was defined with presurgical evaluation and result of postsurgical seizure freedom. Imaging of the tuber was divided into three types: type A, B and C and were compared between epileptogenic and nonepileptogenic tubers. Type A was defined as isointense on T1 and subtly hyperintense on T2 and fluid-attenuated inversion recovery (FLAIR). Type B was defined as hypointense T1 and homogeneously hyperintense on T2 and FLAIR. Type C was defined as hypointense on T1, hyperintense on T2, and heterogeneous on FLAIR characterized by a hypointense central region surrounded by a hyperintense rim.

Results
Among the 37 epileptogenic tubers and 544 nonepileptogenic tubers, 284 tubers are located in frontal lobe, 121 in temporal, 115 in parietal, and 61 in occipital lobes. Within the epileptogenic tubers, 14/37 tubers were in frontal lobe and the others were found in the inferior parietal lobes. Within epileptogenic tubers, five were type A, 23 were type B, and nine were type C. Type B was most common type of tubers in both epileptogenic and nonepileptogenic tubers. There were 13 tubers with calcifications, and six of them were epileptogenic. A total of 48 low T2 signal tubers were found and 14 of 48 were epileptogenic.

Conclusions
Conventional MRI can suggest epileptogenic tuber characteristics in pediatric. TSC epileptogenic tubers were found most commonly in inferior parietal or frontal lobes and most commonly these were type B tubers.
All Tubers

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White Matter Changes of the Unaffected Hemisphere After Hemispherotomy for Pediatric Intractable Epilepsy

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Purpose
Hemispherotomy is a surgical treatment of unilateral pediatric epilepsy refractory to medical treatment. Here we explore the white matter microstructure change in the unaffected contralateral hemisphere in hemispherotomy patients in order to understand the development of the residual normal hemisphere.

Materials and Methods
Ten patients who underwent hemispherotomy (mean age=3.6 years sd=2.8 years) as well as nine
age-matched controls were evaluated retrospectively for the study. Diffusion tensor imaging sequences were performed prior to surgery and at an average of 1.7 year (sd=1.2 year) after surgery. The preoperative diagnosis included hemimegalencephaly (n=6), Rasmussen encephalitis (n=2) and Sturge-Weber syndrome (n=2). A diffusion tensor model was fitted and unaffected hemispheres were aligned to a study-specific template. A histogram-based correction was employed by voxel-wise scaling of the individual fractional anisotropy (FA) mode to correct for scanner differences. Fractional anisotropy within the following regions of interest (ROIs) was compared between controls and patients before and after surgery: corpus callosum, internal capsule, superior longitudinal fasciculus, inferior longitudinal fasciculus, cingulum and the uncinate fasciculus.

Results
The ROI-based analysis showed significantly lower FA in the corpus callosum of patients both before and after surgery relative to controls. In addition, FA in the corpus callosum of patients decreased following surgery (p < 0.05, Figure 1a). Fractional anisotropy within the cingulum and the internal capsule of patients was significantly lower than that of controls following surgery, but not pre-operatively (p < 0.05, Figure 1b and 1c). The other ROIs did not show significant differences.

Conclusions
The results reveal a pattern of white matter microstructure changes in the contra-lateral hemisphere after hemispherotomy. Abnormalities in corpus callosum are expected due to abnormal fiber bundles presurgically as well as Wallerian degeneration in response to surgery. The changes in the cingulum and internal capsule indicate that abnormal white matter development is present in a wider distribution which may explain the affected neurodevelopmental outcomes in the patient group.

(Filename: TCT_P-93_combined.png)
A pipeline for detecting new multiple sclerosis lesions on longitudinal brain magnetic resonance imaging

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Purpose
To develop an automated approach to detect new multiple sclerosis (MS) lesions from longitudinal brain MR images. The goal is to reduce user interaction and provide an objective tool to eliminate inter- and intra-observer variability. This tool could help to predict conversion to MS from a clinically isolated syndrome and improve patient monitoring, providing new robust and automatic biomarkers for disease evolution.

Materials and Methods
A cohort of 35 patients with new lesions scanned with a 3T Siemens Trio machine has been used to evaluate the results. The new lesion volume for all patients ranges between 12.53 and 7563.08 mm³ with a mean of 80.58 mm³ and 5 new lesions per patient. The new pipeline, which relies on 3D subtraction, introduces a novel postprocessing approach based on deformation fields computed using the Demons nonrigid registration algorithm. The full pipeline includes several steps: skull stripping, bias correction, intrasubject normalization, registration (both rigid and nonrigid) between baseline and follow-up images, a tissue segmentation step on both time points, a 3D subtraction, and automated thresholding to obtain an initial positive activity mask and a final postprocessing step that combines rules based on intensity, lesion size and deformation fields to reduce the number of false positives.

Results
Evaluation with expert annotations of new appearing lesions provided by expert radiologists was performed. The following values were obtained: 71% of true positive (TP) fraction and 18% of false positive (FP) fraction, with a mean detection of three new lesions per patient.

Conclusions
Promising new MS lesion segmentation results have been obtained in terms of detection. Our novel approach highly reduces the number of FP providing a good correlation in terms of detection between manual annotations (current standard) and the automatic detection.

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6:00AM - 3:00PM

Clinical Appropriateness of Inpatient Repeat Head CT Examinations

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Purpose
The number of imaging studies has grown rapidly in the last decade. One particular area of concern is repeat imaging within a single admission. To address this issue, implementing an automated barrier for clinicians to bypass when requesting repeat studies within 1 week has been proposed. The aim of this study is to determine whether the most commonly repeated test at our
institution, the noncontrast head CT (NCHCT), is being appropriately ordered, and whether this barrier measure is necessary.

Materials and Methods
From December 2012 to May 2013, a cohort of 174 consecutive patients who had undergone a repeat NCHCT within 24 hours and 1 week was identified via the Radiology/Hospital information system. Clinical indication for the study and the ordering service were obtained. A neuroradiologist and the radiology departmental quality and safety director reviewed the indications and clinical appropriateness.

Results
Repeat imaging for all 174 patients was deemed appropriate. Of those, 106 (60%) were ordered by neurosurgery, neurology, or neuro-rehabilitation, with neurosurgery accounting for 40%. The most common indication for repeat studies was intracranial hemorrhage (35%). Hemorrhage, postoperative and infarct accounted for 83% of the indications for repeat studies.

Conclusions
The use of repeat NCHCT within a single admission was found to be clinically appropriate at our institution. The majority of referring physicians are subspecialists who are appropriately qualified to determine the clinical necessity of repeat imaging. Institution of automated ordering barriers to guide appropriate use of repeat NCHCT is unnecessary.
Signal intensity difference of normal facial nerves on Gd-enhanced three-dimensional T1-weighted images at 3T MRI between with and without fat suppression technique

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Purpose
Recently, fat-suppressed (FS) Gd-enhanced three-dimensional T1-weighted imaging (Gd 3D T1WI) have become common in our daily clinical practice. With an increased dynamic range and reduced chemical shift artifacts, fat suppression technique might improve enhancement of facial nerves. We compared the signal intensities of normal facial nerves on FS Gd 3D T1WI with nonFS Gd 3D T1WI at 3T.

Materials and Methods
We retrospectively reviewed 46 normal facial nerves of 23 patients who underwent gradient echo-based Gd 3D T1WI [T1-fast field echo (T1FFE)] with 3T MRI (Achieva, Philips) at our hospital from October 2012 to March 2014. Six out of 23 patients (4 men, 2 women; mean age, 51.67 years) underwent FS Gd T1FFE, and 17 (12 men, 5 women; mean age, 63.10 years) underwent nonFS Gd T1FFE. Spectral attenuated inversion recovery (SPAIR) was used for fat suppression technique. Cases with clinical facial palsy, cerebello-pontine angle tumor, past history of intracranial surgery, and radiation therapy were excluded from this study. Circular regions of interest (ROIs) with 50mm² were placed including vertical segments (Vt) of the facial nerves, mastoid air cells (Mc) adjacent to Vt, and medulla oblongata (Mo). We measured the maximum signal intensity for Vt, mean for Mc and Mo. The signal intensity ratio of Vt to Mc (Vt/ Mc) and Vt to Mo (Vt/ Mo) on FS Gd T1FFE were compared statistically with those on nonFS T1FFE via unpaired t-test.

Results
Vt/ Mc on FS Gd T1FFE (18.2±7.0) was significantly higher than that on nonFS Gd T1FFE (13.9±5.6) (P<0.05). Vt/ Mo on FS Gd T1FFE (1.69±0.57) also was significantly higher than that on nonFS Gd T1FFE (1.37±0.37) (P<0.05).

Conclusions
Signal intensities of normal facial nerves on FS Gd T1FFE were higher than those on nonFS Gd T1FFE.
Purpose
To ascertain the incidence of calcific prevertebral tendinitis (also known as longus colli tendinitis) on CT examinations of the cervical spine and neck at a large regional health care system.

Materials and Methods
The appearance of five cases in a 9-week period at associated emergency departments prompted a prospective study. All CT examinations of the neck and cervical spine performed over a 4-month period were evaluated for radiologic signs of calcific prevertebral tendinitis.

Results
The incidence of this radiologic diagnosis was significantly higher than expected by either clinicians or radiologists. Although complete data are not available at time of this abstract, a radiology group reading from emergency departments at four academic and six community hospitals can expect to encounter the diagnosis more than once a month. The presenting symptom was almost always severe but nonspecific neck pain. Clinicians seldom considered calcific tendinitis in their differential prior to imaging.

Conclusions
The scarcity of published case reports does not reflect the true incidence of calcific prevertebral tendinitis. Because it is a radiologic diagnosis, the radiologist must maintain a high index of suspicion in all cases of neck pain. Recognition of its characteristic imaging features (calcification at the upper insertion of the longus colli muscle with prevertebral edema) will distinguish it from other sources of neck pain including abscess, tumor, degenerative spine disease, trauma, angioedema, and infected thyroglossal duct cyst. Failure to identify calcific prevertebral tendinitis may lead to costly and invasive workups.
Oblique sagittal T2-weighted MR images for evaluating the cervical neural foramina.

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Purpose
Oblique sagittal T2-weighted imaging has been suggested as a better alternative compared to axial and conventional sagittal T2-weighted MR imaging in the evaluation of cervical neural foraminal stenosis (NFS). This study evaluated the diagnostic utility of oblique sagittal T2-weighted imaging.

Materials and Methods
This retrospective pilot study evaluated 2 patients with varying degrees of cervical NFS using axial, conventional sagittal, and oblique sagittal MR imaging. CT performed within 1 month of...
the MR imaging was used as a reference. The subjects, neither of whom had undergone surgical intervention, were evaluated independently by 2 neuroradiologists who were blinded to the relevant clinical history and results from previous diagnostic tests. Qualitative analysis was performed on a total of 24 neural foramina at each level from C2-C3 through C7-T1. The degree of stenosis was graded as none, mild, moderate, or severe. Each of the three sets of axial/conventional sagittal MR images, oblique sagittal T2 MR images, and CT was read separately and randomly. Using up to a one degree variation in stenosis between the CT and MRI findings as an agreement, the sensitivity, specificity, and accuracy of the MR sequences were calculated. Interobserver agreement between the two radiologists was analyzed using kappa statistics.

Results
Sensitivity, specificity, and accuracy for the oblique sagittal MR images in diagnosing cervical NFS were 100%, 58.82% and 85.41%, respectively. Sensitivity, specificity, and accuracy for the axial and conventional sagittal MR images were 96.9%, 57.1%, and 85.1%, respectively. There was substantial agreement between the two neuroradiologists with = 0.89 for MR images and = 0.916 for the CT images.

Conclusions
Oblique sagittal T2-weighted MR images were equally sensitive, specific, and accurate as axial and conventional sagittal MR images in the evaluation of cervical NFS. While there may be a clinical utility of sagittal oblique imaging in correlating a patient's symptoms and in surgical decision making, claims of marked improvement in diagnostic accuracy as compared to conventional imaging techniques requires more extensive evaluation.
Retrospective review of MR imaging, including enhancement pattern of spinal cord lesion, in neuromyelitis optica: a single-institution study.
Purpose
The characteristics of enhancement of the spinal cord lesion in the cases with neuromyelitis optica (NMO) were not described so far. The aim of our study is to investigate the imaging findings of the cases with NMO and NMO spectrum disorder (NMOSD) including contrast-enhanced MRI.

Materials and Methods
Thirteen patients with NMO and nine patients with NMOSD were enrolled in the analysis. The distribution of abnormal intensity and abnormal enhancement were analyzed retrospectively on MRI of the brain and the spine (including T1WI, T2WI, FLAIR, DWI and contrast-enhanced T1WI) by two experienced neuroradiologists.

Results
T2W hyperintensity or abnormal enhancement of optic nerve, chiasma or tract was found in 63% of cases. On brain MRI, abnormal intensity or enhancement was found in periependymal area, hypothalamus and medulla oblongata. On MRI of the spine, longitudinal extensive spinal cord lesion (>=3 vertebral segments) were found in 89% of the cases and abnormal enhancement were found in 53% of the cases with T2W hyperintense lesions. These findings were consistent with previous reports. The abnormal enhancement was distributed in the periphery of T2W hyperintense areas in 85% of cases with spinal-cord abnormal enhancement, indicating this distribution could be characteristics of NMO and NMOSD lesions. Thickening of cauda equina was found in one case, which may not have been reported yet.

Conclusions
This investigation indicated the abnormal enhancement of the spinal cord lesion located in the periphery of T2W hyperintense areas and thickening of cauda equina could occur in the cases with NMO or NMOSD. If we found these findings in interpretation of MRI, we had better include NMO and NMOSD in the differential diagnosis.
Utility of CT Guided Spinal Biopsy in Diagnosis and Management of Vertebral Osteomyelitis and Discitis

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Purpose
Vertebral osteomyelitis and discitis (VOD) are defined as an infection of the vertebra or intervertebral disc. Delayed treatment can result in serious neurologic morbidity. While various imaging modalities are used in the diagnostic evaluation of VOD, successful treatment is centered upon identifying the causative pathogen. Percutaneous image-guided (CT or fluoroscopic) biopsy has emerged as a frequently used alternative to open biopsy to identify the pathogen. The literature has reported varying microbiologic yields (30-100%) of CT-guided biopsy. The purpose of this study was to report on our departmental experience with diagnostic yield and alteration of clinical management of CT-guided spinal biopsy.

Materials and Methods
CT-guided spinal biopsies along with the clinical data and imaging examinations between 2010 and 2014 were reviewed retrospectively. Inclusion criteria included spinal biopsies with cultures performed for an indication of infection, imaging documenting suspected VOD, and preprocedural imaging within 21 days of biopsy. Alteration of clinical management was defined as a change in antibiotic treatment.

Results
Twenty-four patients met the inclusion criteria. Ten of 24 (41.7%) spine biopsies identified a pathogen. Pathogens identified included MRSA (3), Candida albicans, alpha Streptococcus, Proteus mirabilis, Enterobacter cloacae, Pseudomonas aeruginosa, Staphylococcus lugdunensis, and Group B Streptococcus. In four of those 10 positive cases, the pathogen identified was identical to that in blood (or other source) cultures; and antibiotics were not adjusted in those cases. In six of 24 cases, antibiotics were changed based upon the spinal biopsy culture results.

Conclusions
In our department's experience, the microbiologic yield of CT-guided spinal biopsy fell within the previously reported range. CT-guided spinal biopsy changed management in 25% of cases with an imaging diagnosis of VOD. As CT-guided spinal biopsy is associated with its own set of complications, the decision to perform this procedure should be based upon close clinical consultation.


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Purpose
Cervical transforaminal epidural injections (C TFEI) often are performed for cervical radicular pain (arm pain) using fluoroscopic or CT guidance. This procedure usually occurs without complications but untoward events do happen. Dreadful complications have been reported including spinal cord infarction, stroke, vertebral artery dissection and death. One postulated mechanism of these adverse outcomes is due to needle placement misadventure, including injury to the vertebral artery. The vertebral artery usually is located in the anterior foramen but anatomical variation has been described. Much has been written in the literature concerning injury or injection of injectate solution into the vertebral artery during CT-guided C TFEI, however the literature has been emerging on how to translate these anatomical variations to help guide safe fluoroscopic needle placement for C TFEI. The lateral articular pillar mass and neural foramen are key landmarks when performing C TFEI under fluoroscopic guidance. The purpose of this study is to map the anatomical location of the vertebral artery relative to the lateral mass and neural foramen using CT angiogram in order to locate a safe target zone in view of using fluoroscopy.

Materials and Methods
One hundred consecutive CT angiograms of the neck performed at the Hospital of the University of Pennsylvania were selected (patient age range 16-93 years, median age 59 years and SD: 18.3 years). These then were used to determine the location of the vertebral artery relative to the lateral mass at the C4-5, C5-6, and C6-7 levels dividing up the whereabouts of the vertebral artery in medial, middle, or lateral thirds in relationship to the lateral mass. Also, the positions of the vertebral arteries relative to the neural foramina at the C4-5, C5-6 and C6-7 levels were evaluated and characterized into the anterior portion, posterior portion, or in both anterior and posterior portions of the neural foramina.

Results
Vertebral artery positioning was located posterior to the neural foramen and ranged from 0-7% of the time which was greatest at the left C4-5 level (7 out of 100 cases). The vertebral artery also was located in the lateral third in relationship to the lateral mass 0-4%, greatest at the left C5-6 and C6-7 levels (both positions were 4 out of 100 cases). Greater than 90% of cases proved to show that the vertebral artery was located either anterior to or between (both) the neural foramen at the C4-5, C5-6, and C6-7 levels bilaterally. Also, in greater than 90% of cases the vertebral artery was located either in the middle or medial third in relationship to the lateral mass at the C4-5, C5-6, and C6-7 levels bilaterally.

Conclusions
The standard needle target zone for cervical TFESI is the posterior neural foramen and lateral third of the lateral mass. Rarely the vertebral artery is located within the target zone. However, the location of the vertebral artery should be identified on noninvasive imaging whenever possible prior to an intervention in order to minimize risk of inadvertent vertebral artery injury.

Monday
6:30AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exposition Hall A (Level 1)

Educational Exhibit Poster (Print) - Adult Brain
EdE-45
A Checklist for the Radiological Evaluation of Cerebral Herniation for Trainees and Non-Radiologists.

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Purpose
To provide a simplified checklist of cross-sectional cerebral herniation. A checklist will allow practitioners who do not have the experience to approach an entire Head CT systematically to approach life-threatening herniations systematically.

Materials and Methods
To provide a systematic evaluation of any Head CT limited to the detection of intracranial herniations. We will provide a location-based checklist with annotated high quality images to guide users in a focused systematic evaluation.

Results
The subtleties of cerebral herniation on cross-sectional imaging can be daunting. One study in the Emergency Medicine literature found three asymptomatic herniations that were missed in the preliminary evaluation of CT Head studies for suspected subarachnoid hemorrhage (SAH). The majority of medical students and trainees who rotate through our department can describe and discuss central nervous system (CNS) herniation from a diagram or gross anatomy stand point but often are hard pressed to translate this into assessment of cross-sectional imaging. The broad knowledge base and experience required to systematically approach the entire CNS requires significant time and training to develop. However all radiologic evaluations benefit from a systematic approach at any level. To this end we will provide a short cross-sectional imaging checklist detailing the critical locations to evaluate for CNS herniations. This guide is not intended to teach neuroanatomy, imaging modalities, or allow full diagnosis and description of any pathology. The major goal is to teach the basic approach to and appearance of cerebral herniations on cross-sectional imaging.

Conclusions
We present a location-based checklist to facilitate recognition of cerebral herniation syndromes.
Adult Pilocytic Astrocytoma - An Educational Review of a Rare Entity with Radiopathologic Correlation

T Folan¹, A Hussain¹, D Omer¹, M Johnson¹
¹University of Rochester, Rochester, NY

Purpose
Pilocytic astrocytoma is a World Health Organization (WHO) grade I neoplasm most commonly associated with the pediatric population with 75% of tumors occurring in the first two decades of life. When they occur in adults (> 18 years old) they tend to follow an aggressive clinical course. We will review 35 cases of this rare entity, adult pilocytic astrocytoma (APA), from our institutional database focusing on imaging and pathologic features as well as providing an extensive educational review of the radiological literature on this tumor.

Materials and Methods
We identified 35 cases of pathology-proven adult pilocytic astrocytoma from our institution, reviewing imaging, clinical course, pathology findings and molecular analysis to include testing for mitogen-activated protein kinase (MAP kinase), mechanistic target of rapamycin (mTOR), B-Raf proto-oncogene (BRAF) fusion product, BRAF V600 mutation product and isocitrate dehydrogenase (IDH) I mutation amongst others. Next we compared imaging characteristics with molecular signatures to identify any discernible associations. In addition we performed an exhaustive literature review on APAs.

Results
In contrast to juvenile pilocytic astrocytoma (JPA), which has a predilection for the posterior fossa/cerebellum, APAs tend to occur in a supratentorial location. Imaging features are often similar to the classic cyst with an enhancing mural nodule appearance associated with the juvenile variant of this tumor. Tumor biology was variable with regard to imaging appearance.

Conclusions
Adult pilocytic astrocytoma is indeed an uncommon tumor with distinct imaging and pathologic features. Given the rarity of this tumor it infrequently is considered in the differential diagnosis of a supratentorial intra-axial lesion in an adult. In submitting these 35 cases we aim to re-examine and review what is known about this rare entity, in addition to promoting awareness regarding its imaging and pathologic appearance, molecular analysis, clinical course and outcome.

Bilateral medial temporal lobe signal abnormality on MRI – expanding differential diagnosis and growing understanding

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Purpose
Bilateral medial temporal lobe signal alteration on MRI has multiple differential diagnoses, several of which are relatively recently described entities and early recognition carry important clinical implications. This poster gives a summary of the differential diagnosis and potential differentiating features with illustrative examples.

Materials and Methods
Cases with the MRI finding of bilateral medial temporal lobe signal abnormality were collected at a large tertiary hospital, and a literature search for this finding was done.

Results
Herpes simplex virus (HSV) encephalitis is a well recognized cause for unilateral or bilateral medial temporal lobe signal change. Compared to other causes of limbic encephalitis, onset is more acute and hemorrhage is more commonly seen. Human herpesvirus-6 (HHV-6) encephalitis is an emerging syndrome in immunocompromised patients, especially following allogenic hematopoietic cell transplantation. HHV-6 is resistant to acyclovir but responds to ganciclovir and foscarnet. Paraneoplastic limbic encephalitis is most common associated lung cancer, testicular tumors, thymoma, breast cancer, and Hodgkin lymphoma. Patients with anti-Ma2 often have involvement of the diencephalon or brainstem in addition to limbic system involvement. Other autoimmune limbic encephalitis can occur with or without underlying cancer. The most well known is anti-leucine-rich glioma inactivated-1 (LGI-1) encephalitis. Additional rare etiologies for limbic encephalitis include neurosyphilis, varicella-zoster virus, systemic lupus erythematosus. Prolonged recent seizure activity also can result in bilateral hippocampal signal abnormality. Hypoxic ischemic injury and gliomatosis can involve the bilateral hippocampi but usually have other abnormalities. Mesial temporal sclerosis can be bilateral but usually is associated with hippocampal volume loss.

Conclusions
There is increasingly refined understanding of entities causing bilateral medial temporal lobe signal abnormality in recent years, with the list of important differential diagnosis currently including HSV encephalitis, paraneoplastic and autoimmune limbic encephalitis, HHV-6 encephalitis, neurosyphilis, varicella-zoster, lupus, and prolonged recent seizure activity.

EdE-44

6:30AM - 3:00PM

Blunt Cerebrovascular Injury - a Review

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Purpose
Blunt cerebrovascular injury is found in 1% of all blunt trauma. Controversy remains regarding the appropriate population to screen for these injuries. This educational exhibit aims to review the literature regarding screening for blunt cerebrovascular injury and to present the findings of blunt cerebrovascular injury on CT angiogram and CT venogram of the head and neck.

Materials and Methods
Screening criteria for angiographic imaging in blunt trauma will be reviewed. Numerous case
presentations from our inner city level 1 trauma center will be used to illustrate the cross-section imaging findings of various forms of cerebrovascular injury.

Results
The modified Denver criteria, and the Memphis criteria are both well established screening criteria for blunt cerebrovascular injury. These criteria include both clinical factors such as neurological exam not explained by brain imaging, and neck soft tissue injury, as well as imaging findings such as cervical spine fracture, stroke on follow-up head CT, Le Forte II or III fracture, and a basilar skull fracture involving the carotid canal. Blunt cerebrovascular injury occurs in both the head and neck. The injuries reviewed include: dissection/intimal injury, pseudoaneurysm, and traumatic occlusion of the extracranial and intracranial vertebral and carotid arteries. Traumatic cavernous carotid fistula also will be presented. Additionally, traumatic dural venous sinus compression, injury, and thrombosis will be discussed.

Conclusions
Although blunt traumatic cerebrovascular injury is a rare entity, it is crucial to identify as it can lead to high rates of stroke and mortality. It is important to be aware of the noncontrast CT findings associated with cerebrovascular injury in order to have a high degree of clinical suspicion and to guide the referring clinician to the appropriate next step imaging. Knowing the imaging findings of the various types of injury allows the neuroradiologist to make an accurate diagnosis and alert the clinician to this significant diagnosis.

EdE-43
6:30AM - 3:00PM

Brain Structural and Resting-State Functional MRI Connectivity Biomarkers for Predicting Functional Outcome after Stroke

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Purpose
Approximately one third of patients have persistent disability after stroke resulting in substantial long term health-related costs, partly because recovery mechanisms are poorly understood and accurate methods to predict poor outcome are lacking. Even when early treatment cannot prevent tissue loss, surviving brain areas have substantial reorganizational capacity. Functional reorganization contributes to recovery and is enhanced by neurorehabilitation. Functional and structural connectivity MRI metrics have revolutionized understanding of brain connectivity: diffusion tensor imaging (DTI) reveals the brain's macro- and micro-structure, and functional MRI shows specific cognitive and behavioral domains. We summarize current evidence that
brain connectivity biomarkers could be used to better predict functional outcome, helping patients and clinicians to set treatment goals and strategies and researchers to select and monitor patients for stroke trials.

Materials and Methods
1. We explain DTI and resting-state functional MRI (rs fMRI) techniques and postprocessing, and how to optimize protocols for ischemic stroke. 2. We use cases of acute, subacute, and chronic strokes to address the potential role of structural and functional connectivity by analyzing quantitative and qualitative data to predict outcome after acute ischemic stroke. 3. We highlight the role of structural and rs fMRI connectivity indexes as biomarkers of stroke-related damage and the potential value of lesion mapping techniques.

Results
Advanced MRI biomarkers bring us closer to understanding tissue microstructure and structural connectivity. Motor outcome depends strongly on corticospinal tract (CST) integrity, and involvement of specific regions (e.g., posterior limb of internal capsule) is associated with poor long-term recovery. Corticospinal tract lesion load predicts motor impairment after stroke, showing that infarct location and fiber tract integrity play critical roles in outcome. While MRI reflects focal brain damage, clinical symptoms often are explained better by indirect effects of focal lesions. Disruption and subsequent reorganization of functional connections occur locally and remotely; for example, patients with neglect symptoms can have disrupted interhemispheric functional connectivity within the attention network. Symptom severity correlates with decreased connectivity, and recovery from symptoms correlates with recovery of normal connectivity patterns; this also occurs in sensorimotor and language networks. Advanced MRI biomarkers could help determine patterns of development in individual patients, guiding stimulation aimed at recovering from specific lesions and compensatory rehabilitation and other interventions aimed at improving specific functions.

Conclusions
MRI connectivity biomarkers could serve to develop prediction-based therapy strategies. Incorporating validated connectivity biomarkers into neurorehabilitation decision-making algorithms may improve stroke rehabilitation because potential recovery through stimulating neuroplasticity may justify rehabilitation.

**EdE-31**

**Brain Tumor Mimics: ‘Why Do a Biopsy if You Don’t Have To?’**

P Armstrong¹, R Joseph¹, K Forbes¹

¹Institute of Neurological Sciences, Glasgow, United Kingdom

Purpose
The purpose of this exhibit is to present a pictorial review of brain tumor mimics, highlighting diagnostic features that could be used to help differentiate tumor from non-neoplastic pathologies. There are a number of pathologies, which have enough shared characteristics on imaging with brain tumors to classify them as tumor mimics. These all have the potential for imaging misdiagnosis, delaying appropriate initial therapy and resulting in unnecessary brain biopsy.
Materials and Methods
Imaging examples of tumor mimics were collected from a regional tertiary neurosciences center over the last 5 years (Institute of Neurological Sciences, Glasgow, Scotland, UK). Subjects were identified from the neurosciences multi-disciplinary team (MDT) meetings, where a brain tumor diagnosis was considered most likely by clinicians. Clinical follow up, pathologic findings, where obtained and final diagnosis were collated with imaging findings.

Results
Both classic and atypical examples of brain tumor mimics are presented for teaching purposes, with comparison to pathologically proven tumor. Tumor mimics discussed include stroke, demyelination, granulomatous disease, infection and radiation necrosis. Imaging techniques presented consist of both CT and MRI techniques, including diffusion-weighted imaging, spectrophotoscopy, and susceptibility-weighted imaging.

Conclusions
This educational exhibit offers a comprehensive pictorial review of neuroimaging findings of pathologies, which can mimic brain tumors and can cause diagnostic uncertainty. Drawing on experiences of a neurosciences MDT and concentrating on positive, discriminating, imaging findings, this exhibit offers the neuroradiologist a refresher in the differential diagnosis of brain tumor. Figure 1: Ring-enhancing cerebellar lesion (1a), which resembles a metastasis demonstrates restricted diffusion (1b), pathologically proven as abscess. Mass-like high signal on T2W FLAIR (1c) which demonstrates incomplete ring enhancement (1d), pathological proven tumefactive demyelination.
Brain Tumors and Anti-angiogenic Therapy: An Educational Review

T Folan¹, T LoStracco¹, R Mangla¹, J Almast¹
¹University of Rochester, Rochester, NY

Purpose
Bevacizumab (Avastin) is an anti-angiogenic agent that has reshaped our ability to treat certain primary and secondary brain tumors. Although it has changed clinical practice, the myriad imaging features of these tumors in response to Avastin therapy has not been described comprehensively in the radiological literature. We will describe briefly the mechanism of action of this medication prior to detailing the many and varied imaging appearances of brain tumors in response to Avastin therapy. We then will explain the significance of these variable appearances with regard to tumor response.

Materials and Methods
We reviewed over 180 patients from our institutional database having undergone Avastin therapy for brain tumors. Imaging findings and subsequent clinical course were reviewed for recurring patterns in the imaging appearance of these tumors following Avastin therapy as well as for correlation between imaging appearance and clinical course/outcome. We also performed a comprehensive literature review with regard to anti-angiogenic therapy and the imaging appearance of brain tumors in response to anti-angiogenic agents.

Results
We identified several major categories under which the response of glioma's and metastatic disease to Avastin therapy can be broadly grouped/characterized and discussed including progression, positive response, pseudoresponse, presence/absence of restricted diffusion, confounding appearances on perfusion imaging, intrallesional hemmorhage, calcification, recurrence patterns and the significance of T1 hyperintensity following treatment, amongst others.

Conclusions
Anti-angiogenic therapy is an exciting and promising avenue of therapy for patients with glioma's refractory to other treatments and certain secondary brain tumors. We aim to provide a comprehensive educational review of the varying imaging appearances of these tumors in patients undergoing/having received anti-angiogenic therapy. In doing so we hope to provide a valuable educational review to aid in the accurate interpretation of the variable appearance of this increasingly encountered and often challenging diagnostic entity.

Clinical Neuropathology at 7T compared with 3T

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¹Cleveland Clinic, Cleveland, OH
Purpose
Today, 7T MRI is not FDA 510(k) cleared for routine clinical use, and most patients are imaged on the basis of prospective research protocols. Here we present a wide array of neuropathology imaged at 7T on clinical patients with known neurological disease, using an IRB-approved protocol to compare lesion characteristics already visualized at lower field to those seen at 7T.

Materials and Methods
After IRB approval, any patient with neurological disease and lower-field imaging (i.e., 1.5T or 3T) is eligible to undergo a 7T scan (Siemens, Erlangen, Germany) for the strict purpose of comparing lesion characteristics at low field to those at higher field.

Results
To date, a total of 32 patients have been scanned, including 11 with TBI, 15 with epilepsy, two with MS, three with ALS, and one with cavernous malformation. We present a image survey of how these lesions appear at 7T as compared with lower field. The primary clinical advantages of 7T are due primarily to smaller voxels and stronger susceptibility effect. These advantages have helped to correct misinterpretations at lower field, for example a developmental venous anomaly appearing as TBI lesions as lower field, and superior delineation of malformations of cortical development.

Conclusions
Using an IRB dedicated to the comparison of clinical neuropathology imaged at 7T to lower field, we present a survey of clinical lesions. In particular we highlight the differences between the two fields, and describe the clinical advantages of 7T.

EdE-15

Disseminated Fungal Central Nervous System Infections in Immunocompromised Patients: A Pictorial Review

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1University of Rochester Medical Center, Rochester, NY, 2University of Rochester, Rochester, NY, 3UMass Memorial Medical Center, Worcester, MA

Purpose
Disseminated fungal central nervous system (CNS) infections are relatively rare but significant cause of morbidity and mortality in immunocompromised patients. The purpose of this educational poster is to provide an overview on the differential diagnosis of fungal CNS disease based on their unique clinical presentation and imaging characteristics.

Materials and Methods
A variety of cases of disseminated fungal disease will be presented illustrating unique imaging appearance and attenuation on computed tomography (CT) and signal intensity characteristics on different sequences using magnetic resonance imaging (MRI).

Results
This educational poster will illustrate through case based presentations a variety of disseminated fungal CNS disease in immunocompromised patients including the most common pathogens such as aspergillosis and cryptococcus. Describe the signs and symptoms, laboratory tests, and pathologic features of each pathogen. Discuss the imaging characteristics unique to each fungal disease. Briefly review the therapeutic management.
Conclusions
Disseminated fungal disease represents a narrowed spectrum of CNS infection. However, knowledge of the clinical and imaging features can assist in narrowing the differential diagnosis for more accurate and directed treatment.

EdE-24

**Don't Biopsy Me! Vascular Lesions Mimicking Tumors and Clues to Prospective Diagnosis**

M Shujaat\(^1\), W Johnson\(^1\), H Slone\(^2\), E Bourekas\(^2\), A Kalnin\(^3\), A Yoo\(^4\), P Schaefer\(^4\), D Boulter\(^2\)

\(^1\)Ohio State University Wexner Medical Center, Columbus, OH, \(^2\)Wexner Medical Center at The Ohio State University, Columbus, OH, \(^3\)The Ohio State Univ. College of Medicine, Columbus, OH, \(^4\)Massachusetts General Hospital, Boston, MA

Purpose
Vascular lesions of the central nervous system can uncommonly be confused with tumors, both by their imaging appearance and clinical symptomatology. In these cases, the role of the neuroradiologist is to alert clinicians to the possibility of a vascular lesion and ensure proper imaging triage is obtained in order to avoid a potentially catastrophic biopsy or delay in appropriate treatment. Our aim is to present a case series highlighting these uncommon lesions, with a discussion of imaging features that aid in correct diagnosis.

Materials and Methods
Review of a neuroradiology case file identified cases of vascular lesions that had imaging features that could be confused with tumors. Representative cases are presented in an educational format with an emphasis on differentiating features.

Results
Aneurysms that are large, occur in uncommon locations, and/or erode into adjacent structures such as the vertebral column, petrous apex, and paranasal sinuses can be confused with tumor. Dural arteriovenous fistulae can mimic tumor, particularly when associated with contrast enhancement and mass effect involving the brain, brainstem, or spinal cord. Cavernous malformations can mimic tumor when large and associated with mass effect and significant contrast enhancement. Venous infarction and subacute ischemic stroke may mimic tumor, especially when associated with mass effect and contrast enhancement. Certain vasculopathies can mimic tumor when associated with parenchymal enhancement and mass effect, such as inflammatory cerebral amyloid angiopathy and Bechet's disease. Carotodynia may mimic tumor, when associated with mass-like soft tissue infiltration of the carotid sheath.

Conclusions
Vascular lesions that mimic tumor are comprised of both atypical presentations of common lesions and typical presentations of uncommon disorders. Knowledge of the imaging spectrum of these lesions may help to improve prospective diagnosis and ensure appropriate management.
Idiopathic Hypertrophic Pachymeningitis: a Challenging Imaging Diagnosis
M Gule-Monroe, C Sitton

The University of Texas Medical School at Houston, Houston, TX

Purpose
1. Introduce the presentation, clinical course and treatment of idiopathic hypertrophic pachymeningitis (IHP).
2. Demonstrate the imaging presentation of IHP.
3. Review differential diagnosis and potential pitfalls in diagnosis of IHP.

Materials and Methods
Literature review with focus on presentation, clinical course and treatment of IHP. Review the imaging appearance of IHP, using imaging examples from our own institution, emphasizing the potential imaging pitfalls and differential diagnosis.

Results
IHP is an extremely rare and challenging disease both from an imaging and management perspective. Only a few case reports exist of this rare disorder. The presentation of IHP generally is very nonspecific. Commonly the presentation may be headache or cranial nerve palsy, or less frequently, dural sinus thrombosis or hydrocephalus. The characteristic radiographic appearance of IHP is thick dural enhancement, which may be diffuse and symmetric or very focal. Occasionally the thickening may be mass-like. Associated dural venous thrombosis or white matter changes may be seen. A migratory, relapsing pattern with changing location of the dural thickening over time was seen in one of our patients. The imaging appearance of IHP can mimic numerous other disease entities, as dural enhancing dural thickening is very nonspecific. Common differential diagnoses include en-plaque meningioma, neuro-sarcoidosis, neurosyphilis, fungal or mycobacterial infection, dural metastasis, Rosai Dorfman or Erdheim-Chester disease. IHP generally is regarded as a diagnosis of exclusion and definitive diagnosis is via surgical biopsy. Treatment of IHP generally consists of corticosteroid therapy. In refractory cases other immunosuppressive drugs may be utilized. Surgical resection may be necessary. A relapsing and remitting clinical course has been reported in the literature and was seen in one of our patients.

Conclusions
IHP is a rare and very challenging clinical and imaging diagnosis that may simulate a wide range of disorders. IHP should be considered in the differential diagnosis in the case of relapsing and remitting pachymeningeal enhancement.
Imaging Brain Infections: a Review of common infections

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Purpose
To review the imaging appearance of a variety of brain infections using a multi-modality approach.

Materials and Methods
The role of CT, MRI and MR spectroscopy in the diagnosis of brain infections is reviewed.

Results
Brain infections in immunocompetent and immunocompromised hosts can affect the meninges
and/or the brain parenchyma. Bacterial infections like pyogenic abscesses and bacterial meningitis can progress very rapidly if not promptly diagnosed. Other brain infections like parasitic infections may have an insidious course or present acutely with neurosurgical emergency, e.g., acute ventricular obstruction in ventricular neurocysticercosis. We present a review of the radiologic appearance of common infectious brain diseases.

Conclusions
It is important for radiologists to be aware of the imaging appearance of brain infections and associated secondary complications. Neuroimaging plays a pivotal role in achieving this goal.

EdE-20
6:30AM - 3:00PM

Imaging Findings in Pituitary Apoplexy and Other Mimicking Conditions With Histopathologic Correlation

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Purpose
Pituitary apoplexy is an acute clinical syndrome which occurs when hemorrhage and/or infarction occurs within the pituitary gland. The clinical symptoms of pituitary apoplexy are nonspecific and can mimic other common causes of headache such as subarachnoid hemorrhage and venous sinus thrombosis. It is important that cases of pituitary apoplexy are recognized early before serious complications such as hypotension occur. In this poster we review the common clinical, imaging, and histopathologic findings of pituitary apoplexy as well as other pathology that may occur in the sella turcica.

Materials and Methods
We retrospectively reviewed and located several cases of pituitary apoplexy and summarized the imaging and histopathologic findings. We also examined other etiologies that may present with similar symptoms such as a pituitary abscess and nonadenomatous intrapituitary hemorrhage. We also reviewed other causes of lesions that can mimic the imaging findings of pituitary apoplexy such as craniopharyngioma and Rathke's cleft cyst.

Results
Pituitary apoplexy most commonly occurs within a pre-existing pituitary adenoma. This acute syndrome has a male predominance and occurs most commonly in middle age. The most common risk factor for apoplexy is anticoagulation, however other risk factors such as recent pregnancy, trauma, surgery, or bromocriptine therapy also increases risk. Apoplexy is thought to complicate approximately 1% of all macroadenomas. In the acute setting pituitary apoplexy appears on computed tomography as a heterogeneous sellar and suprasellar mass with areas of increased attenuation indicating acute hemorrhage. Following intravenous contrast peripheral enhancement of the mass suggests that it is not a solid lesion. On magnetic resonance imaging acute hemorrhage initially will appear hypointense to isointense on T1-weighted images similar to other causes of acute hemorrhage. After a few days it will become hyperintense on T1-weighted images. Apoplexy will appear hypointense on T2-weighted and T2*-weighted gradient echo images, with prominent blooming on T2*-weighted sequences. Complications are better seen on MRI including mass effect upon surrounding structures including the hypothalamus and optic tracts. A similar acute syndrome can be caused by a pituitary abscess. Abscess will have a
similar appearance and may be impossible to differentiate from an acute infarct. Abscesses may be more hyperintense, and will lack blooming on gradient echo images. Other causes of pituitary lesions more commonly present with chronic symptoms. Both Rathke's cleft cysts and craniopharyngioma have cystic components and may appear hyperintense on T1-weighted images secondary to increased protein, however usually the pituitary gland can be identified separately. Macroadenomas also can cause chronic mass effect, however usually the suprasellar component is larger.

Conclusions
Pituitary apoplexy is an uncommon yet potentially fatal syndrome that is difficult to diagnose on clinical findings alone. Therefore it is critical for the neuroradiologist to recognize this disease and its mimics.

EdE-18

6:30AM - 3:00PM

Intracranial and Extracranial Manifestations of Sarcoidosis: A Pictorial Review

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Purpose
To examine the numerous and varied manifestations of biopsy-proven sarcoidosis within the intracranial and extracranial structures of the head.

Materials and Methods
A retrospective search of patient neuroimaging studies at our institution from January 2004 through October 2014 was performed, for patients with the clinical diagnosis of sarcoidosis or imaging findings suggestive of the disease. Patients with biopsy results of sarcoidosis were included. Imaging modalities reviewed include CT, MRI and nuclear medicine scans.

Results
Review of the literature demonstrates the myriad manifestations of granulomatous diseases such as sarcoidosis within the intracranial and extracranial structures of the head. Differentiation between sarcoidosis and alternate inflammatory etiologies causing granuloma formation requires a thorough review of patient history and clinical symptoms combined with tissue biopsy. However, the radiologist can play an important role in diagnosing sarcoidosis with specific knowledge of its radiologic appearance. We present a pictorial demonstration of multiple cases involving the soft tissue and bony structures of the face as well as cases affecting the calvarium, meninges and brain parenchyma. In sarcoidosis, exuberant inflammation in the paranasal sinuses can lead to pansinusitis with extension to the deep face and orbits, including infiltration of the retroantral fat and pterygoid muscles, enlargement of the extracranial segments of multiple cranial nerves, erosion of the sphenoid bone, infiltration of the cavernous sinus, optic neuritis, and enlargement of the extraocular muscles and lacrimal glands (Figure A and Figure B). Affected structures generally demonstrate increased T2 signal and avid enhancement on postcontrast T1 images. Glandular disease is common as well, with increased uptake in the lacrimal, parotid and submandibular glands on gallium scan. Intracranially, dural sarcoidosis may mimic tumor or infectious etiologies. A case with pachymeningeal thickening along the anterior cranial fossa with erosion through the cribiform plate is presented (Figure C). Focal
dural lesions can occur, such as an enhancing dural-based mass along the planum sphenoidale (Figure D). Involvement of the pituitary gland has been reported in the literature as well, and we present an expansile lesion along the pituitary stalk with homogeneous enhancement on postcontrast T1 images. Focal calvarial lesions are presented, frequently seen in conjunction with soft tissue disease.

Conclusions
Sarcoidosis is a multifaceted granulomatous disease that affects multiple structures within the head. We demonstrate extracranial involvement of the paranasal sinuses, deep facial soft tissues, optic nerves and extraocular muscles, cranial nerves and glandular tissues. Bony calvarial disease, as well as lesions in the meninges, cerebral parenchyma and pituitary are presented.
Introduction to Texture Analysis for Brain Tumors: Concept and Clinical Relevance.

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Purpose
MR imaging offers insights related to anatomical, physiologic, biophysical detail of the tissue. Image postprocessing can provide quantitative information about pathology that can aid medical diagnosis and disease monitoring. Texture analysis (TA) can detect subtle abnormalities not perceivable with the naked eye. In this work, we describe the concept of TA and its clinical relevance.

Materials and Methods
Texture analysis can be applied to any digital image, thus to medical images. The methodology for TA consists of three steps: Segmentation, Feature Extraction, and Texture Classification. 1) Segmentation: Selection of an appropriate region-of-interest (ROI) is the first step of TA. It is crucial to select an ROI that captures sufficient textural information and also share similar tissue characteristics. In Figure 1a-c, an axial MR image from a glioblastoma patient is shown along with the corresponding ROIs that represent three distinct structures, namely edema/invasion, contrast-enhancing tumor, and necrosis. 2) Feature Extraction: Different approaches can be used to assess the relationship between pixel pairs, resulting in approach-specific features. Those features characterize the spatial distribution of signal intensity variation within the ROI. 3) Texture Classification: In this final step, one can identify the features most capable of discriminating between ROIs by using a decision or discriminant function. In Figure 1d, TA was used to discriminate five distinct regions in a glioblastoma patient. In its clinical application, TA can be used for determination of tumor aggressiveness, response to therapy, association with genomics.

Results
Texture features are associated with specific intensity patterns in the image and can enable us to detect biology-related information.

Conclusions
As a postprocessing technique, TA can provide numerical description of tissues for more objective and reliable classification, diagnosis, and disease monitoring and may complement the macrostructural information already used by the radiologists. The importance of TA is increasing as the spatial resolution of medical imaging is increasing and computer power allows for complex processing.
Figure 1: (a) Example of axial T1 post-contrast MR image from a patient with glioblastoma. (b, c) Three Regions of Interest (ROI)s outlined on the T1 post-contrast and FLAIR MR Image respectively. Necrosis is shown in orange, tumor in yellow and edema/invasion in blue. (d) Two more additional ROI shown; peritumoral NAWM in green and contralateral NAWM in blue.
Is it Progressive Disease? Utility of 18F-FDG PET/MR, Dynamic Susceptibility Contrast Perfusion and Dynamic Contrast Enhanced Permeability Imaging in Differentiating Progressive Disease from Radiation Change

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Purpose
Describe the utility of 18F-FDG PET/MR combined with functional MRI (fMRI) in the evaluation of treated intra-axial malignancy; differentiation of progressive disease from radiation change.

Materials and Methods
At our institution, 50 patients with history of previously treated high grade intra-axial malignancy and recurrent enhancing lesions have been evaluated contemporaneously with 18F-FDG PET/CT, 18F-FDG PET/MR, dynamic contrast-enhanced (DCE) T1 permeability, and dynamic susceptibility contrast (DSC) perfusion imaging (pMRI). Clinical and imaging follow up and pathologic findings have been obtained. Drawing from this data, our focus will be on the complementary utility of 18F-FDG PET/MR and adjunctive fMRI sequences (DSC and DCE T1) in the differentiation of progressive disease from radiation change: 1. Advantages of 18F-FDG PET/MR compared with 18F-FDG PET/CT will be addressed. 2. We will discuss the feasibility and utility of qualitative, quantitative, and semiquantitative assessment of 18F-FDG PET/MR and DCE T1 (permeability) and pMRI in differentiating progressive disease from radiation change. 3. Limitations and advantages of individual techniques will be described with demonstrative examples. 4. Mixed disease (neoplasm and radiation necrosis) can be particularly challenging and will be emphasized with illustrative examples of the complementary utility of 18F-FDG PET/MR and fMRI.

Results
Recurrent enhancement is typical in the post-treatment period of high grade intra-axial malignancy and differentiation of progressive disease from radiation change has great clinical relevance requiring divergent treatment. 18F-FDG PET/CT is currently employed clinically, but is limited by poor anatomical localization. PET/MR is an emerging technique which improves accuracy of 18F-FDG PET, particularly when fused to gadolinium-enhanced images owing to improved anatomical localization and lesion coregistration. Functional MRI techniques including permeability and perfusion imaging have significant independent utility in evaluating for progressive disease. PET/MR affords the opportunity to perform adjunctive fMRI sequences, in a single examination, which provides a wealth of complementary data.
Conclusions
18F-FDG PET/MR and adjunctive functional MRI sequences performed in a single examination can greatly improve sensitivity and specificity and diagnostic confidence in differentiation of progressive disease from radiation change.

EdE-34

**Many faces of intracranial malignant lymphoma.**

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**Purpose**
In this article, we will demonstrate the various imaging findings according to the subtype in the brain parenchyma. We also demonstrate the imaging findings outside the brain parenchyma, where it is important but unfamiliar for neuroradiologists in the daily practice.

**Materials and Methods**
After review of typical and atypical imaging features of the primary central nervous system (CNS) of the brain parenchyma in the immunocompetent patients, we demonstrate the imaging features in the immunocompromised patients, and a rare subtype. Finally, we also will introduce the imaging findings outside the brain parenchyma.

**Results**
Primary CNS lymphoma is a predominantly B-cell lymphoma. It has a diffuse macroscopic growth pattern, distinct perivascular extension and a predilection for the basal ganglia or periventricular region. The high cellularity of tumors appears hyperdense on noncontrast computed tomography, with high signal intensity on diffusion-weighted imaging (DWI), low to intermediate signal intensity on T2WI magnetic resonance image (MRI) and homogeneous enhancement. MR spectroscopy shows prominent lipid peak. Above findings are typical.

Atypical findings are internal hemorrhage and necrosis. In the immunocompromised patients, ring enhancement representing necrosis can be seen. T cell lymphoma presents with subcortical distribution. The internal mass has the similar findings with typical findings. Lymphomatosis cerebri shows extensive or diffuse leukoencephalopathy, no or minimal contrast enhancement. Intravascular lymphomatosis (IVL) shows nonspecific white matter lesions suggestive of small vessel disease or demyelination. Lymphoplasmacytic lymphoma (LPL) shows hyperintensity on T2WI with patchy or no enhancement. Outside the brain parenchyma, skull and dural lymphoma have the similar internal signal feature with typical findings.

**Conclusions**
Primary intracranial lymphoma has various imaging findings. Firstly, we have to be familiar with typical findings and atypical findings of the conventional parenchymal lymphoma. Next, we need to have knowledge about the rare subtype, the imaging findings of which are often different from the conventional lymphoma.
Medication-Related Central Nervous System Complications: Pathophysiology and Imaging

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Purpose
To illustrate the MR imaging spectrum of medication-induced conditions of the central nervous system. To elucidate the importance of imaging in early recognition and management of medication-induced complications. There is generally limited awareness of the neurological complications of well known medications as well as newer chemotherapeutic agents and monoclonal antibodies. This educational exhibit focuses on those medication-induced conditions with MR imaging correlates.

Materials and Methods
From a review of the literature on medication-induced CNS conditions we will provide: I. Classification of agents with discussion of mechanisms of action, and common clinical uses. This will include discussion of newer agents in oncology, neurology and rheumatology. II. Illustration of toxicity profiles of specific agents: pathophysiology, clinical presentation of toxicity, and imaging features. III. Conditions common to several agents. Posterior reversible encephalopathy syndrome. Vascular complications: Ischemic stroke, hemorrhage and venous sinus thrombosis.

Results

Conclusions
Neuroimaging spectrum of medication-induced complications is broad. Radiologists must be aware of the myriad treatment induced manifestations and carefully review the drug history to arrive at the diagnosis in challenging cases. With increasing use of novel agents in chemotherapy, there will be increasing need for early recognition and management of these complications.
Movement Disorders: Review of Radiological Findings and a Suggested Guidline for Diagnosis.

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Purpose
Movement disorders represent a subset of neurological disorders that involve an error within the highly complex central nervous system resulting in an end organ malfunction. The complexity, multiplicity, and symptomatic overlap of these disorders have made their diagnosis and treatment a challenge for neurologist. The relative recent introduction of MR and advancement in MR functional imaging has played an integral role in diagnosing and understanding the pathophysiology of many of these disorders. However, this topic remains a challenging and
perplexing one for a lot of non-neuroradiologists; in particular to radiology residents and fellows. Throughout this educational exhibit we will introduce some of the most common movement disorders while presenting their pathognomonic radiological findings, pathophysiology, and review pertinent anatomy.

Materials and Methods
1) We will start with a pictorial review of pertinent normal anatomy of the brain stem, cerebellum, and medulla via interactive computed tomography (CT), magnetic resonance imaging (MR), and cartoon diagrams. 2) A summary table will display the disorders, pathophysiology, CT imaging findings, MR imaging findings, extra modalities findings if available, and respective differential diagnosis. 3) A flow chart with imaging and clinical clues will provide a simplified approach to distinguish unique movement disorders. 4) Finally, real clinical/radiographic cases of different movement disorders will be used to interactively reinforce the educational exhibit highlights.

Results
Movement disorders diagnosis often is elusive secondary to rarity, clinical overlap, and extensive list of such diseases. Also, most share common clinical symptoms that might be hard to distinguish in the hands of an unexperienced clinician. Furthermore most share similar imagining findings including atrophy, signal abnormality, and metabolic hypofunction. Therefore solid knowledge of gross and functional anatomy is imperative to provide a helpful differential diagnosis. In this selective review we presented some of the more common movement disorders based on anatomical location with discussion of pathophysiology, pertinent clinical findings, and radiological findings. Also, we included a succinct differential diagnosis for each case touching on the more common disorders in each anatomical location. This presentation by no means contains all of the movement disorders nor is it a sufficient source on the topic. However, we do believe that it represents a good starting point for understanding these disorders as it touches on the ones that more likely are to be encountered by residents and general radiologists. 

Conclusions
Movement disorders encompass a wide variety of complex disorders involving the central nervous system that result in debilitating long term symptoms for patients. Imaging plays a central role in diagnosis and sometimes prognosis of these disorders. Through understanding of the central nervous system involved regions normal anatomy and pathophysiology help the radiologist reach reliable and prompt diagnosis.
MR imaging is used increasingly for the diagnosis of venous sinus thrombosis. The MRI diagnosis is not always straightforward due to the variable appearance of both the acute thrombosis, the presence of artifacts, and variation in venous anatomy. These features not infrequently cause resident anxiety "on call " and occasionally lead to misdiagnosis. To date no comprehensive review article has been published on this topic.

Materials and Methods
We present a comprehensive annotated pictorial review of the variable appearances of acute and chronic venous sinus thrombosis, including recently recanalized vessels. We present the full spectrum of imaging artifacts that can confound the diagnosis for the unwary and show the full spectrum of anatomical variants that cause the most confusion to the interpreting radiologist.
Results
Following review of this poster the reader should be able to confidently identify venous sinus thrombosis at all stages of evolution, identify the confounding artifacts and common variations of intracranial venous anatomy.

Conclusions
Venous sinus thrombosis has variable MRI appearances due to the evolution of hemoglobin. It is important that the interpreting radiologist has a comprehensive knowledge of the appearances of not only the thrombus but also the common confounding artifacts and variations in venous anatomy.

EdE-41
6:30AM - 3:00PM

Neural Control of Ocular Movements

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Purpose
To demonstrate the neural pathways and control of ocular movements through imaging and a discussion of patient cases with eye movement deficits.

Materials and Methods
Conceptual presentation of the neural pathways controlling eye movements will be made by figures and text. The relevant cortical and subcortical areas will be discussed and outlined on cross-sectional brain images. Cases will be shown and discussed with lesion location and deficits produced.

Results
Despite having a large visual field, clear vision on the retina can only be achieved with an intact fovea. Ocular movements in their most basic form exist to maintain clear images on the retina by moving the position of the fovea. Several different mechanisms control the eye and vision. Saccades move the eye from one object of interest to another; smooth pursuit helps the eye follow a moving target; gaze holding keeps the eye fixated to a target; vestibular and optokinetic movements keep the eye still in space when the head moves; and accommodation adjusts the individual angles of each eye to keep objects at a certain depth focused. The daunting complexity of these neural mechanisms can hinder our ability to correlate functional eye deficits with lesions. However, an understanding of these mechanisms and the cortical and subcortical areas controlling them can empower the neuroradiologist.

Conclusions
This exhibit provides a simplified and conceptual framework for understanding the complex neural mechanisms of eye movement control, supported by imaging anatomy and patient cases.

EdE-36
6:30AM - 3:00PM

New and Emerging Techniques in Image Guided Radiation Treatment of Brain Tumors: What the Radiologist Needs to Know
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Purpose
Radiation therapy is a quickly expanding field, with advances in radiation treatment paralleling those in imaging. Increasingly, image guidance plays central role in preparation and execution of radiation therapy. We aim to provide an overview of the role of cross-sectional imaging in radiation therapy techniques utilized in the treatment of primary and metastatic intracranial tumors.

Materials and Methods
Multiple radiation therapy techniques utilized in the treatment of intracranial masses are reviewed. Newer and emerging techniques are emphasized, including intensity modulated radiation therapy (IMRT), stereotactic radiosurgery, and heavy particle beam therapy. In addition to the role of cross-sectional imaging, the benefits, drawbacks, and potential complications of each technique are discussed.

Results
Many recent advances have been made in radiation therapy, with image guidance playing an increasingly important role in radiation treatment planning. Pretreatment imaging helps assess extent of disease and guides treatment selection, as well as planning and delivery. Tumor burden and number and location of lesions, as assessed on CT or MRI, aids in directing radiation therapy. Particularly in the central nervous system, image guidance is invaluable in establishing accurate target volumes, allowing for effective treatment while sparing adjacent healthy tissues, such as hippocampal sparing to prevent post-treatment memory loss.

Conclusions
Imaging is an essential part of effective radiation treatment planning, aiding in the safe, effective, and precise delivery of radiation. Familiarity with the increasing diversity of CNS radiation therapies and the role of cross-sectional imaging is important to radiologists in the interpretation of treatment planning studies.

EdE-27

Non-enhancing Intracranial Parenchymal Metastatic Lesions During Bevacizumab Treatment

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Purpose
To present three cases demonstrating the transient effects of the chemotherapeutic agent bevacizumab on metastatic intraparenchymal lesions.

Materials and Methods
Following IRB approval, 62 patients were identified with known metastatic brain lesions, gadolinium contrast enhanced MR imaging during the administration of bevacizumab, and MR
contrast-enhanced imaging either before or after bevacizumab treatment. Patients with concurrent brain radiation were excluded.

Results

The classic MRI findings of metastatic disease within the brain are multiple avidly enhancing lesions. In this case series we describe three patients with known metastatic disease with multiple, transiently nonenhancing brain lesions during bevacizumab treatment. These lesions either were enhancing prebevacizumab administration and became nonenhancing during therapy, or were seen as new nonenhancing lesions during bevacizumab treatment and gained contrast enhancement following therapy cessation. Most solid tumors overexpress the cytokine vascular endothelial growth factor (VEGF), which drives tumoral angiogenesis and growth. Bevacizumab is an anti-VEGF receptor antibody that targets this cytokine. Down-regulation of the angiogenesis signaling pathway decreases the formation of new leaky tumoral vessels, restores the integrity of the blood-brain barrier, and often decreases or eliminates tumor contrast enhancement. Bevacizumab's effects on primary brain tumors are well described in the literature, including the phenomenon of "pseudoresponse" wherein tumoral contrast enhancement is less evident without proportional tumoral cell killing. However, published reports of the effects of bevacizumab on the contrast enhancement of brain metastatic disease are lacking. Since contrast enhancement typically is employed for the detection of metastatic disease and monitoring response to therapy, recognizing that the absence of enhancement does not equate with absence of viable metastatic tumor is very important for understanding prognosis and determining optimal management. Bevacizumab-related loss of tumoral contrast enhancement likely represents pseudoresponse in brain metastases as it often does in primary brain tumors.

Conclusions

Three cases are presented of transiently nonenhancing intraparenchymal metastatic disease during treatment with bevacizumab. These cases demonstrate both the loss of tumor enhancement after initiating bevacizumab therapy and the resumption of enhancement characteristics after stopping bevacizumab. The lack of contrast enhancement does not necessarily indicate a true response to treatment, but may rather represent a metastatic "pseudoresponse."
Figure 1. Select gadolinium contrast enhanced axial T1 weighted images from case 1 (1a and 1b) and 2 (2a and 2b). Initial imaging in case 1 demonstrates multiple non-enhancing lesions in the left frontal and right parietal lobes during concurrent bevacizumab treatment (1a). On subsequent imaging after termination of bevacizumab therapy, there is new enhancement and enlargement of the previously identified lesions (1b). On initial imaging of case 2 there are numerous small enhancing intracranial metastatic lesions (2a). Follow-up imaging was performed during treatment with bevacizumab demonstrating near complete loss of enhancement (2b).
Pathophysiology of Atypical MRI Patterns in Posterior Reversible Encephalopathy Syndrome.

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Purpose
Posterior reversible encephalopathy syndrome (PRES) is a clinical and radiologic diagnosis characterized by reversible changes in the central nervous system associated with vasogenic edema. The purpose of this case-based review is to illustrate the diverse causes, MRI characteristics, and proposed pathophysiology of PRES.

Materials and Methods
A literature review of the pathophysiology and imaging features of PRES was conducted. Selected cases are presented with typical and atypical imaging features and correlated to the pathophysiology. Furthermore rare cases of PRES in the setting of CSF leak and SLE vasculitis are highlighted and proposed mechanisms of injury are described.

Results
PRES occurs in many settings including hypertension, eclampsia, transplant, immunosupression, autoimmune disease, sepsis, chemotherapy and chronic renal failure (1). On MR imaging PRES classically involves the bilateral parietooccipital cortical/subcortical regions as patchy or more confluent T2/FLAIR hyperintensities which in severe cases may demonstrate postcontrast enhancement. Common atypical features of PRES include involvement of the frontal lobes, watershed zones, basal ganglia, brainstem and cerebellum (2). Less common atypical features include hemorrhage (15%) and restricted diffusion (11-26%) (3). Although many theories have been proposed, the current popular theory is hypertension (MAP >150 mm Hg) with dysautoregulation leading to cerebral hyperperfusion and ensuing breakthrough vasogenic edema (2, 4). The proposed pathophysiology of the highlighted cases of PRES relies on the relationship between cerebral blood flow (CBF), cerebral vascular resistance (CVR), cerebral perfusion pressure (CPP), mean arterial pressure (MAP) and intracranial pressure (ICP). This relationship is illustrated by the following equations: CPP=MAP–ICP and CBF=CPP/CVR. We attribute the development of PRES in the CSF leak case to the decrease in ICP which leaves the MAP unopposed. This leads to increased CPP with consequent increased cerebral perfusion. Decreased ICP also lead to increased venous engorgement and hyperemia with subsequent meningeal enhancement (Figure 1A). In the case of PRES in the setting of SLE the decrease in CVR secondary to endothelial injury and maintenance of the CPP results in cerebral hyperperfusion and break through vasogenic edema. Progressive edema increases local tissue pressure and reduces perfusion pressure which ultimately decreases blood flow causing ischemia and restricted diffusion (Figure 1B) (5). These proposed mechanisms are important as common literature implicates only elevated MAP as a common cause for increased cerebral perfusion.

Conclusions
The proposed mechanisms of decreased ICP or decreased CVR leading to unopposed MAP and cerebral hyperperfusion can be viewed as adjuncts to the common theory as methods of injury in
PRES. Familiarity with the diverse radiographic features of PRES and its proposed pathophysiology allow the radiologist to make the correct diagnosis.

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**EdE-11**

**Pictorial Review of Resting State fMRI**

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**Purpose**

To discuss the basic principles of resting state fMRI (RS-fMRI). To demonstrate the main resting state networks from our research and clinical database. To discuss the potential promising clinical applications of RS-fMRI. These include presurgical planning in patient groups who can not perform tasks efficiently during task-related fMRI, namely children and patients under sedation; assessing and monitoring new therapy options for different disease processes and mental disorders; and understanding the physiological processes in epilepsy patients.
Materials and Methods
Functional magnetic resonance imaging (fMRI) in routine clinical practice has relied traditionally upon task-related increases in blood oxygen level dependent (BOLD) signal during neural activity. Although not a new concept, resting-state fMRI (RS-fMRI), or imaging of neural activity in the brain's resting baseline state, is gaining momentum as it moves toward clinical translation. Resting-state fMRI measures spontaneous low frequency fluctuations (<0.1 Hz) in the BOLD signal to investigate the functional architecture of the brain. Application of this technique has allowed the identification of various resting state networks (RSN), or spatially distinct but connected regions of the brain that demonstrate synchronous BOLD fluctuations at rest.

Results
To date, 20-28 spatial maps of resting state networks have been described. These are divided into groups based on their anatomical and functional properties, and include basal ganglia, auditory, sensorimotor, visual, default-mode, attentional, and frontal networks. Research has shown that despite evaluation during a relatively unconstrained state, RSNs exhibit high reproducibility and moderate to high test-retest reliability suggesting a robust examination of the intrinsic functional architecture, or "connectome," of the human brain. Our aim is to give the radiologist an introduction to brain connectivity and discuss the new methods and findings that already have begun to reshape how to understand human brain organization. The images from our research and clinical database will be shown to demonstrate the RS-fMRI networks.

Conclusions
In addition to providing new insights into the functional architecture of the healthy brain, research using RS-fMRI has shown promise for many clinical applications, including use in presurgical planning for patients with brain tumor and epilepsy as well as the assessment of many different disease processes and mental disorders. Because it is noninvasive and requires minimal patient compliance, RS-fMRI may be particularly useful in patients who are not able to undergo currently available methods for lesion localization, mainly patients under sedation and the pediatric population. Radiologists need to be aware of RS-fMRI and develop a basic understanding as this powerful technology makes its way into the clinical realm.
A. Axial image obtained with resting state fMRI in a 26 year-old patient with large intraventricular mass causing acquired functional blindness, showing a preserved fcMRI map of the visual cortex activity within the ICA 1 in the left active area is virtually matched to a task-related fMRI of a healthy control, as well as networks derived from a meta-analysis of 1,414 healthy controls (not shown). (fcMRI = functional connectivity MRI)

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EdE-32

6:30AM - 3:00PM

Pilocytic Astrocytoma in Adults: Experience at the Montreal Neurological Hospital

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Pilocytic astrocytoma is a grade I tumor according to the WHO, that is relatively rare in the adult population. In this age group, the most frequent location is the cerebrum, particularly the temporal and parietal lobes. Pilocytic astrocytoma has a higher mortality in adults than in pediatric patients. In this study we analyzed the demographic and radiological features of pilocytic astrocytoma in a series of adult patients.

Materials and Methods
We retrospectively reviewed all the cases of pilocytic astrocytoma diagnosed by pathology after biopsy or gross total surgical resection in our center between 2000 and 2014; patients below the age of 20 years were excluded from this study. The following data were retrieved from the patient's file, computerized records, and magnetic resonance imaging (MRI): patient's age, gender, location of the lesion (i.e., brain stem, cerebellum-vermis, cerebrum), number of cysts, pattern of enhancement, margin definition, signal intensity in different MRI sequences, and recurrence or progression during follow up. The demographic and radiological features were analyzed according to the tumor location.

Results
A total of 31 cases were identified during the study period (i.e., cerebral hemispheres 18, brain stem 9, cerebellum-vermis 4). There were 16 (51.6%) patients aged between 20-30 years and 15 (48.4%) above 30 years of age; 14 (45.2%) females and 17 (54.8%) males. Patients with cerebellar and brain tumors had a significantly higher number of cysts compared with brain stem tumors OR 9.1 (CI 95% 1.3-59.6, p= 0.021). Exophytic component was observed more commonly in brain stem tumors compared to cerebellum-vermis tumors OR 24.0 (CI 95% 1.1-518.6, p=0.042). There were no significant differences in the presence of enhancement, tumoral margin definition, peritumoral edema, MRI signal intensity and recurrence rates between the different tumor locations.

Conclusions
Pilocytic astrocytoma is an infrequent tumor in adult population. Knowing the different features of this lesion is essential for the identification of the tumor. In our series, pilocytic astrocytomas located in the brain stem demonstrated a significant exophytic component, while cerebellar or cerebral lesions had a significantly higher number of cyst compared to brain stem tumors.

EdE-39

Potential Applications of Dual-Source Computed Tomography (DSCT) in Emergency Neuroradiology

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Purpose
Advances in CT technology have allowed for the simultaneous acquisition of two datasets at different energies. By determining how the attenuation values vary between the two different energies, postprocessing techniques can effectively highlight or remove certain materials, create virtual unenhanced images, and reduce artifact through the use of virtual monochromatic images. We will review dual-source CT (DSCT) techniques and depict various applications through a pictorial review.
Materials and Methods
We will review the basic principles of dual-source CT and discuss methods of optimizing the acquisition and postprocessing of data. We will show examples of studies acquired in our emergency department in which the utilization of these techniques enabled problem-solving and facilitated the detection of pathology, ultimately leading to better patient care.

Results
1. Dual-source CT scanners use two x-ray tubes and two corresponding detectors which operate independently, allowing for the simultaneous acquisition of two datasets at different energies for the same region of interest. 2. With the background knowledge of how the attenuation values of specific materials, such as calcium and iodine, vary at different energies, the presence of these materials can be highlighted as well as subtracted from the acquired images. 3. We will show examples of difficult scenarios in which the subtraction of calcium helped clarify whether a hyperdensity represented acute hemorrhage or calcification, subsequently determining the need for further imaging. 4. We will show examples of how iodine subtraction helped differentiate contrast staining from hemorrhagic conversion in areas of infarcted tissue, which assisted in anticoagulation management. 5. We will show examples of how iodine can be effectively subtracted from contrast-enhanced images to create virtual unenhanced images without sacrificing diagnostic sensitivity, potentially obviating the need for precontrast imaging and reducing radiation dose. 6. We will show how virtual monochromatic images generated to simulate higher energies can reduce streak artifact from metallic implants as well as beam-hardening artifact in the posterior fossa in order to improve visualization of the anatomical region.

Conclusions
Dual-source CT is an innovative, powerful tool that can be utilized in the emergency neuroradiology setting to effectively make accurate diagnoses in situations which typically would present as diagnostic challenges if the images were obtained with traditional single-energy CT.

EdE-02
6:30AM - 3:00PM
Predilection for the Middle Cerebellar Peduncle: Spectrum of Common and Less Common Diseases.

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Purpose
Pathologic processes can have predilection for specific anatomical locations. Our purpose is to describe common and less common diseases that can cause MR signal abnormalities of the middle cerebellar peduncle (MCP); thus helping radiologist to provide a systematic approach and narrow a diagnosis.

Materials and Methods
Through illustrative cases, this exhibit will describe and correlate imaging findings with clinical clues and pathologic mechanisms of MCP involvement.

Results
The middle cerebellar peduncles (MCP) are composed of axons arising from the pontine nuclei
that cross the midline and end in the cerebellar cortex. Most of these afferent tracts are projections from the motor cortex and somatosensory cortex. Common clinical manifestations of MCP involvement include difficulty walking (cerebellar ataxia), difficulty speaking (scanning speech) and in some cases vertigo and facial weakness. Myelin abnormalities, different types of edema or neurodegenerative processes involving the MCP cause areas of abnormal T2 signal and might also show different patterns of diffusivity. Demyelinating (e.g., multiple sclerosis) and some neurodegenerative diseases (e.g., multiple system atrophy) have special predilection for MCP. Infectious/inflammatory (e.g., JC virus, PML-IRIS, Bechet's), vascular (e.g., PRES, AICA infarction), and metabolic-toxic (e.g., myelinolysis, Wilson's disease) diseases also can involve the MCP and should be considered in the differential with variable index of suspicion.

Conclusions
Pathologies such as demyelinating disorders or certain neurodegenerative processes have predilection for the MCP. Careful evaluation of concomitant findings such as volume loss for neurodegenerative diseases; or focused correlation with key clinical findings such as immunosuppression for PML; hypertension/eclampsia, post-transplant status or high dose chemotherapy for PRES; sodium disorders for myelinolysis or suspected toxic-drug related encephalopathy; would yield an appropriate and accurate differential diagnosis in the majority of cases.
Revisiting the Progression of Hippocampal Sclerosis: A Pictorial Review of Serial MR in the Evolution from Initial Hippocampal Injury to Hippocampal Sclerosis

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Purpose
- Describe detailed imaging anatomy of hippocampus and associated neural network.
- Describe the imaging evolution of hippocampal sclerosis at various stages.
- Describe surgical management of temporal lobe seizure.
Materials and Methods
MR imaging studies of patients followed for temporal lobe seizure were reviewed by board certified neuroradiologists. We reviewed cases of temporal lobe seizure and found several patients with serial changes on follow-up MR studies. All patients were scanned on 1.5 or 3T MRI scanners.

Results
Imaging findings of hippocampal sclerosis is a well known entity. But, natural progression of hippocampal sclerosis at various stages rarely is seen. We present patients with initial hippocampal injury and who showed changes on follow-up MRI studies. All patients presented with temporal seizures. The initial MRI showed hippocampal enlargement, and T2/FLAIR hyperintensity. Several patients showed restricted diffusion in the hippocampus, enlargement of the hippocampus and moderate enhancement on postcontrast imaging. Intermediate follow-up MRI showed near complete normalization of hippocampal enlargement and hyperintensity but with loss of internal architecture. Delayed follow-up MR showed persistent loss of hippocampal architecture, volume loss and increased T2 and FLAIR signal.

Conclusions
Mesial temporal sclerosis is not encountered infrequently in neuroimaging practice. As shown in our cases, the age of patients and cause of clinical presentation is varied. These help explain the variability of findings in hippocampal sclerosis. Knowledge of initial hippocampal injury and its natural progression to hippocampal sclerosis is important for accurate assessment and better medical surgical planning and outcome for the patients.
Coronal FLAIR image (A) from the initial MRI showing right hippocampal hyperintensity and The DWI image (B) show restricted diffusion in the Right hippocampus. The intermediate follow-up FLAIR image (C) show Normalization of the signal abnormality in the right hippocampus. The follow-up MRI/FLAIR image (D) show hippocampal volume loss and FLAIR hyperintensity. This patient extra-temporal features of mesial temporal sclerosis (not shown).
Spectrum of Imaging Findings in Mesial Temporal Sclerosis-Related Epilepsy

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Purpose
Mesial temporal sclerosis (MTS) commonly is associated with temporal lobe epilepsy and the imaging features of this condition have been well described. However, failure to recognize the complete spectrum of MTS may lead to limited surgical resection and suboptimal outcomes. The purpose of our exhibit is to review the MR imaging findings associated with the full MTS spectrum.

Materials and Methods
We will present a case series reviewing the different subtypes of MTS, including classic unilateral hippocampal sclerosis, bilateral hippocampal sclerosis and hippocampal sclerosis plus with confluent extension into the anterior temporal pole. Dysplasia of the mesial structures without abnormal signal, hippocampal enlargement with increased signal and dual pathology including hippocampal sclerosis and other temporal and extra-temporal lesions also will be presented. Assessment of these subtypes are based on brain magnetic resonance imaging (MRI) studies of patients evaluated at the University of Michigan Medical Center. All images were obtained using either a 1.5T GE or Philips scanner using a dedicated temporal lobe epilepsy protocol which includes thin section, diffusion-weighted, SPGR, T2W, FLAIR, T2*, T1W postcontrast, diffusion tensor, FFE, and IR sequences.

Results
In the mesial subtype of MTS, the most common and classic form, imaging findings include hippocampal volume loss, ex vacuo dilation of the temporal horn, atrophy of the ipsilateral fornix and mammillary body, and potentially increased T2W signal in the hippocampus. The alternate subtypes are differentiated based on the extension of these imaging findings into nearby structures. Differentiation of these subtypes can account for variability in clinical presentation and more importantly have implications in surgical planning.

Conclusions
Along with the more classic appearance of MTS, there are other subtypes based primarily upon location which are essential to recognize for optimal surgical planning and seizure-free outcome.

Structural Composition of The Tween Brain; Functional, and Anatomical Approach

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Purpose
Diencephalon "Tween-brain" is a rostral segment of the forebrain. It will differentiate to
everything that has the suffix "thalamus"; thalamus, hypothalamus, epithalamus and subthalamus. Despite the relative small size of these related structures they are dominating and controlling most of the vital brain functions. These structures are possessing neuronal connections to almost the entire cortex, basal ganglia, brain stem, cerebellum and limbic system. Detailed knowledge of the microstructure, embryologic development, structural anatomy, neural circuitries and white matter tracts of the diencephalon is essential for the interpretation of DTI, fMRI and routine clinical MRI.

Materials and Methods

The exhibit will provide a fundamental knowledge of the micro and macrostructure of the different subdivisions of the diencephalon. By the use of DTI and illustrated functional diagrams the internal and external neural circuitries/loops that are connecting thalamus, hypothalamus, epithalamus and subthalamus to the limbic system, cortical association areas, cerebellum, basal ganglia and brain stem will be demonstrated. The morphology and location of these pathways will be related to readily visible anatomical landmarks and the functional significance of these connections will be identified.

Results

Although the diencephalon is relatively small brain domain, any structural abnormalities that involve any part of its subdivisions will lead to significant functional deficits. This is because it lies in the vicinity and interrelated to vital structures. Diencephalon and cortical association areas are the realm of the brain where sensation is processed to create a cognitive perception to the outer world. Thalamus integrates and relays almost all sensory information through well defined reciprocal fibers designated as thalamic peduncles. These reciprocal fibers interestingly are organized into thalamo-cortical and cortico-thalamic fibers that comprise a large portion of internal capsule and corona radiata. Medial forebrain bundles, dorsal longitudinal fascicles of Schutz, fornix, and stria terminals are principle neuronal pathways connecting the hypothalamus and thalamus to limbic system, brain stem and related cortical association areas. Epithalamus comprises stria medullaris thalami, habenular nuclei, and pineal gland. Stria medullaris thalami/fasciculus retroflexus of meynert is the principle circuitry connecting the information from limbic system, hypothalamus and basal forebrain to the brain stem by relaying in the epithalamus.

Conclusions

Proper understanding of the microstructure of the diencephalon and its different neural pathways is the key for accurate interpretation of DTI, fMRI and routine MRI. The diencephalon contributes to several important functional pathways that modulate homeostasis, autonomic nervous system, eating behavior, emotions, stress, memory, and learning functions. We hope this pictorial review will be able to deliver fundamental understanding of any functional deficits that will result from any congenital, acquired or degenerative diseases.

EdE-35

Temporal Run: A Pictorial Essay of 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 predilection 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.

Materials and Methods
Noteworthy cases will be provided with initial discussion focusing on presenting clinical signs and symptoms and diagnostic planning. Different imaging modalities from initial studies to advanced techniques, including CT, MR, and CTA, 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.
The neuroradiological assessment of cerebrovascular reserve (CVR) is essential to the hemodynamic evaluation of patients with chronic steno-occlusive disease. The purpose of this educational exhibit is to provide a comprehensive review of CVR through an explanation of its underlying hemodynamic principles, exploration of the various neuroimaging techniques and vasodilatory stimuli used to measure CVR, and discussion of the clinical implications of these measurements. Particular attention will be given to the role of novel/advanced imaging in CVR assessment.
Materials and Methods
The information presented will both summarize the cerebrovascular literature on CVR and will incorporate the authors' extensive personal experience performing and interpreting CVR assessment.

Results
1. Cerebrovascular physiology adapts to changes in cerebral perfusion. The hemodynamics distal to a site of stenosis/occlusion can be conceptualized as a staged response (Powers' classification) based on: collateral circulation, cerebral autoregulation/vasodilatation, and increased brain regional oxygen extraction to maintain its metabolic demands. 2. The neuroradiological evaluation of these hemodynamic stages is performed by either directly measuring oxygen extraction (O-15 PET, BOLD MR) or by measuring paired cerebral blood flow measurements before and after a vasodilatory stimulus. These measurements have been performed using all imaging modalities, including: bedside Doppler, SPECT, contrast CT/MR perfusion, ASL, and Xenon-CT. Vasodilatory stimuli include acetazolamide, hypercapnia (CO2/hyperventilation), and theoretically, systemic hypotension and cognitive tasks. 3. Impaired CVR is an important predictor of stroke risk, serves as a predictor of postoperative outcome/complications following cerebral revascularization (stroke, hyperperfusion syndrome), provides an assessment of the cerebrovascular effects of chronic medical conditions, and is essential to the assessment of moyamoya patients.

Conclusions
The evaluation of CVR entails the imaging of a complex physiologic process. An understanding of the underlying hemodynamic principles and current imaging methods/vasodilatory stimuli enables the neuroradiologist to refine the work up and treatment of patients with chronic cerebrovascular disease.

EdE-33

The Role of Imaging in the Management of Pituitary Lesions

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Purpose
To review the role of imaging in the diagnosis, treatment and follow up of patients with common pituitary lesions.

Materials and Methods
Based on a comprehensive review of the pituitary imaging literature and a retrospective analysis of relevant cases in our Neuroradiology database, we summarized the role of imaging in the management of common pituitary lesions. We weighed clinical data alongside radiographic findings, with special attention to factors unique to pituitary disorders. Patient age, gender and past medical history were correlated with the most relevant findings at presentation, such as visual changes or hormone levels (1). Essential branch points in management were identified. From an imaging perspective, features like lesion size, interval change, T2 signal, enhancement, local invasion and mass effect often proved critical to management (2). We concluded with a summary of imaging features that narrow the differential diagnosis for common pituitary lesions.
highlighting findings that often guide treatment options. We hope such a framework will help guide the radiologic evaluation of these interesting lesions.

Results
MR provides excellent visualization of perisellar structures and has proved instrumental in selecting treatments, assessing responses and improving both operative and nonoperative management. During the initial work up, imaging features critical to formulating a differential diagnosis of a pituitary lesion included location, size, morphology, signal characteristics, relationship to adjacent structures, the presence of calcifications (where CT can be helpful) as well as cysts or hemorrhage (3). On follow up, size (especially any changes), mass effect, extent of the enhancing component, extent of T2 signal and the involvement of adjacent structures were features influencing decision-making. Symptoms related to mass effect often separate conservative versus nonconservative management, as with visual field cuts from elevation and compression of the optic chiasm, or diplopia due to cavernous sinus invasion (4). Follow-up imaging proved essential both for gauging surgical results and evaluating response to nonsurgical treatment. The latter is demonstrated in the accompanying graphic of a macro-adenoma treated conservatively (5).

Conclusions
MR imaging has revolutionized the management of pituitary pathology. Findings on MR are instrumental in governing and assessing treatment for a range of lesions. From initial work up to routine follow up, MR serves as an increasingly powerful tool in the clinician's armament for the management of these disease entities. Given appropriate MR protocols, advances in MR quality and precision have enabled more accurate diagnosis and sharper management, with the distinction between operative and nonoperative cases now clearer than ever. In patients with residual tumor after surgery, tailored sequences with better spatial resolution have improved the efficacy of nonoperative treatments like Gamma knife. MR has enabled teams to more successfully navigate diagnostic and therapeutic pitfalls in the management of pituitary disease.
The spectrum of MRI findings and patterns of tumor progression in patients with recurrent high-grade gliomas after initiation of bevacizumab

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Purpose
To review and illustrate the spectrum of MRI findings and patterns of tumor progression in patients with recurrent high grade gliomas following initiation of bevacizumab.

Materials and Methods
We retrospectively reviewed the clinical data and serial MRI studies of 81 patients with recurrent high grade gliomas who received bevacizumab therapy at our institution between 2011 and 2013. Inclusion criteria included pathology available for review and available imaging within 30 days prior to bevacizumab initiation and first post-bevacizumab imaging within 60 days. The patients were categorized as full response, mixed response, stable disease and progressive disease based upon the changes in initial follow-up MRI: Degree of enhancement, extent of T2 hyperintensity (mass-like areas as well as vasogenic edema), mass effect and restricted diffusion. The full response group was further divided into subgroups based upon the presence of new diffusion restricting lesions. The progression free survival (PFS) of these two subgroups was evaluated using Kaplan-Meier curves and log-rank test.

Results
A total of 49.3% of patients had response without new areas of diffusion restriction, 23.4% response with new areas of diffusion restriction, 10.4% mixed response, 10.4% progressive disease, and 6.5% stable disease. With respect to the response group, there was no statistically significant difference in PFS between the patients with or without new areas of diffusion restriction (median PFS of 167 days versus 232 days respectively, P-value = 0.112). Most of the new areas of restricted diffusion occurred within initially enhancing tumor. A subset of patients developed progression of restricted diffusion becoming larger and more confluent over the next several months. MR perfusion of a representative patient demonstrated increased cerebral blood volume corresponding to the areas of diffusion abnormality compatible with primarily recurrent tumor over treatment-related effects.

Conclusions
The spectrum of MRI findings following bevacizumab therapy is highly variable, in which substantial proportion of patients develop new areas of diffusion restriction. This mostly occurs within the pre-existing enhancing tumor and is associated with a trend to shorter progression free survival suggesting the diffusion response is an imaging biomarker of aggressive disease.
EdE-09

The Variable Vertebral

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Purpose
The purpose of this exhibit will be to demonstrate the common and some more rare variants of vertebral artery anatomy including variable origins, duplicated origins, and variable entry points into the transverse foramen. We also will discuss the clinical relevance of these variables as it pertains to angiography and head, neck, and spine surgery.

Materials and Methods
We reviewed all CT angiography of the head and neck and contrast-enhanced CT soft tissue neck studies over a 3-year period. All patients with a vertebral artery originating from a site other than the subclavian artery or from a non-arterial origin will be described.
than the subclavian artery were documented. All patients with a vertebral artery entering the transverse foramen at a level other than C6 were documented. All patients with a duplicated origin of the vertebral artery were documented.

Results
In our search we discovered frequent variability in the origin of the vertebral arteries as well as in the entry point into the transverse foramen. The majority of patients had both vertebral arteries arising from the subclavian arteries. Several patients, however, demonstrated vertebral artery origins from the aortic arch between the subclavian and left common carotid arteries. Patients also displayed a more rare origin of the left vertebral artery from the aortic arch distal to the subclavian artery. A few patients were found to have duplicated origins from the aortic arch and the subclavian artery eventually joining in the transverse foramen at an abnormally high level. More variability was discovered when we looked at the entry point into the transverse foramen. The majority of patients had both vertebral arteries entering the transverse foramen at C6. However, multiple patients demonstrated entry points varying from C7 to C3. This anatomical variance is clinically relevant for many reasons. Surgeons performing neck dissection or anterior approach spinal fusion may encounter the vertebral artery at an abnormally high location unexpectedly if they are not aware of the presence of these anatomical variations. Angiographers often experience difficulty in locating and accessing the vertebral arteries when they arise from anywhere other than the subclavian arteries. Duplicated origin of the vertebral artery on angiography can cause two problems. First, the entire vertebral artery will not be interrogated if the angiographer is unaware of a second abnormal origin being present. Second, noncontrasted blood flow entering the artery at the junction between the two segments will cause an apparent filling defect or irregular narrowing of the artery simulating the presence of thrombus or dissection. The clinician then may inappropriately treat an otherwise normal vessel.

Conclusions
There are several frequent and less frequent normal anatomical variations of vertebral artery anatomy. Knowledge of these variations will help surgeons and angiographers plan procedures and avoid potential complications that may arise as a result of the variable vertebral artery anatomy.

EdE-19

Three Different Faces of an Uninvited Guest – Therapy-Associated Progressive Multifocal Leukoencephalopathy (PML) during Multiple Sclerosis (MS)-Treatment

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Purpose
Therapy-associated PML has gained an inglorious relevance in MS treatment, particularly among patients on long term treatment with natalizumab: nearly 500 cases worldwide have been reported until end of 2014. As we still lack reliable predictors for its occurrence, our aim was to contribute some clinical and neuroradiological features to further meet the diagnostic and therapeutic challenges of this potentially fatal adverse event.
Materials and Methods
We present the specific clinical and radiological features of three female patients with relapsing-remitting MS (RRMS) and therapy-associated PML: Two had received natalizumab, the third was on monotherapy with interferon beta-1a. MR data were obtained with Philips Intera-Achieva (1.5T) and include patient-specific longitudinal databases of the magnetization transfer ratio (MTR) during the entire disease process. We used a PDW SE sequence for MTR registration: TR=1710 ms, TE=30 ms, NSA=1 before and after an off resonance MT pulse. Postprocessing was performed with the FDA-approved software package NordicICE, and we used STATA 12 for the statistical analysis (Ksmirnov and Mann-Whitney tests for equality of distribution, and ANOVA for differences of mean MTR values).

Results
In all cases PML lesions were identified best on FLAIR and DIR images. They typically involved subcortical U fibers and did not significantly enhance. Both clinically unsuspicous natalizumab cases were detected incidentally during routine MRI. Peak PML was reached within 3 months after lesion progression "per continuitatem" like unstoppable invasion fronts from different foci at different speed and momentum. Upcoming spotty gadolinium enhancement marked transition to IRIS, which passed off much smoother in the patient with monthly iv prednisolone pulses, compared to vast skeletonization of the cortex in the patient with inconsequent prednisolone treatment. Case 3 presented with severe neurological deterioration during monotherapy with interferon, and MR findings were atypical for MS deterioration. After PML diagnosis a concomitant and previously unrecognized common variable immunodeficiency (CVID) was found. Monthly intravenous immunoglobulin (IVIg) was administered. No clinical or MRI signs of IRIS occurred in this case, and we observed a marked improvement of MRI findings within the first 3 months. During the monitoring period over up to 4 years, all cases showed gradual and significant (p<0.0001) changes in mean MTR and shifts of MTR histograms respectively preceding the relevant clinical events. We found some evidence in favor of a consequent pulsed prednisolone therapy in the natalizumab cases, and amelioration of clinical and MRI findings in case 3 by IVIg.

Conclusions
Clinical and neuroradiological vigilance are the mainstays in the detection of therapy-associated PML in MS. FLAIR and DIR images were most important in our cases, and longitudinal MTR databases contributed additional evidence towards an early recognition of significant changes. During interferon monotherapy, apparently therapy-associated PML can occur in susceptible individuals.

EdE-12
6:30AM - 3:00PM

Threshold Bias influencing 3-Dimensional Diffusion Tensor Tractography using Fiber Assigned Continuous Tracking (FACT) Approach: A case in point

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Purpose
Diffusion tensor imaging-based 3D tractography is a widely applicable technique in both clinical and research settings. While it provides topographically precise quantitative and qualitative
information, it is also prone to confounds due to thresholding parameters (1). A commonly used deterministic approach, namely fiber assigned continuous tracking or FACT, generates fiber trajectory defined by principal eigen vector in a 3D voxel by voxel approach. The fiber propagation restricted by maximum angulation and minimum fractional anisotropy (FA) parameters, user defined thresholds (2). Although a robust approach, occasionally threshold parameters can lead to measurement bias. We present an example of such a case to review the impact of threshold parameters on tractography results.

Materials and Methods
An 18-year-old male with attention deficit hyperactivity disorder was recruited for a study evaluating smoking related brain changes. SSEPI DTI was performed on 3T MRI with 32 gradient directions, b value of 800 s/mm2 and a nondiffusion-weighted image. DTI studio was used for image processing, (H Jiang, S Mori, Johns Hopkins University). The diffusion-weighted images were coregistered to the nondiffusion-weighted image using affine transformation to minimize distortions due to eddy currents and head motion. Manual inspection was performed for elimination of images with technical artifacts postregistration. Subsequently tensor calculation was performed using standard linear regression. After tensor diagonalization, three eigen values, three eigen vectors, were computed. 3D tractography was performed using FACT approach with FA threshold of 0.2 and angle threshold of 40 degrees, wherein tracking constrained by FA<0.2 and angles > than 40 degrees. Cingulum bundle was reconstructed using previously published predefined ROI manual delineation in subject's native space (3).

Results
Using pre-defined study threshold parameters and ROI protocols, detailed above, the cingulum bundle reconstruction resulted in very low fiber count, and anterior segment truncation (Figure 1a). Lowering FA tracking threshold to .15, improved fiber count, however anterior truncation persisted (Figure 1b). Increasing angle threshold to 90 degrees, improved fiber density, however shows persistent anterior truncation (Figure 1c). Lowering both FA threshold to 0.15 and increasing tracking angle to 90 degrees yielded satisfactory results (Figure 1d). Such high angulation threshold is unusual, typically used for hairpin angulation. For the purpose of consistency of parameters across study participants, results from this subject were not included in the final analyses.

Conclusions
Although robust, FACT approach for deterministic tractography has known susceptibility to threshold parameters. Understanding their impact on qualitative and quantitative tractography results is critical for accurate interpretation. Additionally contextual application relevant to the scientific hypothesis and clinical population is emphasized. Related salient considerations are reviewed in the ASFNR guidelines (4).
Toxic Leukoencephalopathy: Causes and Potential Mimics.

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Purpose
The purpose of this exhibit is to familiarize the viewer with the various causes of toxic leukoencephalopathy along with its differential diagnosis and mimics.

Materials and Methods
The known causes of toxic leukoencephalopathy will be listed and discussed along with numerous case examples. Also, a list of the various differential diagnoses and mimics will be listed and discussed with corresponding case examples.

Results
Toxic leukoencephalopathy refers to injury of the cerebral white matter which presents with a wide variety of clinical symptoms. It has various causes including chemotherapeutic agents, immunosuppressive drugs, radiation, antimicrobials, drugs of abuse and environmental toxins. In addition to known toxic causes of leukoencephalopathy, there are several diseases that can present with a similar constellation of signs and symptoms. For example, genetic leukodystrophies, demyelinating diseases and some infectious agents like AIDS dementia complex, progressive multifocal leukoencephalopathy, subacute sclerosing panencephalitis, rubella, varicella-zoster, and cytomegalovirus can be misdiagnosed readily as toxic leukoencephalopathy. Various metabolic and vascular disorders also have been shown to have similar presentations. Magnetic resonance imaging reveals white matter FLAIR signal abnormalities, which typically are symmetric owing to the systemic nature of the insult. The early manifestations can be seen as reduced diffusion in the periventricular and supraventricular white matter. Early recognition often is helpful as this entity may reverse both clinically and on imaging. The pattern of findings tends to be nonspecific making it imperative that the interpreting radiologist is aware of the differential diagnosis.

Conclusions
In addition to known toxic causes of leukoencephalopathy, there are several diseases that can present with a similar constellation of signs and symptoms. As a result, the imaging findings of toxic leukoencephalopathy can present as a diagnostic dilemma making it imperative that the interpreting radiologist be aware of differential diagnosis as there are many potential mimics.
Coronal T2 FLAIR reveals increased signal in the periventricular and supraventricular white matter bilaterally.

ADC map reveals corresponding decreased signal.
Purpose
1. Introduce the appearance and physiology of unusual intracranial aneurysms. 2. Demonstrate the imaging presentation of Blister, Dissecting and Infectious intracranial aneurysms. 3. Review novel concepts in the treatment of these lesions.

Materials and Methods
1. Introduce the appearance and physiology of unusual intracranial aneurysms. 2. Demonstrate the imaging presentation of Blister, Dissecting and Infectious intracranial aneurysms. 3. Review novel concepts in the treatment of these lesions.

Results
Blood blister aneurysms resemble pseudo-aneurysms and often are covered only by thin cap of fibrous tissue/adventitia. The imaging appearance of blister aneurysms is a broad-based, shallow out-pouching of the vessel wall in a nonbranching location. These lesions frequently are occult on CT angiogram and may be seen only in one projection on digital subtraction angiography. Dissecting intracranial aneurysms increasingly have become recognized as separate entities with distinct imaging and management characteristics. Arterial dissection results in blood accumulation within the vessel wall with intramural hematoma extending into the sub-adventitial plane forming a saclike out-pouching. Imaging demonstrates aneurysms that may be in a nonbranching location and have associated signs of dissection. This includes the presence of a false lumen, stenosis with dilatation (pearl with string sign), or stenosis alone. Infectious (mycotic) aneurysms are abnormal dilatations of the blood vessels, associated with infections, most commonly bacterial. They may be multiple and vary in size, typically present in nonbranching locations. Management of atypical intracranial aneurysms is problematic as a result of the tenuous clinical course with frequent re-bleeds. Traditional treatment methods such as aneurysm clipping or bypass surgery can have high morbidity. Novel endovascular methods using flow diverting stents and coils are potential alternate therapies with good outcomes.

Conclusions
The diagnosis and treatment of atypical intracranial aneurysms is challenging. Appropriate identification using their distinctive imaging appearance is vital in order to guide therapy. Novel endovascular therapies represent a new and exciting option in the historically difficult management of these disorders.
EdE-01


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Purpose
The primary treatment option for hydrocephalus treatment remains ventricular shunting. Despite the controversy over the utility of radiographs for shunt evaluation, shunt series continue to be performed due to their rapidity, minimal radiation exposure, and ready availability. We re-examined both normal and abnormal radiographic findings associated with shunt malfunction to provide a pictorial essay and suggested approach for interpretation. In addition, we investigate the utility of shunt series by comparing radiography with computed tomography scans.
Materials and Methods
A total of 2,038 shunt series from adult patients in the Emory Healthcare system from January 1, 2009 through August 31, 2014, inclusive, were identified through ISYS database search. Exclusion criteria included suboptimal shunt series and patients who did not have a ventricular shunt. Thus far, we have completed a pilot group of 28 patients comprising a total of 224 shunt series, and we plan to review the remaining studies prior to the ASNR meeting.

Results
Out of the 224 shunt series, 171 were normal. Of those with abnormal results, five were indeterminate/abnormal on both CT scans and shunt series, 29 were indeterminate/abnormal only on CT, and 18 were indeterminate/abnormal only on shunt series (4 had no associated CT scan). Despite a study showing low diagnostic utility of shunt series, we found that 18 shunt series detected abnormalities when CT head was negative or not obtained, and five of these studies led to subsequent shunt revisions. Our initial review showed a multitude of abnormal radiographic findings including abnormal distal tip (7), discontinuity (11), fracture (1), kinks (3), and calcification (1).

Conclusions
In conclusion, our pilot study suggests that shunt series remain a valuable tool for initial assessment of VP shunt malfunction. In addition, our pictorial essay demonstrates multiple radiographic findings that can be used as a reference for radiologists during shunt evaluation.

EdE-22

Vertebrobasilar Dissections and Dissecting Aneurysms: A Management Dilemma with Important Diagnostic Considerations

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Purpose
Vertebrobasilar dissections and dissecting aneurysms present a management dilemma. Treatment options classically applied to these processes elsewhere in the cerebrovascular system are fraught with complications. Radiology plays a key role in detecting vertebrobasilar pathology. However, the radiologist can provide vital added value with sophisticated interpretation of first line CT or MR angiography targeted to guide difficult management decisions facing neurology, neurosurgery, and neurointerventional colleagues. This exhibit focuses on a comprehensive approach to interpreting these studies.

Materials and Methods
To produce a sophisticated interpretation of cross-sectional angiography of vertebrobasilar dissections and dissecting aneurysms, these entities first need to be identified with proper terminology. Detailed description of pathologic findings, secondary effects, and depiction of the local, upstream, and downstream vascular anatomy is essential. Understanding of vascular anatomy is critical. Familiarity with treatment modalities is necessary to provide a quality management-targeted report. 3D and multiplanar reformats can help clinicians efficiently understand the pathology and associated anatomy.

Results
Three index cases of vertebrobasilar dissections and dissecting aneurysms are presented to
illustrate how to build an impactful interpretation. A review of the vertebrobasilar anatomy readily seen on cross-sectional angiography, its variance, and anatomy not often appreciated on cross-sectional imaging but that can be well seen on conventional subtraction angiography or inferred based on knowledge and experience is presented. An introduction to treatment modalities is presented to understand management decisions which should help guide critical impression points. Additionally, exam protocoling is discussed which is essential for enabling quality definitive results.

Conclusions
Vertebrobasilar dissections and dissecting aneurysms may be relatively easy to detect on cross-sectional angiographic imaging; however, producing a sophisticated comprehensive report that referring providers will value requires an advanced understanding of proper terminology for these disease processes, related anatomy, and management options.

EdE-21

“Blood is thicker than water:” A Radiographic Review of Cerebral Vascular Malformations

A Arneja¹, H Mehta¹, P Gerard¹, M Tenner¹
¹Westchester Medical Center, Valhalla, NY

Purpose
Vascular malformations of the central nervous system are a common neurovascular problem. These lesions typically are divided into low and high flow vascular malformations. Many are congenital and may remain asymptomatic or incidental. However, they also may result in neurologic symptoms including seizure, acute brain hemorrhage, and possible lead to rapid death. Each type of malformation has distinguishing imaging features that aid in radiologic diagnosis. An understanding of the anatomy, imaging characteristics and typical presentation of each particular cerebral vascular malformation is vital in making an accurate diagnosis.

Materials and Methods
We present a comprehensive review of the anatomy and typical components of cerebral vascular malformations. We review common and rare pathologies including both high and low flow cerebral vascular malformations. We further discuss a case-based review of the CT and MR findings of a variety of vascular malformations, including arteriovenous malformation, dural arteriovenous fistula, capillary telangiectasia, cavernous malformation, developmental venous anomaly, vein of Galen malformation and mixed vascular malformation.

Results
We provide an educational radiographic review of cerebral vascular malformations. We use a multimodal approach to evaluating each lesion and its extent, utilizing CT/CTA MRI/MRA and catheter angiography. We further discuss the important role of the radiologist in initial imaging, diagnosis, follow-up evaluation and evaluation of potential complications. We evaluate key pre-operative imaging findings and postoperative complications.

Conclusions
Cerebral vascular malformations present unique radiographic features and result in a complicated constellation of findings. The radiologist's role in accurate diagnosis of these lesions and
understanding of their imaging characteristics plays a crucial role in patient care and management.

Figure 1. A. Non-contrast head CT showing acute left temporal intraparenchymal hemorrhage with intraventricular rupture of blood product and mass effect. B-C. CT angiography showing serpiginous mass of vessels in the left temporal lobe with scattered calcifications along the margin of the region compatible with arteriovenous malformation. D-E. Catheter-based angiography showing a 3 cm ruptured left temporal AVM. Arterial supply was from branches of the middle cerebral artery with early venous drainage into the vein of Labbe and Trolard and subsequent transverse-sigmoid junction and superior sagittal sinus, respectively. F. Successful embolization of the majority of the left temporal AVM.

(Filename: TCT_EdE-21_cvmasn.jpg)

Monday
6:30AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exposition Hall A (Level 1)

Educational Exhibit Poster (Print) - Head & Neck
3D FLAIR MR Imaging Applied for Diseases of the Temporal Bone and Peripheral Nerves of the Extracranial Head and Neck

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¹Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea, Republic of

Purpose
Three-dimensional fluid-attenuated inversion recovery (3D FLAIR) is an MR technique that combines FLAIR, which is sensitive for subtle changes of longitudinal magnetization in the fluid space, and 3D turbo spin-echo sequence with variable refocusing flip angle. The purpose of this exhibition is to present the usefulness of 3D FLAIR imaging in the evaluation of various diseases of the head and neck, including those of the temporal bone and the peripheral nerves.

Materials and Methods
After addressing the basic features of 3D FLAIR, we present its clinical application for various conditions, including diseases of the temporal bone and the extracranial cranial nerves. All 3D FLAIR MR examinations used in this exhibition were performed on 3T units using an 8- or 32-channel sensitivity-encoding (SENSE) head coil with a factor of 2. The specific absorption rate (SAR) limitation was set at 4.0 W/kg. A 40 mm-thick single slab with a voxel size of 0.8 cubic mm and turbo factor of 100 was acquired with an approximate acquisition time of 6 minutes.

Contrast-enhanced FLAIR is obtained 7 min after intravenous injection of contrast material, so that the contrast of 3D FLAIR is determined approximately 10 min after contrast.

Results
In normal subjects, the labyrinth is hardly visible on 3D FLAIR before and after contrast injection. In contrast, the labyrinth in patients with sudden sensorineural hearing loss frequently shows increased signal intensity that is comparable to the cerebellum and there is significant enhancement after contrast. 3D FLAIR can well demonstrate the microenvironmental changes of the labyrinthine fluid in various conditions of the temporal bone, including various inflammation of the labyrinth and various cerebellopontine angle tumors. These findings hardly can be seen on the other MR imaging sequences. Contrast-enhanced 3D FLAIR is valuable for the detection of inflammation of the facial nerve, probably due to its contrast enhancement characteristics, such as higher sensitivity to lower gadolinium concentrations as well as reduced sensitivity to gadolinium with high flow velocity. 3D FLAIR imaging also is useful for the evaluation of various neurovascular compression syndromes. In patients with hemifacial spasm, 3D FLAIR frequently is better than MR cisternography for depiction of the root exit zone of the facial nerve, which frequently is obscured by the accompanying vascular structures on the latter. By showing subtle changes of the signal intensity of the trigeminal nerve, 3D FLAIR may be used to predict the clinical outcome in patients with trigeminal neuralgia after surgery. On 3D FLAIR, the branches of the oculomotor and trigeminal nerves outside the brain frequently are visible nicely.

Conclusions
3D FLAIR is a useful technique for the evaluation of various diseases of the temporal bone. It also is a promising tool for the evaluation of the pathology of the extracranial cranial nerves.
A Scheme Based Algorithm for Hearing Loss

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Purpose
We will present an algorithm for the evaluation of hearing loss. This algorithmic approach to hearing loss allows targeted evaluation of specific anatomy based on a narrowed differential diagnosis.

Materials and Methods
The scheme we propose begins with the main branch point of conductive versus sensorineural versus mixed hearing loss. Progression down the scheme uses the main delineating points of symptom onset, age, medical history, and reported physical findings to arrive at a most likely diagnosis with a focused differential. Each pathology illustrated will be accompanied by a high quality annotated cross-sectional image.

Results
The current trend in medical education is scheme-based problem solving, and the newest curricula are chief complaint directed. To illustrate this learning method's compatibility with radiology, we chose the symptom driven pathology of hearing loss as our initial presentation. We will present an algorithmic scheme based on the patients chief complaint, age, and associated findings that could reasonably be expected to be present in an imaging request. The scheme should direct the practitioner or student to the particular area of the study most commonly associated with the specific radiologic abnormality.

Conclusions
Adaptation to new learning styles is an essential component of medical education. This educational exhibit is meant to teach radiology trainees about hearing loss and share an approach to teaching hearing loss with the neuroradiology community at large.
EdE-67

An Anatomical Variant of the Basiocciput – Fossa Navicularis Magna

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Purpose
To increase awareness of an under-recognized radiologic entity known as Fossa Navicularis Magna (FNM). We aim to improve the recognition of this finding by reviewing its embryologic origin, typical imaging appearance, possible differential considerations, and potential complication. By doing so, we hope to increase the incidence of detection, reduce the incidence of misdiagnosis, and avoid unwarranted imaging and/or clinical follow up for FNM.

Materials and Methods
High resolution CT and MR imaging were acquired on a 16-channel Siemens Somatom CT scanner (Malvern, PA) and a 1.5T Philips Intera MR scanner (Eindhoven, Scotland). 2D and 3D CT reformations were created from a noncontrast CT sinus study using Voxar software (BRACO, Edinburgh Scotland). A contrast-enhanced MRI of the brain was performed with multiplanar, multiecho imaging.

Results
FNM is a notch-like developmental anatomical variant on the extra-cranial surface of the clivus. Current theories postulate that the bony defect results from incomplete ossification, either prevented by a persistent notochord remnant (1), or due to enlargement of emissary veins that passed through the clivus (2). Literature review suggests that FNM may be found in 3.2% of the CT imaging population (3). Our clinical experience suggests that this is less common but possibly under-diagnosed, and at times, confused with other lesions. Imaging characteristics of this lesion consist of a round or multilobulated notch-like defect that often is located within the midline of the clivus along its ventral surface (Figures 1, 2). The diameter of the defect usually is less than 2 cm but can be variable in size. The notch may be completely or partially filled with lymphoid tissue and may contain air or fluid. A rim of enhancement can be seen on MR imaging (Figure 2). The border of the notch generally is sclerotic, often thin but occasionally thick, if in the setting of prior infection. MR appearance may vary depending on the contents within the notch. Given its location and variable imaging appearance, it may be mistaken for an epidermoid cyst, hemangioma, plasmacytoma, benign or malignant chondroid lesion or possibly metastasis. Given the presence of adenoid lymphoid tissue within the notch defect, it has been theorized that FNM could act as a direct route of infectious spread. At least two case reports have implicated contiguous spread of the retropharyngeal infection through the fossa navicularis magna resulting in clival osteomyelitis (4, 5).

Conclusions
Fossa Navicularis Magna is a normal anatomical variation that may be under-recognized, under-reported and possibly misdiagnosed. Awareness of this entity, its various presentations, and potential complications can reduce unnecessary clinical and radiologic work up.
Contrast enhanced magnetic resonance cisternography in cerebrospinal fluid leaks. First experiences in Uruguay.

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Purpose
Show the role of gadolinium-enhanced magnetic resonance cisternography in cerebrospinal fluid (CSF) leaks in a group of patients in our Institution.

Materials and Methods
The first 10 cases of CSF leak studied in our country with contrast-enhanced MR cisternography are presented. The technique and its indications will be described. We included 10 patients with a history of CSF leak, nine of which had rinorreaquia in activity at the time of the study, the other patient had ceased rinorreaquia days prior to the study. Previous studies of CT were evaluated by the study to guide the probable topography of the leak. After discarding the overall contraindications and obtain informed consent 2 ml of gadolinium was injected intrathecally through a lumbar puncture at L4-L5 space under local anesthesia. Patients remained supine for an hour after contrast medium administered and T1 Fat Sat sequences with 3 mm thickness were acquired in the sagittal and coronal planes of the anterior floor of the skull base. The time of image acquisition was between 9-10 minutes.

Results
The study was well tolerated in all patients. One of them with epilepsy medical history, had a seizure. In nine patients the point of CSF leak later was confirmed during surgical repair. In these patients the leak was at the level of the ethmoidal cells in six cases, one in the posterior wall of frontal sinus, and two patients into the orbit. In one patient the study demonstrated no leak. In this case the rinorreaquia had clinically arrested days before the study. The nine patients in which a leak was demonstrated underwent surgery. In all cases the leak site was correctly point consistent with the finding of MRI. The correct pre-operative identification of CSF leaks increases the likelihood of successful surgical repair procedure. This technique has a overall sensitivity of 81% to 100%.

Conclusions
Contrast-enhanced magnetic resonance imaging is a well tolerated, cost effective and relatively easy realization technique for patients with CSF leak; has an overall sensitivity between 81 and 100%. In comparison with computed tomography technique the great advantages was the lower rate of complications (headache, seizures) and less technical complexity due to passive diffusion of gadolinium through the LCR stands.
Purpose
To elucidate the MRI characteristics (both on conventional and advanced sequences) associated with human papilloma virus (HPV) + oropharyngeal cancer (OPC).

Materials and Methods
We have reviewed retrospectively and extracted the imaging features of 14 patient with HPV+ OPC, specifically squamous cell cancer. We will present the characteristics most associated with OPC squamous cell carcinoma. We will present, describe and demonstrate on MRI the most common imaging features. This will include: 1) General features of OPC seen on conventional MRI sequences (T1WI, T2WI); 3D features of necrosis and enhancement. 2) IVIM characteristics. 3) Perfusion characteristics, 4) Correlative CT imaging characteristics.

Results
HPV+ OPC are associated with specific imaging characteristics to include but not limited to those seen on CT, conventional MRI, MRI-IVIM, and MRI perfusion.

Conclusions
Given the incidence of HPV+ OPC as well as its noninvasive treatment using radiotherapy, the radiologist should be cognizant of their specific imaging characteristics.

EdE-62
6:30AM - 3:00PM
CSF Skull Base Leaks and Their Surgical Repair: A Cross-Sectional and Intraoperative Pictorial Essay

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Purpose
The pre- and post-treatment imaging evaluation of anterior and middle cranial fossa skull base cerebrospinal fluid (CSF) leaks can be challenging for neuroradiologists in training, as well as those in practice. We aim to review the more commonly performed surgical approaches for skull base CSF leaks and their indications, as well as some of the commonly encountered pre- and post-operative imaging findings on CT and MRI. A greater understanding of the radiologic appearance of CSF skull base leaks can guide treatment and reduce subsequent postoperative complications and morbidity.

Materials and Methods
We aim to present a pictorial essay coupling schematic illustrations of various common anterior and middle cranial fossa skull base leaks, their imaging appearance on thin section cross-sectional CT and MRI, as well as surgical techniques used in their repair. Intra-operative 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 pre- and post-operative appearance of CSF skull base leaks can be especially challenging. We will review the various types of CSF leaks as categorized by the Omaya Classification, with division into traumatic and nontraumatic subtypes. We also will
review the most common endoscopic and traditional surgical approaches to repair these leaks. In addition, we will discuss harvest sites for grafts or flaps, synthetic materials such as hydroxyapatite and tissue adhesives such as fibrin glue, which often are used to treat CSF leaks. Finally, the intra-operative appearance of these techniques will be presented, and the pre- and postoperative appearance of these leaks will be discussed.

Conclusions

Familiarity with the various surgical approaches used in repair of CSF skull base leaks, their indications and commonly encountered pre- and post-operative imaging appearances enables the radiologist to provide expert interpretation to the surgeon, reducing complications and morbidity.

EdE-46

6:30AM - 3:00PM

Deep soft-tissue venous malformations of the neck: Imaging pitfalls to avoid in the adult.

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Purpose

Venous malformations are slow-flow vascular malformations, the most common vascular malformation and occur in approximately 1% of the population. However, venous malformations are seen uncommonly 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, and describe the specific multimodality imaging features. The patients have venous malformations in the posterior cervical triangle, submandibular, or premandibular space. Comparison to common neck malignancies 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, 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. Vascular malformations are divided into low-flow and high-flow lesions, with low-flow lesions further divided into venous, lymphatic, and venolymphatic malformations. Venous malformations can present as diagnostic dilemmas when encountered in the deep soft tissues of the neck, and can be confused with malignant neoplasms. On noncontrast CT, venous malformations typically present as intermediate density, well circumscribed lobulated masses containing characteristic phleboliths. Contrast-enhanced studies are variable but predominantly show an avidly enhanced pattern. The excellent soft tissue 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 T2W1, 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. As on CT, avid postcontrast enhancement usually is present. Conventional MR imaging and dynamic contrast-enhanced MR angiography can be especially useful in distinguishing between high and low flow lesions when assessing the type of vascular abnormality. In addition, nuclear red blood cell scintigraphy can be a powerful problem-solving tool showing 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 imaging features of these benign lesions across modalities. Awareness of these imaging features can prevent unnecessary invasive testing, and guide the patient towards more appropriate testing.
Purpose
To identify complications of dental implants and describe their radiographic appearance and treatment.

Materials and Methods
We reviewed the images and treatment plans of patients returning to their periodontist or oral surgeon secondary to the complications of the patient's dental implants. Various types of dental implant complications were identified through radiologic imaging and their treatment described.

Results
Dental implant complications included implant fracture, surgical injury to surrounding structures (inferior alveolar nerve, maxillary sinus, and nasal cavity), inflammation/infection from subgingival cement, implant failure (poor osseointegration, bone resorption, and infection), and poor cosmesis secondary to deficient soft tissue and/or insufficient bone preservation. Dental implant imaging complications are described as well as their treatment.

Conclusions
The use of dental implants has increased significantly in the last few decades and naturally the number of complications also has increased. As a result, patients now are referred more often to radiology departments for jaw evaluation and diagnosis of potential dental implant complications. Since many of these complications are diagnosed on postsurgical imaging, it is important for radiologists to recognize, diagnose and understand treatment of dental implant complications. In a pictorial fashion, this poster will present the complications of dental implants through radiologic imaging.
Purpose
Evaluating external auditory canal dysplasia cases is challenging and the practicing radiologist may have a sinking feeling akin to "going down a rabbit hole" when coming upon these cases. Having a working knowledge of the developmental anatomy of the temporal bone is crucial to approaching these complex cases. Additionally, knowledge of the relevant findings is helpful to tailor the reporting for pre-operative evaluation. We will present cases to review the anatomy relevant to external auditory canal stenosis/atresia cases as well as highlight findings previously identified as critical to stratifying risk versus benefit regarding surgical treatment.

Materials and Methods
Pre-operative selection of external auditory canal stenosis/atresia patients relies on audiometric testing as well as findings seen on high resolution CT scanning of the temporal bones. We will present a number of cases to highlight the relevant anatomical abnormalities the practicing radiologist should be familiar with in order to interpret these exams.
Results
External auditory canal atresia occurs with a frequency of 1/10,000-20,000 (1). Patients present with conductive hearing loss. Given the common embryologic origin, ossicular abnormalities occur in up to 98% of patients (2). The Jahrsdoerfer Grading Scale established in 1992 has shown to have good predictive ability in assessing candidates who are likely to benefit from surgery to improve hearing outcome (3). The grading scale is based on a point system assigning one point each to the oval window status, size of middle ear space, facial nerve course, status of the malleus incus complex, pneumatization of the mastoids, incus stapes connection, appearance of the external ear and round window patency. The presence of the stapes is given a two point significance (4). The practicing radiologist plays a large role when interpreting the high resolution CT scan in the presurgical assessment of these patients given that there may be a significant chance at hearing restoration.

Conclusions
The preoperative assessment of external auditory canal stenosis/atresia cases is challenging. The practicing radiologist plays an invaluable role in contributing to the care of these patients by having a good working knowledge of the developmental anatomy of the temporal bone. We present several cases of external auditory canal stenosis/atresia to highlight these concepts and reinforce the role of the radiologist within the interdisciplinary team.
Imaging After Strabismus and Craniofacial Malformation Surgery

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Purpose
The goal of this exhibit is to review the radiologic findings related to orbital surgery for strabismus and craniofacial malformation.

Materials and Methods
Strabismus surgery plays an important role in visual development in pediatric and adult patients by restoring the normal alignment of the eye. Different types of strabismus surgery are performed depending upon the etiology of the strabismus. High-spatial resolution orbital MRI
can help delineate anatomy prior to intervention, detail previous surgical procedures when records are unavailable, and help the strabismus surgeon with pre-operative surgical planning after complications. Strabismus occurs in 60 to 70% of patients with craniosynostosis. There are a number of potential corrective surgeries and imaging can be performed after calvarial expansion to assess the evolution of the calvarial morphology, determine the degree of excyclorotation of the extra-ocular muscles, assess aberrancy in the path of the superior oblique muscle, and aid in pre-operative planning.

Results

Conclusions
Surgery for strabismus and related craniofacial malformations often results in complex findings on diagnostic neuroimaging. Thus, familiarity with the spectrum of procedures can facilitate postoperative imaging interpretation and patient management.

EdE-61
6:30AM - 3:00PM

Imaging of Oropharyngeal Cancer

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Purpose
The purpose of this exhibit is to provide a radiologic overview of oropharyngeal cancer using images from high resolution computed tomography (CT) and MRI, with correlative endoscopically obtained pictures. Imaging is used in the diagnosis, staging and surgical planning of oropharyngeal cancers. Oropharyngeal cancer spread varies significantly depending on the anatomical locale. Understanding these specific variations is critical for both the radiologist and clinician when evaluating diagnostic and treatment decisions.

Materials and Methods
Using CT and MR images, clinical and endoscopic photos, this exhibit will review the imaging appearances and staging of oropharyngeal cancers.

Results
Squamous cell carcinoma (SCC) of the oropharynx accounts for 90-95% of oropharyngeal cancers. Lymphoma and minor salivary gland cancers (MSG) make up the remainder of the additional malignancies. Tobacco and alcohol are well recognized chemical carcinogens of SCC cancers of the oropharynx. Human papilloma virus (HPV) is now the most common risk factor for oropharyngeal cancers, particularly the papillary subtype of oropharyngeal SCC. Squamous cell carcinoma and MSG oropharyngeal cancers are staged using the TNM system. The disease stage has major implications for treatment. Stage I or II tumors typically are treated with single-
modality therapy (surgical resection or radiation therapy), whereas Stage III or IV tumors are treated with multimodality therapy. Additionally, specific therapies can differ based on the anatomical subsite. Oropharyngeal cancer spreads in three ways: direct extension over mucosa, muscle, and bone, via lymphatic drainage pathways, or by extension along neurovascular bundles. Mucosal spread of SCC is best evaluated by physical examination. However, submucosal spread and involvement of deeper tissues requires imaging. Nodal involvement is the single most important prognosticator for oropharyngeal SCC. The size, morphology, and capsular appearance of lymph nodes are evaluated when determining if a node is pathologically involved. Vascular and perineural invasion often is clinically silent. MR often is necessary for evaluation of perineural spread, as several of the imaging findings are not apparent on CT. The major subsites of oropharyngeal cancer include the base of the tongue, the palatine and lingual tonsils, the soft palate, and the oropharyngeal mucosa. Imaging findings and route of spread vary depending on the subsite involved.

Conclusions
Mastery of the staging, diagnosis and accurate interpretation of the extent of oropharyngeal cancer depends on a thorough understanding of the subtle differences between the routes of spread of the involved anatomical subsite.

EdE-63

Imaging of the Calvarium in Adults

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Purpose
The adult calvarium is affected by a wide array of pathology, and it is important for radiologists to be able to recognize these and differentiate them from normal variants that mimic pathology. Although the appearance of calvarial lesions often is not a focus of resident education, it remains essential to daily practice. Our aim is to present the imaging characteristics of both normal and abnormal findings of the calvarium with MRI, CT, and scintigraphy.

Materials and Methods
A case series of calvarial findings spanning a 7-year period are used to demonstrate imaging characteristics of normal and abnormal findings.

Results
We demonstrate a spectrum of benign and malignant processes of the calvarium in adults. Specifically, we discuss Paget's, osteogenesis imperfecta, osteomalacia, hyperostosis frontalis interna, metastasis, lymphoma, myeloma, meningioma, osteonecrosis, and osteomyelitis. We also demonstrate normal variants and mimics such as arachnoid granulations and arachnoid cyst herniations. We discuss key differential features when present.

Conclusions
We provide a review of the spectrum of benign and malignant processes that involve the calvarium, with a discussion of the key differential imaging characteristics on MRI, CT, and scintigraphy.

EdE-64
Keeping Your ENT Surgeon Happy and Out of Trouble. Relevant Normal and Variant Sinonasal Anatomy: A Pictorial Review

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Purpose
Review and illustrate variant sinonasal anatomy which the neuroradiologist should know and document, as it pertains to endoscopic sinus surgery.

Materials and Methods
Routine and pre-operative multidetector sinus CT studies are reviewed as case illustrations of variant sinonasal anatomy. Prior sinus surgery, except nasoantral window procedures, are exclusion criteria given anatomical distortion.

Results
Variant sinonasal anatomy is a common finding and seen in the majority of patients presenting for sinus CT. CT is well established in illustrating sinus disease burden but also depicts specific anatomy as it pertains to functional drainage and endoscopic treatment of sinus pathology. Some variants are of limited clinical significance while others directly or indirectly affect the functional drainage and therefore the potential success of the intervention. Additionally, several anatomical variants are important as they may increase the risk of complication related to endoscopic sinus surgery. Variations in the uncinate, middle turbinate, ethmoid bulla, nasal septum, cribiform plate, lamina papyracea, sphenoid sinus, and carotid artery will be illustrated and discussed as they relate to functional drainage and/or risk of complication.

Conclusions
The radiologist should be aware of and document relevant sinonasal anatomical variants as we play a crucial role in alerting the ENT surgeon to potential pitfalls in operative planning. Prospective observation may assist in maximizing the success and minimizing the complications of endoscopic sinonasal surgery.

Mimics of Dental Infection: What the radiologist needs to know.

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Purpose
To illustrate odontogenic and nonodontogenic lesions that may appear similar to odontogenic infection.

Materials and Methods
Selected case scenarios will illustrate the most common odontogenic and nonodontogenic lesions that may mimic odontogenic infection, their appearances on multiple imaging modalities, and keys to differentiating these lesions from infection.

Results
There are a myriad of lesions that occur in the jaws of both odontogenic and nonodontogenic
origin. The osseous architecture of the jaws, however, lends itself to generating a similar response to a variety of insults. This exhibit demonstrates imaging features that help to differentiate the most common fibro-osseous and related lesions from odontogenic infection. Conclusions
By recognizing imaging characteristics of noninfectious dental disease, radiologists can help prevent unnecessary treatment.

EdE-54

Multimodality Imaging Following Cornea Surgery

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Purpose
Numerous procedures can be performed for treating corneal diseases. The purpose of this exhibit is to review the variety of expected and complicated findings that can be encountered on different imaging modalities after corneal surgery.

Materials and Methods
There is a plethora of procedures that can be performed and implants that can be used for corneal transplantation and refractive surgery (PKP, FAPK, IEK, DALK, DSEK, DSAEK, DMEK, KPro, OOKP, LASIK, PRK, LASEK, and Intacs). We strive to elucidate this alphabet soup and depict the corresponding findings and complications on imaging, including CT, MRI, ultrasound, including biomicroscopy, and optical computed tomography.

Results
• CT may be indicated for evaluating gross complications after cornea surgery, such as hemorrhage, orbital infection, and epidermal cyst formation. It also is useful for follow up of OOKP laminar resportion. Otherwise, the various corneal implants may be encountered incidentally on CT and should be recognized appropriately. • MRI of the brain is the imaging modality of choice for evaluating patients with suspected Creutzfeld-Jacob disease, which may rarely result from prions transmitted during corneal transplantation. Otherwise, the use of MRI for direct evaluation of corneal surgeries is limits and the modality is considered conditional for patients with Kpro implants. • Anterior segment OCT provides high resolution cross-sectional images that allow for a qualitative and quantitative appraisal of the anatomy after lamellar surgery and to screen for postoperative complications, particularly in cases of corneal edema, which limits direct visual inspection. • It sometimes is necessary to quantify the thickness of the cornea after refractive surgery and anterior segment OCT can provide precise measurements of the cornea.

Conclusions
Cross-sectional imaging after corneal surgery is obtained when the cornea is opaque from edema and graft failure or rejection, for example, and direct visualization of the anterior chamber and the fundus is not possible. Although complications after refractive cornea surgeries generally are diagnosed clinically, imaging can serve as an adjunctive to diagnosis and planning for possible further interventions.
EdE-65

Non-PC NPC: Atypical presentations of nasopharyngeal carcinoma

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Purpose
This exhibit will guide readers through atypical appearances of nasopharyngeal carcinoma (NPC) using a set of notable patient cases compiled from our institution in collaboration with the Department of Otolaryngology. Radiologic blind spots and mimics will be discussed, allowing participants to refine their sensitivity for detection of these important lesions.

Materials and Methods
Representative cases will be selected from a database of unusual cases of nasopharyngeal carcinoma compiled in conjunction with the Department of Otolaryngology. Diagnostic imaging and pathologic correlates will be presented.

Results
Nasopharyngeal carcinoma is one of the most common cancers of the head and neck and displays increased incidence in Asian populations. Here we present a series of unusual cases drawing from our unique patient demographics as a major academic hospital located in Chinatown. These cases can be grouped broadly into 1) unusual presentations, 2) unusual patterns of spread, and 3) unusual clinical courses and complications.

Conclusions
Awareness of atypical presentations of nasopharyngeal carcinoma can increase sensitivity for detection of these important lesions. It is our hope that improved detection of NPC will result in timelier intervention with subsequent reduction in morbidity and mortality.
Oral Cavity and Oropharyngeal Carcinoma: Review of Surgical Resection and Reconstruction Techniques and Imaging the Post-Operative Neck

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Purpose
Treatment of cancer of oral cavity and oropharynx requires a multidisciplinary approach. As a radiologist, having an understanding of common surgical techniques to treat head and neck malignancies is invaluable, both during initial clinical staging and subsequent pathologic staging and surveillance imaging of the postoperative neck. This exhibit will review imaging findings after common surgical approaches for resection and reconstruction - from minimally invasive
transoral laser microsurgery to composite resection. A systematic, multimodality approach will be outlined for evaluation of the postoperative neck, with illustrations of common complications and methods to optimize detection of recurrence.

Materials and Methods
1. Targeted review of pertinent anatomy and head and neck subsites for clinical staging, with attention to implication for surgical management of oral cavity and oropharyngeal cancer. 2. Description and illustrations of common surgical techniques for resection, types of reconstruction and classification of neck dissection with imaging correlate. 3. Review of common postsurgical complications including infection, fistula, flap dehiscence/necrosis and nerve palsies. 4. Imaging techniques to optimize detection of recurrence and differentiation from post-treatment changes, such as diffusion-weighted imaging, 18F-FDG PET/CT with pathologic correlation.

Results
It can be difficult for the radiologist to stay current with the advances in surgical techniques for treatment of head and neck cancers. However, understanding the surgical approaches for resection and various types of reconstruction in management of cancer of oral cavity and oropharynx can: a) provide valuable insight when learning the normal and complex altered postsurgical anatomy of the head and neck. b) clarify (TNM) staging system, as well as its implication for treatment options and patient's quality of life. c) improve radiologist's efficiency and accuracy in detecting post-treatment complications and recurrence. d) promote collaboration with referring head and neck surgeons to optimize patient care.

Conclusions
Familiarity with the imaging findings of various methods of surgical resections, lymph node dissections and reconstructions for cancers of oral cavity and oropharynx, is not only important for diagnostic accuracy, but is essential to providing a multidisciplinary approach for optimal patient care.

EdE-55

Orbital Bands/Accessory Extraocular Muscles

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Purpose
Orbital bands and accessory extraocular muscles (EOM) rarely have been described in the neuroradiology literature. We discuss the various forms of these anatomical variants, their imaging appearance, clinical significance, and imaging pitfalls.

Materials and Methods
Seven patients with orbital bands/accessory EOM seen on MRI/CT orbits were reviewed retrospectively from 2011 to 2014 from a single institution.

Results
The normal human orbit contains six EOM, levator palpebral superioris muscle, and the orbicularis oculi muscle. Numerical aberrations of the EOM are rare with an estimated prevalence of 2%. Three types of accessory EOM include: anomalous bands of muscle bridging two muscles; fibrous tissues adjacent to the muscles, which may attach to the globe; and muscles
arising from the posterior orbit and inserting on the globe or EOM. Accessory EOM rarely have been reported in ophthalmologic literature but only one report has been found in radiology literature. The clinical importance of orbital bands likely depends on the size and location. Often they are found incidentally in autopsy or for work up of nonassociated visual symptoms. However, there is an increased incidence of orbital bands in patients with restrictive strabismus, globe retraction, and eyelid retraction. We present seven cases of orbital bands. All were believed to be unrelated to the patient's presenting symptoms. Reasons for initial imaging evaluation include thyroid orbitopathy, trauma, sinusitis, papilledema, esotropia, and orbital neoplasm. Six of our cases involve bands that bridge the superior and inferior rectus muscles. One case revealed bilateral bands that extended from the inferior rectus muscles and attached to the temporal aspect of the globes. Five of the cases were found on MRI, two on CT. Bilateral bands were seen in four cases, unilateral in three cases. Orbital bands on imaging are found to be isodense and isotense to normal EOM on CT and MRI respectively. They often are smaller in bulk than normal EOM. Orbital bands should not be confused with the normal lateral rectus-superior rectus band (LR-SR) or the lateral levator aponeurosis (LLA) connecting the levator muscle to the lacrimal gland. Degeneration of the LR-SR has been implicated with two forms of strabismus, heavy eye syndrome and sagging eye syndrome.

Conclusions
Orbital bands or accessory EOM are a rarely reported entity where there exists an abnormal connection of tissue bridging EOM and/or the globes. While many patients with orbital bands have no visual symptoms, they have a higher prevalence in people suffering from strabismus among other conditions. Awareness of orbital bands by radiologists will improve their detection, guide surgeons in their anatomical approach, and ultimately improve patient outcomes. Knowledge of orbital bands also will help radiologists avoid the pitfall for describing a suspicious orbital mass, especially when present bilaterally, with unnecessary work up for an unrelated symptom.
Orbital Lesions with Low Signal Intensity on T2-Weighted Imaging

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Purpose
The purpose is to discuss and display orbital pathologies that demonstrate hypointense signal on T2-weighted images (T2WI).

Materials and Methods
The physical basis for hypointense signal on T2WI produced by various substances is discussed. Orbital pathologies that are hypointense on T2WI subsequently are reviewed, including a discussion of their chemical composition as well as relevant clinical and imaging clues that may aid in their diagnosis.
Results
Low signal intensity on a T2-weighted pulse sequence implies the presence of certain substances, which are known to possess short T2 relaxation times (e.g., hemorrhage, melanin, minerals, protein, amyloid, fibrosis) (1, 2). Orbital pathologies that characteristically produce hypointense signal on T2WI include various neoplasms (melanoma, retinoblastoma, meningioma, schirrhous metastases), vascular lesions (high flow vascular lesions, superior ophthalmic vein thrombosis, veno-lymphatic malformation), fibro-osseous lesions (fibrous dysplasia, ossifying fibroma), infectious/inflammatory processes (fungal infection, Wegener's granulomatosis, sclerosing pseudotumor, amyloidosis), traumatic hemorrhage, and orbital prostheses (3, 4, 5).

Conclusions
Diverse orbital pathologies produce hypointense signal on T2WI. Knowledge of the possible composition of an orbital lesion based on T2-shortening, combined with the clinical presentation and other imaging characteristics may facilitate an accurate differential diagnosis.

Table 1: Classification of Hypointense Orbital Lesions on T2 Weighted Images

<table>
<thead>
<tr>
<th>Neoplasm/Tumor</th>
<th>Fibro-Osseous</th>
<th>Infection/Inflammation</th>
<th>Vascular</th>
<th>Trauma/Iatrogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melanoma</td>
<td>Fibrous</td>
<td>Fungal</td>
<td>Cavernous Carotid Fistula</td>
<td>Traumatic Hemorrhage</td>
</tr>
<tr>
<td>Retinoblastoma</td>
<td>Ossifying Fibroma</td>
<td>Sclerosing Pseudotumor</td>
<td>AVM</td>
<td>Surgical Prostheses</td>
</tr>
<tr>
<td>Meningioma</td>
<td></td>
<td>Wegener Granulomatosis</td>
<td>Veno-Lymphatic Malformation</td>
<td>Fixation Mesh</td>
</tr>
<tr>
<td>Schirrhous Metastasis</td>
<td></td>
<td>Amyloidosis</td>
<td>Thrombosis</td>
<td>Silicone Oil</td>
</tr>
</tbody>
</table>

(Filename: TCT_EdE-58_Table1OrbitalLesions.jpg)
EdE-57

Orbital Sarcoidosis: Radiology-Pathology-Clinical Correlation.

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Purpose
Sarcoidosis is a multi-system disorder that can present with a range of ocular presentations, most commonly swelling, proptosis, and discomfort (1). The visual system is involved by sarcoidosis in between 25-60% of cases, and the lacrimal gland is the most commonly affected orbital tissue (1). Though this disease can lead to visual loss or impairment, it is responsive to steroids and immunomodulators, and early recognition and prompt treatment can reverse or impede unfavorable sequelae. Using a combined radiologic, pathologic and clinical approach we can recognize this disease and ensure early treatment.

Materials and Methods
We retrospectively review 15 cases of orbital sarcoidosis, the majority of which are characterized by extraocular muscle and lacrimal gland involvement. The paranasal sinuses, optic nerve sheath...
and cavernous sinus also are commonly involved. We review the various imaging manifestations of orbital sarcoidosis using CT and MRI images and clinical and pathologic correlates. Participants will understand the primary clinical, radiologic and pathologic features useful for distinguishing between sarcoidosis and pertinent differential diagnoses. Relevant management issues also will be discussed.

Results
Sarcoidosis occurs worldwide but has an ethnic predilection for those of African American, Scandinavian and Irish descent (2), and commonly involves the orbits and ocular adnexa. The lacrimal gland is the most commonly involved orbital tissue, however the disease can affect the extraocular muscles, retrobulbar fat, optic nerve sheath, cavernous sinus and dural reflections as well. Epithelioid cells, which are abundant in sarcoid granulomas, contain Angiotensin converting enzyme (ACE), which is elevated in approximately 60% of patients with sarcoidosis, however lacks sensitivity or specificity (3). The presence of noncaseating granulomas, in the appropriate clinical and radiologic setting usually is considered proof of the diagnosis of sarcoidosis (2).

Conclusions
Familiarity with diverse imaging spectrum of orbital sarcoidosis is important in distinguishing between this disease and pertinent differential considerations. Accurate diagnosis is of critical importance since this disease can lead to visual loss, and because treatment with steroids and immunomodulators can prevent or reverse unfavorable sequelae. As the disease is a diagnosis of exclusion, a combined radiologic, pathologic and clinical approach is necessary for appropriate diagnosis and early treatment.
EdE-49

Patterns of Perineural Spread in Head & Neck Malignancies - A Review

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Purpose
To review the relevant anatomy of the skull base foramina and course of the cranial nerves most commonly involved in perineural spread of tumor. To review the most common patterns of perineural spread of tumors in the head and neck. To demonstrate patterns of perineural spread using different imaging modalities and correlate CT/MRI findings. To review the clinical/neurological findings associated with different patterns of perineural spread. To discuss several common mimics of perineural tumor spread.

Materials and Methods
We will present an overview of the relevant skull base foramina anatomy with regards to perineural spread of tumors using a CT of the skull base on bone windows as well as relevant anatomy diagrams. Using CT and MRI we will review the normal branches and course of the most common nerves involved in perineural spread. We will present several cases of perineural spread and will discuss the most common primary and secondary signs to look for when evaluating head and neck malignancies. We will discuss several common mimics of perineural spread and methods to avoid these pitfalls.

Results
Tumors of the head and neck may spread by direct extension, hematogenous or lymphatic routes, or perineurally. Perineural spread is a form of metastatic disease implying tumor extension to noncontiguous regions along the endoneurium, perineurium, or perineural lymphatics. Perineural extension is a potentially life threatening complication of head and neck malignancies and is associated with a nearly threefold increase in local recurrence and approximately 30% decrease in the 5-year survival rates. Unfortunately, most patients with perineural spread of disease are asymptomatic or only exhibit subtle, nonspecific symptoms, which often are overlooked clinically. Therefore imaging plays a critical role in its detection and determination of the appropriate treatment course. A precise understanding of the normal cranial nerve anatomy and most commonly involved neural pathways is paramount.

Conclusions
The presence of perineural spread of head and neck malignancies frequently makes a significant impact on prognosis and treatment. Given that the symptoms associated with perineural spread often are absent or subtle, the radiologist plays a crucial role in its diagnosis. A familiarity with the normal cross-sectional cranial nerve anatomy, common mimics, and often subtle MRI patterns is therefore critical to identify and optimally treat this condition.

EdE-51

Spectral Evaluation of Head and Neck Lesions Using Dual Energy CT

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Purpose
There is increasing evidence to support the advantages of using dual energy CT (DECT) for evaluating head and neck lesions. The purpose of this exhibit is to provide a practical review of the approaches to, and of the current applications of, DECT for head and neck imaging.
Materials and Methods
This exhibit will provide an overview of (1) general approaches to lesion analysis using a single source DECT scanner with rapid kVp switching, and (2) of its specific applications in the evaluation of head and neck lesions. A review of the principles of Gemstone Spectral Imaging (GSI; GE Healthcare, Milwaukee, WI), of virtual monochromatic images (VMIs), and of analytic tools such as spectral Hounsfield unit attenuation curves, effective Z, and iodine overlay maps, will be undertaken. Subsequently, specific applications of DECT for evaluation of head and neck lesions, such as head and neck squamous cell carcinoma (HNSCC), will be discussed.

Results
DECT with GSI enables reconstruction of VMIs at various energy levels, which can be used to accentuate different tissue characteristics. Iodine overlay maps can be generated, which reflect and can be used to quantify the iodine content of enhancing lesions such as HNSCC. Additional analysis, including calculation of the effective Z of tissues, analysis of ROIs, and comparison of spectral curves, can also be performed. Low keV VMIs can be used to increase the conspicuity of enhancing lesions such as tumor, whereas high keV VMIs can be used to improve visualization of areas obscured by artifact. High keV VMIs and iodine overlay maps may improve evaluation of thyroid cartilage invasion.

Conclusions
Dual energy CT is a useful tool for evaluating head and neck pathology. Virtual monochromatic image reconstructions at different energy levels, iodine overlay maps, and spectral curve analysis can be used to improve lesion visualization and characterization, including evaluation of thyroid cartilage invasion.

*Image: TCT_EdE-51_Slide1.jpg*

**EdE-47**
6:30AM - 3:00PM

**The Dark Passenger: How Much Do You Really Know About Plasmablastic Lymphoma?**

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¹Baystate Medical Center, Tufts Univ Sch of Med, Springfield, MA, ²Baystate Medical Center / Tufts University School of Medicine, Springfield, MA
Purpose
Plasmablastic lymphoma is a recently identified and very rare subtype of non-Hodgkin's lymphoma that can present in the severely immunocompromised population. Prognosis often is poor and there currently is little evidence to support any particular treatment regimen. Plasmablastic lymphoma also may be poorly recognized by both pathologists and radiologists given its rare occurrence and unusual features. The aim of this exhibit is to review the clinical, radiologic, and histologic findings that can lead to the accurate diagnosis of this highly aggressive and poorly understood disease.

Materials and Methods
Case reviews will be provided with the initial discussion focusing on the patient presenting clinical signs and symptoms and diagnostic planning. Associated secondary conditions will be identified. Different imaging modalities from initial studies to advanced techniques, including x-ray, CT, MRI, and PET then will be illustrated. Histologic imaging and features as well as post-treatment clinical course also will be included.

Results
1. Discuss the history of the disease, epidemiology, and clinical features currently established in evidenced-based literature. 2. Discuss anatomical imaging findings with emphasis on advantages and disadvantages of various imaging modalities/techniques. 3. Discuss differential diagnoses and the consequences of misinterpretation. 4. Discuss importance of accurate pathological diagnosis, post-diagnostic treatment, and plans of intervention.

Conclusions
Plasmablastic lymphoma is a very rare and poorly understood disease that has been discussed only recently in the literature. It is one of the more aggressive sub-types of non-Hodgkin's lymphoma and often can be overlooked in terms of its diagnostic features, potentially leading to either delayed or improper diagnosis. At the end of the presentation, the viewer will become familiar with causes, clinical findings, diagnostic imaging features, histologic features, and consequences of interpretations.
**TWIST with Gadofosveset Trisodium (Ablavar) for the Evaluation of Pediatric Head and Neck Soft Tissue Vascular Anomalies following 2014 updated ISSVA classification system**

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¹The Johns Hopkins University School of Medicine, Baltimore, MD

**Purpose**

We review the clinical application of time resolved contrast-enhanced MRA (TWIST) using gadofosveset trisodium, a blood pool contrast agent, in soft tissue vascular anomalies in the head and neck in children following ISSVA 2014 updated classification system.

**Materials and Methods**

1. An overview of TWIST as an MRA technique will be summarized, followed by technical properties of gadofosveset trisodium. 2. Pitfalls of TWIST will be presented showing importance of recognizing normally enhancing anatomical structures and importance of choosing the right imaging plane depending on lesion location. 3. Image interpretation with combination of conventional anatomical sequences and TWIST will be highlighted especially in small size lesions. 4. TWIST features of common soft tissue vascular anomalies following ISSVA 2014 will be summarized with example cases.

**Results**

TWIST is a time resolved 4D MRA technique which provides valuable hemodynamic information with the ability to obtain diagnostic quality images without the need for bolus timing. The advantage of using a blood pool contrast agent such as gadofosveset trisodium in the pediatric population is to use a much lower dose (1/3) compared to GdDTPA (commonly used in conventional contrast-enhanced MRI) with higher image contrast and signal to noise ratio. The combination of TWIST with Gadofosveset trisodium is the ideal protocol for assessment of soft tissue vascular anomalies in children. TWIST provides important information for lesion classification, treatment planning and follow up of these complex anomalies in the head neck. Clinical applications of this approach require an understanding of the technique including its advantages and limitations.

**Conclusions**

Soft tissue vascular anomalies of the head and neck in children are complex, and are best described using standardized nomenclature and definitions provided by the recently revised ISSVA classification system (2014). TWIST with gadofosveset trisodium provides quick hemodynamic information leading to accurate characterization of these lesions with additional advantage of 1/3 of the regular contrast dosage.
Monday
6:30AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exposition Hall A (Level 1)

Educational Exhibit Poster (Print) - Interventional
EdE-72
6:30AM - 3:00PM

Computational Flow Modeling of Intracranial Aneurysms for Rupture Prediction

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¹QE II Health Science Center, Dalhousie University, Halifax, Nova Scotia, ²Universidade Estadual Paulista, Ilha Solteira, São Paulo, ³UNESP - State University of São Paulo, Ilha Solteira, São Paulo, ⁴Dalhousie University, Halifax, Nova Scotia
Purpose
The application of computational fluid dynamics (CFD) to hemodynamic modeling of intracranial aneurysms is an expanding research interest. Our educational exhibit explores the potential of CFD to improve aneurysm rupture risk prediction.

Materials and Methods
We review fundamental CFD principles and components of the simulation process. We describe the application of CFD to aneurysm modeling and review the current literature, focusing on the contribution of hemodynamic factors to rupture risk. This includes a review of key parameters under investigation, including wall shear stress (WSS) and oscillatory shear index. We discuss theories of aneurysm growth as influenced by local flow alterations demonstrated by CFD. We also explore hemodynamic predictors of aneurysm rupture points identified by CFD.

Results
Intracranial aneurysms cause 85% of nontraumatic subarachnoid hemorrhage (SAH). Morbidity and mortality from both aneurysmal SAH and pre-emptive repair remain high. Current models of rupture risk are somewhat rudimentary, relying on patient demographics and aneurysm geometry. However, patients with similar aneurysm geometry may have different rupture risk profiles. The high spatial resolution of modern cross-sectional imaging permits creation of high-fidelity CFD models (Figures A and B). Accuracy of flow simulations has been validated experimentally. By providing aneurysm-specific hemodynamic data, CFD may improve rupture risk prediction for individual patients, but current understanding of CFD-derived variables is limited. The influences of local wall shear stress and blood flow profile on aneurysm growth remain controversial, with competing theories implicating both high- and low-stress environments (Figures C and D). Studies comparing CFD data from ruptured and unruptured aneurysms aim to identify hemodynamic risk factors. Some authors have assessed the local hemodynamic environment at clinically identified aneurysm rupture points to determine further high-risk characteristics. Incorporating structural models of the aneurysm wall has been described recently and may refine rupture point prediction.

Conclusions
Computational fluid dynamics techniques provide aneurysm-specific hemodynamic data. Characteristics predicting aneurysm growth and rupture have been investigated with encouraging results but controversies remain. Computational fluid dynamics is a promising technique for aneurysm work up but requires further investigation prior to inclusion in routine clinical decision-making.
Aneurysm/vessel segmentation

CFD mesh: 0.3 mm 

CFD solution: velocity (streamlines)

CFD solution: wall
Hemodynamic Modeling of Intracranial Aneurysms Using Open Source Computational Fluid Dynamics Software

M Bligh\textsuperscript{1}, A Demétrio Sales de Lima Dias\textsuperscript{2}, E Del Rio\textsuperscript{3}, J Militzer\textsuperscript{1}, J Shankar\textsuperscript{4}
\textsuperscript{1}Dalhousie University, Halifax, Nova Scotia, \textsuperscript{2}Universidade Estadual Paulista, Ilha Solteira, São Paulo, \textsuperscript{3}UNESP - State University of São Paulo, Ilha Solteira, São Paulo, \textsuperscript{4}QE II Health Science Center, Dalhousie University, Halifax, Nova Scotia

\textbf{Purpose}

Computational fluid dynamics (CFD) is a promising technique that may predict the natural history of an individual intracranial aneurysm. However, CFD is a labor intensive and technically challenging process requiring dedicated software. Due to its complexity and investigational status, CFD currently is performed mainly at high level technical institutions. The purpose of this educational exhibit is to provide step-by-step instruction on creating a CFD model of an intracranial aneurysm using open access, freely available software.

\textbf{Materials and Methods}

For the example case of a ruptured internal carotid artery aneurysm, we use the Vascular Modeling Toolkit (Orobix, Bergamo, Italy) to demonstrate the process of extracting an aneurysm/parent vessel complex from thin section computed tomography angiography (CTA) data, creating a surface model (Figures A and B). We then describe methods of generating a grid, or mesh from the surface model and preparing it for use in the simulation (Figure C). We review the basic functionality of a selected unsteady state solver in the CFD software package OpenFOAM (ESI-OpenCFD, Bracknell, United Kingdom). We demonstrate the setup of a simulation including physical parameters and boundary conditions, incorporating pulsatile inflow. Finally, we describe postprocessing techniques using the data analysis software package ParaView (Kitware, Clifton Park, New York, USA) to produce visual representations of velocity, wall shear stress and other parameters of interest (Figure D).

\textbf{Results}

Morbidity and mortality from both aneurysmal subarachnoid hemorrhage and pre-emptive aneurysm repair are high. Current rupture risk models rely on patient demographics and aneurysm geometry. Hemodynamic modeling of intracranial aneurysms using CFD aims to produce aneurysm-specific data that may refine rupture risk. Clinical investigation and application of CFD aneurysm modeling is limited in part by technical complexity and time investment. Software packages required for CFD often are costly. This step-by-step guide uses exclusively open-source software, demonstrating that users can access sophisticated computational techniques without the burden of additional financial cost, whether for research or clinical purposes.

\textbf{Conclusions}

Given adequate cross-sectional imaging data, CFD simulations can be performed on most intracranial aneurysms. Our educational guide familiarizes users with CTA data extraction, mesh generation, flow simulation and post-processing techniques using freely available software.
CTA: right ICA aneurysm

Mesh: 0.3 mm cells, boundary layer

Aneurysm/vessel

CFD solution: velocity
Phrenology of arteriovenous malformations: a review of eloquence as well as changes in brain function before and after treatment.

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Purpose
To review cerebro phrenology as it relates to arteriovenous malformations and to review the definition of eloquence. To use examples of functional outcome in patients with treated lesions in both eloquent and non eloquent areas using modern surgical and nonsurgical treatment to illustrate what a neuroradiologist needs to know when advising a clinician about the location of this disease process.

Materials and Methods
The imaging findings in 20 patients with arteriovenous malformations as identified by either MRA or CTA, were reviewed retrospectively. The angiograms, CT and MRI scans were examined as to the location of the nidus of disease, and size of the lesion at the time of identification as well as the time of follow up. Patient age and neurologic function also were recorded. Functional change was evaluated using modified rankin scale.

Results
We will review: 1. Illustrative review of anatomy of the Brodmanns map of the brain. 2. neurologic deficits associated with lesions in key eloquent areas of the brain as well as description of other functional maps. 3. Review the Spetzler Martin Criteria as well as additional important AVM features as they relate to treatment. 4. MR imaging and CT findings in patients before and after treatment of arteriovenous malformation. 5. Outcome scoring and case examples of arteriovenous malformations associated with complete and incomplete neurologic impairment. 6. References.

Conclusions
At the end of this presentation, the viewer should have an understanding of the imaging appearance of arteriovenous malformations as demonstrated on angiography, CT and MRI as well as better understand eloquence as it relates to associated neurologic deficits. By reviewing topographical anatomy as well as reviewing the Spetzler-Martin grading system, the viewer should have a better sense of the additional imaging characteristic features that are helpful to know in these patients both within and beyond this grading system.
A Review of Fetal MRI Findings of Posterior Cranial Fossa Cystic Lesions

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¹Beaumont Health System, Royal Oak, MI

Purpose
Fetal MRI is emerging as a highly sensitive method of evaluating the fetal brain, most commonly used as an adjunct to prenatal ultrasound once abnormal findings are detected. Prenatal ultrasound also has some limitations, including in differentiating posterior fossa cystic processes leading to more frequent suspicion of Dandy-Walker malformation. The goal of this educational exhibit is to provide a case-based review of the ultrasound and MR findings of different developmental cystic lesions of the posterior cranial fossa, as well as provide a brief review of relevant embryologic development and pathogenesis. Postnatal correlation in select cases also is provided.

Materials and Methods
A retrospective review of patients diagnosed with posterior fossa cystic processes on fetal MRI and prenatal ultrasound at our institution was performed. Relevant images from patients with Dandy-Walker malformation, persistent Blake's pouch cyst, posterior fossa arachnoid cyst, and mega cisterna magna on both ultrasound and MRI were extracted.

Results
MR imaging affords an ability to assess the posterior fossa in any number of planes, thus overcoming a limitation of ultrasound when acoustic shadowing from the petrous temporal bone limits evaluation. One of the critical factors in separating Dandy-Walker malformation from some of the other conditions is assessment of the vermis, which can be performed accurately by MRI. Additionally, supratentorial assessment can be performed, supporting and adding to the original diagnosis. An understanding of the underlying embryology also is helpful in assessing the pathogenesis.

Conclusions
Fetal MRI is a useful adjunct to prenatal ultrasound and permits more definitive assessment of posterior fossa cystic developmental abnormalities. Additionally, MRI increases the confidence in making a diagnosis and hence helps with patient counseling, delivery planning and potentially early management. It also aids clinicians in better understanding the embryogenesis of the central nervous system and development of posterior cranial fossa cystic lesions.

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Purpose
Increasing availability and sophistication of neuroradiology, in particular magnetic resonance imaging, has improved our ability to characterize the anatomical detail of developmental abnormalities of the midline cerebellum. In this scientific exhibit, we review normal cerebellar embryology, with particular emphasis on the cerebellar vermis. We will summarize recent advances in the current understanding of the genetic basis of vermian abnormalities and relate these to disrupted embryological processes that result in abnormal radiological appearances.

Materials and Methods
It has long been recognized that knowledge of cerebellar embryology can contribute to an understanding of the morphology of vermian abnormalities. In recent years there have been significant advances in our appreciation of the underlying genetic pathways involved in cerebellar development. Awareness of how disruption to these processes lead to defects in proliferation and migration of neurones and characterization of the cerebellar territory is
enhancing our ability to relate imaging findings to underlying embryogenetic pathology. Using cases from our institution we will explain how aberrations in normal development may result in vermian hypoplasia, dysplasia or agenesis with specific anatomical, clinical and imaging features and genetic etiology.

Results
Cases from our own institution are used to illustrate the wide ranging nature of these abnormalities. Conditions include the Dandy Walker spectrum, CASK-related pontocerebellar hypoplasia, Joubert's syndrome and rhomboencephalosynapsis. The concepts summarized will provide readers with a framework for categorizing and diagnosing cerebellar vermian abnormalities in their own practice.

Conclusions
Through synergy of embryogenetics and clinical radiology we can enhance our ability to recognize and categorize abnormal patterns of development in order to make accurate diagnoses that can guide prognosis and appropriate use of genetic counseling.

EdE-79

Fast MRI Techniques

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¹University of Minnesota, Minneapolis, MN, ²University of Minnesota, Minneapolis, MN

Purpose
The most common complication of a cerebrospinal fluid (CSF) shunt is failure of the shunt, occurring in 50% of children within 2 years of surgery. Magnetic resonance imaging (MRI) is used increasingly as the imaging modality of choice in the evaluation of shunt failure. Computed tomography (CT) generally is less favorable, particularly in the pediatric population, due to the inherent exposure to ionizing radiation. Some patients may undergo more than 50 scans in less than a year. Routine MRI for the pediatric population also often requires sedation, with a rate of adverse events as high as 4% and suboptimal image quality in as many as 29% of studies. Therefore, the implementation of a "fast" MRI protocol and knowledge of its strengths and weaknesses is crucial to sequence selection and interpretation.

Materials and Methods
We comprehensively have reviewed the literature with respect to "fast" brain MRI with search terms including "quick brain", "fast brain", "rapid sequence", and "ultrafast". Our institution implements a "fast" brain MRI protocol for pediatric shunt evaluation utilizing the Half-Fourier Acquisition Single-Shot Turbo Spin-Echo (HASTE) sequence. Diffusion-weighted images also are obtained.

Results
In comparison to conventional MRI sequences, the HASTE sequence has the advantage of faster acquisition time and is hence less susceptible to motion. However, the tradeoffs include decreased resolution, contrast, and susceptibility sensitivity, and decreased signal to noise ratio. These shortcomings make the HASTE sequence poor in the evaluation of myelination and migration disorders. Furthermore, evaluation of intracranial hemorrhage is difficult with the HASTE sequence.
Conclusions
Under the appropriate circumstances, the use of a fast brain MRI technique is an invaluable tool, especially in the pediatric population for the evaluation of shunt failure. However, the limitations of such a technique also must be understood to avoid the misuse of this specialized technique.

EdE-76

Imaging Findings in Kearns Sayre Syndrome. A Typical Case of an Infrequent Pathology

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Purpose
To illustrate the typical findings in a case of Kearns Sayre syndrome (KSS). To review the diagnostic criteria and the genetic work up in patients with KSS.

Materials and Methods
We present a patient with diagnosis of KSS from the Neurometabolic Clinic at our institution, in which the typical imaging findings prompted the diagnosis in spite of an atypical clinical presentation.

Results
The patient presented at 5 years of age with short stature and subsequently was diagnosed with a growth hormone deficiency as well as glucose intolerance. She also has 'Best disease', vitelliform macular dystrophy. MR imaging of the brain demonstrates white matter changes involving the subcortical U fibers, the midbrain, and the pons. The DNA analysis revealed low level heteroplasmic large deletion (m.8483_13459del4977) in the mitochondrial DNA. Lactate and pyruvate values are normal. Cerebrospinal fluid (CSF) protein is elevated markedly. Although this patient did not present with the classic clinical triad of KSS (typical onset before age 20, chronic progressive external ophthalmoplegia, and pigmentary retinopathy), the typical imaging findings prompted the work up and further genetic confirmation of KSS. Variable imaging findings in patients KSS have been reported in the literature. Frequent features include hyperintensity in the basal ganglia, brainstem, and cerebral/cerebellar white matter; cerebral and cerebellar atrophy; high-signal lesions bilaterally in subcortical white matter, thalamus and brain stem, and cerebellum.

Conclusions
We present a patient with genetically confirmed diagnosis of KSS, in which the diagnosis was based on the typical imaging findings rather than the clinical presentation.
Low Grade Brain Tumors with Spectroscopy Typically Seen in High Grade Tumors

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Purpose
Magnetic resonance spectroscopy (MRS) can be useful in noninvasive evaluation of brain tumors to establish tumor grade, guide biopsy site selection, and following treatment response. On MRS, the choline/creatine ratio greater 2 with low NAA and creatine, typically is seen in high grade tumors. However, some low grade tumors can have these high grade MRS features despite being low grade. Our purpose is to raise awareness of the neuroradiology community concerning these tumors, which to our knowledge has not been reported collectively in the literature.

Materials and Methods
At our cancer center, we have seen at least four different low grade brain tumors that have the choline/creatine ratio greater 2 with low NAA or NAA/Cho ratio, which is typically seen in high grade tumors. These are juvenile pilocytic astrocytoma (JPA), atypical choroid plexus papilloma, meningoangiomatosis, and papillary glioneuronal tumor (PGNT). Most cases are in children. We present the MRS of these tumors, with CT and conventional MRI images along with diffusion and some perfusion and PET images. All diagnoses are confirmed by pathology.

Results
Juvenile pilocytic astrocytoma is a low grade, relatively well defined astrocytoma (WHO Grade I). It is the most common primary brain tumor of childhood, accounting for 70-85% of all cerebellar astrocytomas. Most often it has large cystic component with an avidly enhancing mural nodule but also can be heterogeneous, mixed solid and multiple cysts or completely solid. Meningioangiomatosis is a rare, benign, focal lesion of the leptomeninges and underlying cerebral cortex characterized by leptomeningeal and meningovascular proliferation. It often exhibits peripheral edema or gliosis on CT and MR imaging studies. It usually manifests as a solitary lesion; however, multifocal lesions or masses associated with cyst formation may be present. Atypical choroid plexus papilloma (WHO grade II) is a rare, neuroepithelial intraventricular tumor which occurs most commonly in pediatric population. They usually enhance homogeneously, demonstrating an irregular frond-like pattern, resulting in a cauliflower-like appearance. Papillary glioneuronal tumor (PGNT) is a rare brain tumor of mixed neuronal and glial cells. On MRI, the contrast enhancement is variable but often with no significant surrounding T2 FLAIR hyperintensity to suggest edema. In all these low grade tumors on MRS, the choline/creatine ratio is greater 2 with low NAA or NAA/Cho ratio, which typically is seen in high grade tumors. An example is shown in Figure 1 which is the MRS of an atypical choroid plexus papilloma.

Conclusions
We present four low grade tumors, which on MRS have a high choline/creatine ratio (>2) with low NAA or NAA/Cho ratio, typically seen in high grade tumors. Most of these tumors with exception of JPA are rare. Despite their rarity, neuroradiologists should be aware of these rare brain tumors and consider them in the differential diagnosis when the characteristic features are encountered.
Mimics of Head and Neck Vascular Lesions in the Pediatric Population

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Purpose
Vascular lesions often display similar features despite their clinical variance, and must be characterized accurately to ensure appropriate clinical management. Common vascular lesions involving the head and neck in the pediatric population include capillary hemangioma, capillary malformation, venous malformation, lymphatic malformation, and arteriovenous malformation. Pathologies that can mimic these lesions upon physical examination include lingual cyst, nasal glioma, teratoma, pilomatrixcoma, hemangioendothelioma, schwannoma, neurofibroma, fibrous hamartoma, plunging ranula, branchial cleft cyst, and sarcoma. The following presentation is a
review of the spectrum of pathologies that mimic head and neck vascular lesions in the pediatric population.

Materials and Methods
A retrospective review of magnetic resonance (MR) imaging cases was performed and pertinent scientific literature was reviewed.

Results
Pediatric vascular lesions of the head and neck can be challenging to diagnose on clinical grounds, and require a multidisciplinary approach in work up. The spectrum of clinical management varies greatly depending on the etiology and may involve watchful waiting or surgical intervention. MR imaging, along with patient history and physical examination, plays an essential role in treatment planning following discovery of lesions. It is essential for the diagnosing radiologist to be familiar with the imaging characteristics of the common lesions as well as their mimics, which may otherwise be difficult to distinguish on clinical grounds.

Conclusions
When evaluating a head and neck lesion in the pediatric population, it is essential to consider potential mimics. Familiarity with MR imaging characteristics of these lesions is critical, as part of the multidisciplinary approach in determining appropriate management.

EdE-80
6:30AM - 3:00PM

MR Spectroscopy findings in pediatric leukodystrophy: A pictorial essay

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Purpose
For children who present with developmental delay, diagnosis may be very difficult and extensive testing and evaluation often is performed. When an inborn error of metabolism is suspected, brain MRI is a critical tool in the evaluation process; however, imaging findings may be very nonspecific. As 1H-MR spectroscopy (MRS) has the ability to noninvasively detect in vivo metabolites, this technique may be a helpful adjunct in the evaluation of suspected pediatric leukodystrophy. Though these diagnoses are uncommon, it is important for radiologists to be familiar with the benefits and limitations of MRS and the significance of abnormal findings to assist in the efficient diagnosis for these patients. The purpose of this educational exhibit is to 1. Describe the 1H-MRS techniques available for the evaluation of inborn errors of metabolism in pediatric patients. 2. Review the common patterns of spectra seen in both relatively well known and extremely rare pediatric leukodystrophy. 3. Discuss the role for 1H-MRS and review the limitations for this technique in clinical practice.

Materials and Methods
This education exhibit will review the various techniques and discuss the technical parameters for performing 1H-MRS in pediatric patients. The exhibit will include a pictorial display of MRI and MRS findings for a variety of pathologies (e.g., Canavan, Alexander's disease, metachromatic leukodystrophy) including very rare diagnoses. In addition, we will discuss the pearls and pitfalls for performing and interpreting MRS studies in clinical practice.

Results
Though diagnosis of pediatric leukodystrophy can be difficult and efficient diagnosis has
important implications both for treatment and peace of mind for parents. Advances in the genetics and pathology of pediatric leukodystrophy has allowed for a better understanding for the significance of patterns of white matter changes on brain MRI. In turn, this also has allowed for better understanding of the metabolite markers in pediatric inborn errors of metabolism. MRS is an advantageous method for employing this knowledge to assist in diagnosis.

Conclusions
MR spectroscopy may be a very helpful technique when interpreted in association with brain MRI findings in the diagnosis of pediatric inborn errors of metabolism for narrowing the differential diagnosis to allow for more efficient targeted testing. The purpose of this poster is to improve the radiologist's understanding of the techniques, interpretation, and limitations of MRS imaging for the evaluation of pediatric patients with suspected inborn error of metabolism.

EdE-82 6:30AM - 3:00PM

Post-mortem High Resolution (HR) magnetic resonance imaging (MRI) in fetuses with brain abnormalities and confirmation of in utero MRI findings.

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⁴Anatomia Patologica, Fondazione IRCCS Ca Granda Ospedale Maggiore Policlinico, Milan, Italy

Purpose
To describe the role of HR post-mortem MRI (HRpmMRI) in validating in utero fetal MRI findings for brain abnormalities.

Materials and Methods
Six HRpmMRI of unfixed fetal brain were performed on a 3T scan within 30 hours from pregnancy termination [range: 21 postconceptual weeks (pcw) + 4 days (d) and 22pcw + 3d]. Axial, coronal and sagittal T2-weighted HR images (voxel size 0.3x0.3x1.2mm) and T1 isotropic-weighted images (voxel size 0.7x0.7x0.7 mm) were acquired. All fetuses were studied previously with in utero fetal MRI at 1.5T (range: 21 pcw + 3d and 22pcw) and later underwent the conventional autopsy.

Results
In three cases the HRpmMRI confirmed the diagnosis of in vivo fetal MRI (cerebellar hypoplasia, romboencephalosynapsis and syntelencephaly); in three cases the HRpmMRI added diagnostic information (in two cases of agenesis of septum pellucidum HRpmMRI ruled out septo-optic dysplasia, in one case of cerebellar hypoplasia it demonstrated olivary nuclei hypoplasia). The conventional autopsy confirmed the HRpmMRI findings. In one case the conventional autopsy was not performed because of severe brain autolysis. The diagnostic window of in utero fetal MRI is narrowed by safety and logistical concerns from 18-19 pcw to 22 pcw (Prayer et al., Chung et al., Triulzi et al.). Therefore the diagnostic accuracy of in vivo fetal MRI can be limited by the early gestational age and may need autopic confirmation. HRpmMRI does not replace conventional autopsy but shows some advantages over it: it is less
sensitive to autolysis, it allows in situ assessment without removing the brain from the skull, it may direct the following conventional autopsy; moreover the HRpmMRI images can be reviewed at a later stage (Whitby et al.).

Conclusions
The HRpmMRI can be a tool to validate in utero MRI findings and can complete and guide the conventional autopsy in the evaluation of macroscopic anatomy in fetal brain abnormalities.

EdE-75

The Spectrum of Imaging Findings in Hemiplegic Migraine

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Purpose
Hemiplegic migraine (HM) is a migraine variant that includes an aura of unilateral, reversible motor weakness. Sporadic and familial forms exist. Hemiplegic migraine is a diagnosis of exclusion, as two similar episodes are required to make the diagnosis, and it often occurs in children where history can be difficult to obtain. Over the past two decades, neuroimaging has played a role in characterizing HM, particularly with the aid of perfusion-weighted imaging. Hypoperfusion and hyperperfusion have been described in association with migraine headaches both in the absence and presence of abnormal arterial imaging. We provide a pictorial essay of the various imaging findings seen with HM.

Materials and Methods
A literature review was performed to determine the spectrum of neuroimaging findings that have been described in HM. We demonstrate the spectrum of neuroimaging findings at various stages of HM using a multi-institutional series of children and adolescents. Our findings are correlated with those described in the literature.

Results
Common imaging findings in HM include subtle signal changes in the brain parenchyma, such as cortical edema (Figure 1A) or patchy restricted diffusion, the latter of which is less a "feature" of HM but rather a complication. Vascular and perfusion abnormalities include vasoconstriction of intracranial arteries (Figure 1B), vasodilatation or less likely vasoconstriction of cortical veins (Figure 1C), as well as alterations in cerebral blood flow (Figure 1D) (2, 3). Conventional and advanced neuroimaging techniques are highlighted, including susceptibility and perfusion-weighted imaging.

Conclusions
Acute hemiplegia in children is distressing to parents and medical providers. Prompt and accurate diagnosis is necessary to guide appropriate treatment and prognosis. Conventional and advanced neuroimaging techniques play a role in characterizing the perfusion changes associated with HM and excluding clinical mimics such as acute arterial ischemic stroke. Knowledge of these frequently subtle imaging findings can aid clinicians in reaching a more timely diagnosis.
Figure 1. Imaging findings of HM include subtle cortical swelling/sulci effacement on T2 (A, white arrows), faint restricted diffusion on DWI (not shown), attenuation and narrowing of M2 and M3 branches on T1 MRA (B, curved arrow), asymmetric dilatation of cortical veins on SWI black arrows), and decreased blood flow on CTP (D).

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¹Medical College of Wisconsin, Wauwatosa, WI, ²University of Pennsylvania, Philadelphia, PA, ³Medical College of Wisconsin, Milwaukee, WI

Purpose
To explore the anatomy of the human insula and discuss its functional organization.

Materials and Methods
Gross anatomy of the human insula will be detailed on cross-sectional brain images. Different functional regions will be discussed and relevant patient cases will be shown.

Results
The human insula is situated deep to the lateral fissure and is hidden by the frontal and parietal operculum. The anterior and posterior parts of the insula are divided by the central sulcus. The anterior part includes three short gyri, named the anterior, middle and posterior short gyri. The posterior part of the insula has two long gyri, the anterior and posterior long gyri. From a functional perspective, besides containing primary and secondary olfactory and gustatory cortices, the insula also is involved in limbic, cognitive, somatosensory, and viscerosensory functions via its extensive connections with the thalamus, amygdala, and other cortical areas. This brain region often is overlooked during neuroradiological evaluation secondary to limited knowledge of its functional role.

Conclusions
Despite emerging evidence that the insula plays a crucial role in multiple neurologic behaviors and processes, this brain region often is underappreciated by neuroradiologists in clinical practice. The aim of this exhibit is to explore the functional insular anatomy and its various roles with the support of anatomical and relevant case-based imaging.

Beyond the Spine: Extra-spinal Lesions and What To Do with Them

J Angel¹, M Whitehead²
Purpose
Extra-spinal findings commonly are encountered in patients who undergo spinal MR. Both benign and pathologic lesions that require follow-up studies may be found. It is imperative for neuroradiologists to be familiar with current practice standards and recommendations for extra-spinal pathology. The purpose of this educational exhibit is to review the most common extra-spinal lesions and to discuss follow-up recommendations from current literature.

Materials and Methods
Various examples of extra-spinal lesions in the neck, chest, abdomen, and pelvis discovered on spine MRI are shown. A literature review was conducted specific to each lesion for current follow-up guidelines.

Results

Conclusions
Extra-spinal findings are common in patients who undergo spinal MR imaging. It is important for neuroradiologists to be familiar with the current follow-up guidelines pertaining to these lesions.
appropriate work up and treatment of CSF leaks and fistulae facilitating diagnosis and management.

**EdE-85**

**Lumbar Disc Nomenclature 2.0 - Not Such a Pain After All**

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¹Montefiore Medical Center, Bronx, NY, ²Albert Einstein College of Medicine, Bronx, NY

**Purpose**

The purpose of this abstract is to review the recently updated, consensus-based recommendations for lumbar disc nomenclature endorsed by the ASNR, ASSR and NASS.

**Materials and Methods**

Using a case-based approach, we will review categories of degeneration of the lumbar spine. Illustrations and complementary clinical cases will highlight terminology that has been approved by a multisociety taskforce to describe spinal pathology. Individual subcategories of degenerative changes will be highlighted with focus on updated nomenclature and confusing terminology.

**Results**

The terms "annular fissure," "tear," herniation," and "bulge" carry specific pathological implication. Other confusing terms describing spinal disc pathology include: "protrusion," "extrusion," and "migration." Updated definitions of "acute" and "chronic" disc herniation will be presented. Additionally, we will highlight the proper usage of the term "asymmetrical disc bulge." By reviewing the proper application of these terms, as updated in a recent consensus document, standard usage will be emphasized.

**Conclusions**

Lumbar disc nomenclature can be confusing; however radiologists must be consistent in their terminology. Adherence to updated guidelines will enhance communication between radiologists and referring clinicians and promote standardization in the research setting.

**EdE-87**

**Post Operative Lumbar Spine: Imaging Review of Expected Appearance and Complications**

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**Purpose**

The number of spine surgeries performed annually in the United States has increased rapidly over the last several decades with a subsequent increase in postoperative complications and imaging. Postoperative imaging, therefore, accounts for a large volume of spinal radiographs, CT examinations, and MRI studies. Some of the most commonly encountered procedures are lumbar
fusion, stabilization, disk replacement, inter-spinous distraction, and disk arthroplasty. There are some unique causes of low back pain in the postoperative setting, not encountered prior to surgery. There are both immediate postoperative complications, such as infection, and remote complications including hardware displacement, loosening, and failure. The purposes of this educational exhibit are as follows: 1. Demonstrate the normal postoperative anatomy following spinal surgery. 2. Illustrate expected appearances of certain hardware after lumbar spine surgery. 3. Discuss the complications associated with commonly performed lumbar spinal procedures and review the imaging findings associated with these complications. 4. Outline the appropriate studies for different suspected complications.

**Materials and Methods**

Multiple examples of postoperative lumbar spine imaging with associated complications are shown. Additionally, a review of the current literature will be conducted focusing on the types of procedures performed, associated complications, and imaging characteristics.

**Results**

- We will review normal postoperative anatomy following the more common spine surgeries.
- We will discuss the preferred imaging techniques and common findings of immediate and remote postoperative complications.
- Immediate postoperative complications include infection and postoperative fluid collection.
- Remote postoperative complications include hardware failure, bone graft migration, fractures, accelerated degeneration of the spine adjacent to the fused segment, scarring, spinal leaks and particle disease associated with bone grafts and other synthetic material.

**Conclusions**

Imaging of postoperative lumbar spine is increasingly common in the U.S. and worldwide. Therefore, recognition of the various procedures and likely associated complications is vital for neuroradiologists for appropriate patient management.

**EdE-93**

**Review of MRI Imaging of Retained Intraspinal Bullet Fragments**

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¹Mt Sinai St Luke's Roosevelt, New York, NY, ²St. Luke's Roosevelt Hospital Center, New York, NY

**Purpose**

Gunshot wounds are the second most common method of spinal injury in the United States. Imaging in these injuries is complicated by the presence of retained bullet fragments, and the widely accepted practice is to avoid utilizing MRI due to the fear of possible fragment movement and inducing local heat injury. However, not all gunshots are created equally, and certain types of gunshot injuries may in fact be amenable to MR imaging. The purpose of this presentation is to provide a review of which types of bullets are considered safe to be imaged with MRI, which factors may result in increased risk of projectile displacement, and then to specifically review any studies dealing with MR imaging of retained intraspinal bullet fragments.

**Materials and Methods**

1. Literature Review.
Results
1. Most retained bullet fragments are considered safe to image in magnets up to 7T. Notable exceptions include armor-piercing bullets with steel cores (mostly used in military situations) and stainless steel shotgun pellets (birdshot), which may demonstrate fragment movement. Significant heating did not occur with steel containing bullet fragments in magnets up to 3T. 2. In phantom studies, there was no significant movement from the most commonly used civilian bullets (predominantly composed of lead and copper, which are nonferromagnetic). Military/armor-piercing bullets or shotgun pellets (steel core or jacketed) are ferromagnetic and therefore demonstrated significant heating and motion during MR imaging. 3. One notable patient trial showed no movement of intraspinal nonferromagnetic bullet fragments and no change in neurologic status. However, this study was somewhat limited as most of the patients already were paralyzed prior to the MRI examinations.

Conclusions
Gunshot wounds and resulting retained bullet fragments unfortunately are not as rare as one might hope. As multiple studies have demonstrated the relative safety despite the presence of retained bullets, MR imaging need not be studiously avoided in these situations. The clinician should of course use his or her clinical judgment and available imaging prior to ordering any MR examinations. Plain films or CT scout images are useful to evaluate the bullet for deformity of shape, density and presence of fragmentation. The situation in which the patient sustained the gunshot wound is also invaluable in formulating an educated guess as to the MR safety of the retained bullet.
Monday
6:30AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exp Hall A (Level 1)-1

Electronic Educational Exhibit (eEdE) - Adult Brain
eEdE-77

6:30AM - 3:00PM
Purpose
Foramen magnum (FM) tumors are challenging for neurosurgical resection due to their proximity to the brainstem, vertebral arteries, and lower cranial nerves. Due to the complexity of surgery, there is a need for improved presurgical planning techniques for resection of FM tumors. Our purpose is to improve pre-operative reports by utilizing a novel software program (Anatom-e Information Systems), which generates anatomically labeled 3D volume-rendered MR images. Simulations of differential surgical approaches (i.e., lateral extension of the posterior midline; lateral; and far lateral approaches) to the FM tumors can be provided. The program provides check lists of important anatomical landmarks and vascular structures.

Materials and Methods
Eleven patients (6 meningioma; 2 chordoma; 1 hemangiopericytoma; 1 vestibular schwannoma related to neurofibromatosis, 1 clival sarcoma) with tumors involving the anterior FM were selected for illustrative purposes. Displaying the tumor and surrounding anatomy from the surgical perspective using 3D confocal MR reconstructions of the patient's own thin section MR images was performed. The location, and extent of neural and/or vascular encasement by tumor were described. For example, this evaluation included the extent of vertebral artery (VA) involvement or displacement, VA dominance, and any collateral blood supply in the region. The presence or absence of tumor above and/or below the foramen magnum and hypoglossal canal were factors in selecting the simulated surgical approach. In addition, the positions of the condylar veins and lower cranial nerves are provided in the report.

Results
The presence or absence of tumor above and/or below the foramen magnum and hypoglossal canal were appropriate landmarks in selecting the simulated surgical approach. In addition, the positions of the condylar veins and lower cranial nerves are provided in the report.

Conclusions
3D MR imaging-based simulations of surgical approaches to anterior foramen magnum tumors using a novel software program were performed. In all cases, the 3D confocal reconstructions improved understanding of the anatomy and surgical approach beyond conventional 2D skull base imaging.
Acquired Focal and Diffuse White Matter Pathologies - A Practical approach to Radiologist's Dilemma. Role of Multimodality Imaging, Histopathology and Laboratory correlation.

P Hanagandi¹, L Amaral², A Bag³, R Glikstein¹, T Nguyen¹, S Chakraborty¹, J Woulfe¹, G Jansen¹
Purpose
We intend to show an image-based practical approach to acquired white matter abnormalities in adults. We will describe characteristic features of a wide spectrum of focal and diffuse white matter diseases comprised of infectious, inflammatory diseases, vasculitic processes and neoplasms and will include a clinico-radiological algorithm demonstrating how to approach different white matter lesions in a day-to-day clinical practice.

Materials and Methods
Diffuse or focal white matter abnormalities on T2-weighted sequences are common abnormalities in routine clinical practice that can be challenging at times because normal aging and many different diseases can manifest as white matter T2 imaging abnormality. The initial imaging assessment often can be intriguing due to considerable overlapping of imaging features. However, a close introspection and use of multimodality imaging yields certain pertinent clues that can help in narrowing down the probable list of differential diagnoses. A combination of relevant clinical input and laboratory work up with follow-up imaging can further aid in the diagnosis. Very often a biopsy is mandatory to distinguish inflammatory and vasculitic pathologies from neoplastic etiology. PML, tumefactive demyelination, vasculopathies like amyloid angiopathy associated inflammation, central nervous system (CNS) angitis, angiocentric/angioinvasive lymphoma and gliomatosis cerebri will be the highlights of this educational exhibit. We want to highlight these specific abnormalities in this electronic exhibit with a simplified practical approach using clinico-radiological algorithm to evaluate white matter disease.

Results
Diffuse infiltrative pattern of white matter pathologies are every neuroradiologists dilemma. This "non-specific" imaging entity encompasses a wide spectrum of diseases like infectious, granulomatous, inflammatory, vascular and tumoral pathologies. The initial imaging assessment often can be intriguing due to considerable overlapping of imaging features. However, a close introspection and use of multimodality imaging yields certain pertinent clues that can help in narrowing down the probable list of differential diagnoses. A combination of relevant clinical input and laboratory work up with follow-up imaging can further aid in the diagnosis. Very often a biopsy is mandatory to distinguish inflammatory and vasculitic pathologies from neoplastic etiology. PML, tumefactive demyelination, vasculopathies like amyloid angiopathy associated inflammation and CNS angitis, angiocentric/angioinvasive lymphoma, gliomatosis cerebri will be the highlights of this educational exhibit.

Conclusions
Upon completion of viewing this exhibit, one will be able to identify the characteristic imaging abnormalities of many of the entities that manifest as white matter lesions and their specific clinical and/or laboratory abnormalities. The viewer will be able to integrate all these findings to sail through many dilemmas to reach the right diagnosis.
50 year old immunocompromised male with altered level of consciousness. CSF evaluation positive for JC Virus
Atypical and infrequent sellar and suprasellar lesions: what the neuroradiologist needs to know!

R Glikstein¹, C Torres¹, B Moosavi¹, J Davila², M Castillo³
Purpose
To review imaging characteristics of atypical and infrequent pathologies in the sellar/suprasellar region.

Materials and Methods
This pictorial essay of atypical and infrequent diseases affecting the sellar/suprasellar region will describe the underlying pathophysiologic processes and relevant MR imaging findings. In order to narrow the differential diagnosis, the neuroradiologist must be familiar with the intricate details of the anatomy and pathologic processes that can occur in this region.

Results
While pituitary adenomas account for the majority of sellar/suprasellar lesions, other tumors and tumor-like conditions as well as inflammatory/infectious diseases and developmental anomalies also can occur in this region. These pathologic processes can present with field of view disturbance and pituitary dysfunction similar to that of adenomas; however, the absence of typical findings of pituitary adenoma at neuroimaging should alert the neuroradiologist to consider alternate diagnoses. A diverse group of pathologic processes that can affect the sellar/suprasellar region will be described including: craniopharyngioma, chordoid glioma, mobile intracystic nodule of Rathke's cleft cyst, cyst of Lilliequist membrane, pituitary gangliocytoma, pituitary involvement of CNS lymphoma, post-traumatic bleed within the pituitary gland, lymphocytic hypophysitis, sarcoidosis, Ipilimumab-induced hypophysitis, hypothalamic cavernoma, hamartoma of the tuber cinereum and hypermanganesemia. MR imaging is the imaging modality of choice to evaluate the complex anatomy of the sellar/suprasellar region. Dynamic contrast-enhanced (DCE) and DWI provide valuable information that help differentiate various lesions that can occur in this location. The combination of key imaging findings and clinical information can narrow the differential diagnosis and guide patient management.

Conclusions
Diverse pathologic processes that infrequently affect the sellar/suprasellar structures have characteristic features on MR, which help in narrowing the differential diagnosis.

Brain Trauma: Advantages of High Resolution Susceptibility Weighted Imaging

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Purpose
MR imaging (MRI) usually is employed in traumatic head injury after the acute event to assess diffuse axonal injury and other forms of intracranial injury to guide the management of unexplained neurological deficits. T2*-weighted gradient echo (GRE) sequence is replaced increasingly by high-resolution 3D susceptibility-weighted imaging (SWI) and its allied sequences to assess various forms of intracranial hemorrhage in trauma. The goal of this exhibit
is to detail the clinical applications of SWI in both primary and secondary traumatic head injuries.

Materials and Methods
This pictorial review will demonstrate the relative strengths of SWI in evaluating various types of traumatic head injury compared to T2* GRE. It also will review briefly the physics behind SWI. Case examples from teaching files will be used with de-identification of all records. Additional MRI sequences and modalities will be provided for illustration where pertinent.

Results
Traumatic head injury can be classified as primary and secondary injuries. High sensitivity of SWI technique to paramagnetic substances as well as its high spatial resolution permits accurate identification and characterization of hemorrhagic axonal injuries with prognostic implications. Further, it is helpful to identify various forms of extra-axial hemorrhages, hemorrhagic brain contusions and intracerebral hemorrhage. Traumatic sinus thrombosis and arterial clots can be recognized on SWI. This sequence is highly sensitive to detect chronic forms of traumatic injury to the brain associated with hemorrhage. With the use of magnitude and phase images, a differentiation, to some extent, can be made between blood products and calcium.

Conclusions
This exhibit provides an overview of SWI as a powerful emerging tool in the evaluation of patients with various forms of intracranial hemorrhage in head injuries. Knowledge of the sequence can contribute significantly to the correct diagnosis and management of traumatic head injuries.

eEdE-34
6:30AM - 3:00PM

Cavernous Sinus Syndrome Imaging: A Myriad of Etiologies

A Patel¹, A Singh¹, C Pluguez-Turull¹, W Altmeyer¹
¹University of Texas Health Science Center at San Antonio, San Antonio, Texas

Purpose
1. Review cavernous sinus syndrome. 2. Review cavernous sinus anatomy. 3. Familiarize with the common causes of cavernous sinus syndrome. 4. Describe the imaging findings of cavernous sinus lesions and their etiologies.

Materials and Methods
CT and MRI brain images were retrieved from University Hospital and The Audie L. Murphy Veterans Association Hospital in San Antonio, Texas for review of cavernous sinus lesions and their etiologies.

Results
Cavernous sinus syndrome is a devastating constellation of neurologic symptoms manifested by ophthalmoplegia, proptosis, chemosis, Horner's syndrome, or trigeminal sensory loss. The etiologies of cavernous sinus lesions are broad including meningioma, nerve sheath tumors, metastasis, Tolosa-Hunt syndrome, carotid-cavernous sinus fistulas, and macroadenomas. The radiologist plays a critical role in not only identifying the presence of cavernous sinus lesions but also pinpointing the exact etiology of the lesions. Accurate, timely identification of the cause of the lesion is imperative in guiding the course of treatment and establishing prognosis. Any delay in appropriate management may prove to be fatal.
Conclusions
Cavernous sinus syndrome is a medical emergency that requires prompt, accurate diagnosis of cavernous sinus lesions and their etiologies by radiologists. Familiarity of imaging findings and pathologies associated with cavernous sinus lesions consequently is imperative.

eEdE-40  
6:30AM - 3:00PM

Cerebral Venous Thrombosis and Infarct: Review of Imaging Manifestations

A Lu\textsuperscript{1}, P Lee\textsuperscript{2}, P Shen\textsuperscript{3}
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Purpose
Cerebral venous thrombosis and infarct are rare but serious conditions with devastating consequences without prompt diagnosis and treatment. There is a wide variability in its clinical presentation as well as the imaging manifestations. We review the variable imaging presentations of venous infarcts, pitfalls and review current treatment recommendations.

Materials and Methods
We utilize a case-based approach to illustrate the radiologic signs of dural sinus thrombosis and venous infarct, as well as potential imaging pitfalls.

Results
We present cases of hyperdense sinus sign, a case of subtle cortical edema as initial presentation of venous infarct, and cases of intraparenchymal hemorrhage in different venous infarct distributions. We also present cases of venous infarct mimics including infiltrating gliomas, encephalitis, and traumatic hemorrhage.

Conclusions
Imaging findings of venous infarct can vary from the most subtle findings of sulcal effacement to the extremely complex, with concomitant infarct, vasogenic edema often complicated by hemorrhage, thus making it a challenging diagnosis to both radiologists and our clinical colleagues. Proper history, high index of suspicion and proper interpretation of images are necessary for prompt diagnosis, treatment and favorable patient outcome.
Cerebral Venous Thrombosis: An Imaging Review

R Seltman

6:30AM - 3:00PM
Purpose
Although cerebral venous thrombosis (CVT) accounts for only a small percentage of all strokes, prompt recognition of CVT is critical due to its potential for significant morbidity and mortality if untreated. The challenge in early diagnosis lies in its wide range of predisposing factors, variable clinical presentations, and heterogeneous neuroimaging findings. The purpose of this educational exhibit is to provide a comprehensive review of the anatomy, pathophysiology, etiologies, complications, and imaging findings of CVT.

Materials and Methods
We conducted review of our institution's imaging database for illustrative cases of cerebral venous thrombosis. The multiple imaging modalities used to quickly and accurately diagnose CVT (CT, MRI, and angiographic) are included in the selected cases. A review of the current medical literature also was performed.

Results
Cerebral venous thrombosis (CVT) is a relatively uncommon type of stroke. When present, rapid identification of CVT is imperative due its potential for significant morbidity and mortality if untreated. Delay in diagnosis often results from a wide range of etiologies, clinical presentations, and imaging findings. Multimodality neuroimaging, including CT, MRI, and angiography, facilitates the emergent and accurate diagnosis of CVT. The pathophysiology of CVT is similar to most other vascular thrombosis and follows the Virchow triad of blood flow stasis, endothelial injury, and hypercoagulability. A myriad of conditions (trauma, infection, hormones, malignancy, chemotherapeutics, etc.) may disrupt one or more of these variables, thus increasing the risk of developing a thrombus. A thrombus within the dural venous sinus may propagate into the deep cortical veins and obstruct venous outflow. Elevation in venous pressure compromises the blood-brain barrier with subsequent venous infarct and cytotoxic edema. An understanding of the predisposing conditions, pathophysiology, cerebral venous anatomy, and neuroimaging findings will be discussed in detail in this educational exhibit.

Conclusions
Cerebral venous thrombosis is an uncommon yet important neuroimaging diagnosis due to its potential for significant morbidity and mortality without treatment. Delay in diagnosis often can be minimized when the radiologist references the electronic medical record with an understanding of the myriad clinical presentation and predisposing factors. Likewise, knowledge of cerebral venous anatomy and the heterogeneous neuroimaging findings of CVT and its complications facilitates accurate and timely diagnosis.

cEdE-86a

Clinical and Surgical Pearls in Imaging Epilepsy

N Lall\textsuperscript{1}, J Honce\textsuperscript{2}, H Dahmoush\textsuperscript{3}, E Nyberg\textsuperscript{4}, D Mirsky\textsuperscript{5}, L Nagae\textsuperscript{4}

\textsuperscript{1}University of Colorado, Denver, CO, \textsuperscript{2}University of Colorado, Aurora, CO, \textsuperscript{3}The Children's Hospital of Philadelphia, Philadelphia, PA, \textsuperscript{4}University of Colorado Hospital, Aurora, CO, \textsuperscript{5}Children's Hospital Colorado, Aurora, CO
Dedicated epilepsy centers are growing in prevalence throughout the USA and abroad. The critical role of imaging in guiding clinical decision-making for both lesional and nonlesional epilepsy requires radiologists to actively participate in multidisciplinary meetings where patient treatment strategies are discussed. It is crucial that radiologists be up to date on technical developments in epilepsy imaging and be familiar with imaging findings of temporal and extratemporal epilepsy. For radiologists to provide added value, they additionally must be familiar with new terminology and classification systems introduced by the International League Against Epilepsy (ILAE) and also understand the advancements of treatment procedures. Implantable devices such as vagal nerve and deep brain stimulators for seizure control introduce additional difficulties in imaging with MRI, and it is critical that radiologists understand the associated MRI safety issues.

Materials and Methods
After outlining changes in epilepsy classification and reviewing advanced imaging techniques for evaluation of nonlesional epilepsy, an interactive case-based review will highlight important imaging features of major pathologies in both temporal and extratemporal epilepsy. Clinical/surgical pearls are discussed as relevant to each case. Finally, MRI safety issues regarding implantable anti-epileptic devices are reviewed.

Results
This exhibit summarizes ILAE 2010 Revised Terminology and Concepts for Organization of Seizures and Epilepsies and provides an overview of epilepsy diagnosis and management. Imaging findings of a wide variety of causes of lesional epilepsy are reviewed on a case-by-case basis, including mesial temporal sclerosis, neoplasias, cavernous malformations, channelopathies, neurocutaneous syndromes, and malformations of cortical development. PET, SPECT, and MEG of nonlesional epilepsy are reviewed, and post-treatment changes also are overviewed. Finally recommendations of safe MRI techniques for patients with vagal nerve stimulators and deep brain stimulators are detailed.

Conclusions
In conclusion, the radiologist's participation in the clinical and surgical management of patients with epilepsy is key, and familiarity with concepts and approaches to the work up, diagnosis, and management of patients is mandatory. This exhibit will educate the radiologist in these regards.

Clinical usefulness of 3 dimensional basiparallel anatomic scanning (3D BPAS) for evaluating vertebrobasilar vascular disorders

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Purpose
Basiparallel anatomic scanning (BPAS) was designed to visualize the surface appearance of the vertebrobasilar artery within the cistern. The purpose of this exhibit is to: 1) Review the imaging findings of vertebrobasilar vascular disorders with emphasis on 3-dimensional BPAS (3D BPAS) technique for clarifying the surface contour of these disorders; 2) Correlate the findings of 3D...
BPAS with those seen on 3D time-of-flight MRA (3D TOF MRA) or on digital subtraction angiography (DSA); 3) Discuss the potential role of the outer contour measurement in following these disorders.

Materials and Methods
We will discuss briefly the basics of 3D BPAS. Then we will provide examples of the normal vertebrobasilar vascular anatomy, and clinically relevant variants. We also will review the cases of aneurysm/dissection/steno-occlusive disease of vertebral and basilar artery, dissecting aneurysm of posterior inferior cerebellar artery (PICA), dural arteriovenous fistula draining into pontomesencephalic veins, and these mimics. The cases will be illustrated with 3D BPAS, 3D TOF MRA, CTA, and DSA, highlighting the imaging features and the time course after intervention.

Results
3D BPAS easily discloses the outer contour of the aneurysm clearly. Mismatched 3D TOF MRA or DSA findings occur in a condition of dissection or thrombosed aneurysms. Multiple projection images of 3D BPAS is sufficient for precise evaluation of PICA dissecting aneurysm, and is useful for recognition of the PICA orifice in large vertebral artery aneurysm. Hypoplasia or aplasia of the unilateral distal VA can be confirmed on 3D BPAS. After endovascular procedure of vertebral artery aneurysms, 3D BPAS provides exact vessel outer diameter measurement, and easy recognition of its shrinkage.

Conclusions
3D BPAS is a simple MR imaging technique for visualization of the surface appearance of the vertebrobasilar vascular abnormalities. Achieving the correct diagnosis is critical for therapeutic decision-making, prognostication, and improved patient outcomes.

Clinical Utility of PET-MRI in Neuro-Oncology

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Purpose
The aim of this exhibit will be to provide a comprehensive overview of the clinical utility of the emerging hybrid modality: PET-MRI (positron emission tomography magnetic resonance imaging) in neuro-oncology.

Materials and Methods
1. Review physical principles and techniques of PET-MRI. 2. Clinical applications of PET-MRI including neuro-oncology. 3. Discuss key imaging findings that help exclude mimics resulting from neurodegenerative disorders and inflammatory conditions. 3. Review common pearls and Pitfalls of PET-MRI. 4. Future role of PET-MRI in neuroradiology.

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.
GBM s/p Resection Now With Multifocal Recurrence

Common Neuroimaging Findings in Systemic Autoimmune Disorders

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Purpose
The purpose of this exhibit is to review neuroimaging findings in systemic autoimmune disorders (SAD).

Materials and Methods
Patients with established diagnosis of systemic autoimmune disorders (SAD) presenting for neuroimaging in the past 10 years were reviewed. Subsequently the role of various imaging technique and neuroimaging findings in SAD were reviewed. Case examples of key anatomical imaging findings were catalogued.

Results
Systemic autoimmune disorders can affect central nervous system. These conditions including SLE (systemic lupus erythematosus), RA (rheumatoid arthritis), SSC (systemic sclerosis/scleroderma), SS (Sjögren syndrome), PAN (polyarteritis nodosa), GCA (giant cell arteritis), Takayasu's Arteritis, Bahcet's Syndrome may have their initial presentation as central nervous system (CNS) diseases. Assessment and recognition of these findings may be helpful in averting the development of serious complications.

Conclusions
The major points of this exhibit are to review neuroimaging findings in systemic autoimmune disorders.
Current status of hybrid MR-PET in neuro-oncologic imaging

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\textsuperscript{1}Sapienza, University of Rome, Policlinico Umberto I, Rome, Italy, \textsuperscript{2}NYU School of Medicine, New York, NY, \textsuperscript{3}NYU Langone Medical Center, New York, NY

T2 Flair image (A) demonstrates abnormal increased signal in the anterior cerebral lobes and post contrast T1 image (B) demonstrates abnormal parafalcine and leptomeningeal enhancement. These findings are consistent with vasculitis secondary to rheumatoid arthritis.
Purpose
To provide a brief summary of hybrid MR PET scanner characteristics and its clinical application in patients with brain tumors. We would particularly discuss the advantage of obtaining concurrent functional (perfusion) assessment of the tumor with metabolic (PET) assessment, an adjunct to the superior anatomical detail provided by MR PET.

Materials and Methods
We will illustrate hybrid MR PET scanner, technique, imaging protocols and also work flow issues. We will describe its clinical utility in brain tumor patients, with special focus on functional information derived from perfusion-weighted imaging (PWI) and its correlation with metabolic/PET information. We will illustrate clinical cases to demonstrate the added use of MR PET in diagnosing high and low grade tumors as well as its role in surgical/biopsy guidance. We also will demonstrate its role as a surveillance tool in differentiating tumor recurrence from treatment-induced effects/radiation necrosis.

Results
We will discuss the diagnostic value of regional cerebral blood volume (rCBV) and SUV analysis and how the two information datasets could be used as complementary tools. We are going to briefly discuss previous scientific reports about using hybrid MR PET in patients with brain tumors and describe our experience with hybrid MR PET in our neuro-oncologic practice.

Conclusions
PET/MRI is used increasingly in the clinical management of patients with brain tumors, due to the possibility to simultaneously provide anatomical, perfusion and metabolic information. According to our experience, combining the superior anatomical detail provided by MR with functional and metabolic data can be extremely advantageous in different clinical scenarios, such as suggesting the tumor's grading or differentiating recurrent tumor from radiation necrosis in treated patients. However, the advantage of interpreting the results in conjunction often can be observed in the everyday radiological practice, the effective usefulness of PET/MRI in brain tumors and the real correlation between PWI and PET parameters have to be validated fully in large patient series.
Diffusion Tensor Imaging: Is it ready for the Clinic?

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Purpose
Diffusion tensor imaging (DTI) is a novel neuroimaging technique with various clinical and research applications. It is a powerful tool for the qualitative and quantitative assessment of tissue microstructure. The purpose of this exhibit is to provide a succinct review of the principle, techniques and applications of various DTI metrics, fiber tractography (FT) and diffusion kurtosis imaging (DKI).

Materials and Methods
1. Fundamental principles and techniques of DTI, FT and DKI. 2. Simplified interpretation of DTI metrics such as fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (Da) and radial diffusivity (Dr). 3. Application of these metrics in neuropathology such as ischemia, demyelination, axonal loss and neoplastic processes. 4. Technical limitations and pitfalls.

Results
Diffusion of water is very sensitive to microstructural alterations in brain, as reflected by various DTI metrics; FA, MD, Da and Dr. Fractional anisotropy is highly sensitive to microstructural change, but is nonspecific. Mean diffusivity is an inverse measure of membrane density and is sensitive to edema, cellularity and necrosis. Axial diffusivity is a measure of diffusion tensor parallel to white matter pathways whereas Dr is a measure of diffusion tensor perpendicular to white matter tracts. Fiber tractography aids in presurgical mapping and has been shown to decrease neurological deficits after surgery. Diffusion kurtosis imaging is a closely related, recent technique which has many applications and can better characterize gray matter microstructural change.

Conclusions
Diffusion tensor imaging is a powerful tool to investigate tissue microstructure and brain connectivity. These DTI metrics are insufficient to make specific diagnosis in isolation, but used in conjunction with other MRI techniques can improve the diagnostic as well as prognostic accuracy. It is critical for the radiologist to be aware of the fundamental principles, applications and pitfalls of this technique to guide effective treatment.

Dynamic Contrast Perfusion and Permeability MRI of High Grade Gliomas

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Purpose
The characterization of high grade glial tumors based on tumor perfusion and permeability has a number of implications for diagnosis and assessment of treatment effects. This exhibit will discuss the background tumor pathophysiology, relevant physics and basic mathematical principles of MR perfusion, and clinical use of MRI perfusion including dynamic susceptibility contrast (DSC) and dynamic contrast enhancement (DCE) in assessment of high grade glial tumors at diagnosis and post-treatment. The goal of this exhibit is to provide an introduction of these factors to the resident or fellow and a refresher module to the practicing neuroradiologist on current MR perfusion techniques.

Materials and Methods
Referencing the current literature and our institutional experience in MR perfusion, the viewer will review: (1) tumor biology of high grade glial tumors including anaplastic astrocytoma, oligodendroglioma, ependymoma, and glioblastoma multiforme (GBM), (2) differentiation of primary GBM, secondary GBM, and glioblastoma with oligodendroglial components including important genetic mutations associated with each conferring chemoradiation sensitivity and prognosis/outcome, (3) basic mathematical and MR physics principles important for understanding DSC versus DCE MR perfusion parameters including TR, TE, flip angle effects, and components of T2* and T1 effect, (4) determinants of tissue perfusion, relative blood volume without and with leakage correction, relative blood flow, tissue permeability, the influx rate constant (Ktrans), as well as the fitting constant (K2), and lastly, (5) clinical significance of each parameter during interpretation using demonstrative cases including radiology-pathology correlation.

Results
MR perfusion is an important and evolving tool in the evaluation of high grade glial tumors. Given the relative newness to the neuroradiologist's arsenal, a review of this technique drawing from the biology of the tumors to the clinical significance of post-treatment imaging findings may be beneficial. Relevant imaging exercises such as assessing tumor grade, primary versus secondary GBM, true progression versus pseudoprogression, and true response versus pseudoresponse in the setting of anti-tumor therapies including radiation, temozolomide, and bevacizumab are important for the interpreting radiologist to be aware of.

Conclusions
The authors will present an educational exhibit on the basic methods of MR perfusion acquisition, processing, and interpretation that can be utilized by practicing radiologist to characterize high grade gliial tumor biology, diagnosis, and treatment response. The exhibit will introduce the resident or fellow in the basics of MR perfusion techniques and value and also reinforce the practicing neuroradiologist with a relevant refresher module on MR perfusion techniques.

**eEdE-08**

6:30AM - 3:00PM

**Electrical Stimulation and Monitoring Devices of the CNS: An Imaging Review**
Purpose
The purpose is to describe and display various neurological electrical monitoring and stimulation devices, with specific attention to their imaging appearance.

Materials and Methods
The radiology databases at our institutions were searched for cases of electrical stimulation and monitoring devices displayed on neuroradiology studies. The normal components, configuration, positioning, and function of each device are described in detail. Safety precautions for the devices (e.g., MRI compatibility) are described. Representative imaging examples are displayed.

Results
The following monitoring and stimulation devices are discussed, and their normal imaging appearance demonstrated: intracranial subdural and depth electrodes; foramen ovale electrodes; vagal nerve stimulators; deep brain stimulation; responsive neuro-stimulation device; motor cortex pain stimulator; temporal lobe stimulator; cochlear implant; auditory brainstem implant; middle ear ossicular stimulator; spinal cord stimulator (1-5).

Conclusions
It is important for the diagnostic neuroradiologist to be familiar with the normal appearance, function, and positioning of various neurologic electrical monitoring and stimulation devices.

Essential Tenets of Clinical fMRI: A Case-Based Review

6:30AM - 3:00PM

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Purpose
The purpose of this interactive electronic educational exhibit is to review the fundamental principles of fMRI and the role it plays in the pre-operative assessment of potential neurosurgical patients. While the exhibit will include a basic primer on the basis of the BOLD imaging, the focus will be on the application and clinical utility of this technique.

Materials and Methods
Utilizing a step-by-step approach, the exhibit will review all aspects of clinical fMRI from preprocedural patient assessment and protocolling through postprocessing and imaging interpretation. Important concepts such as neurovascular coupling/uncoupling, functional neuroanatomy, language and memory lateralization, somatotopic organization of the primary somatosensory cortex and cortical reorganization will be included. Presentation also will include a discussion on mitigating imaging pitfalls and artifacts. Using over a dozen different cases, a wide variety of clinical scenarios are presented; pathologic entities include intra-axial and extra-axial masses, developmental lesions and vascular malformations.
Results
BOLD fMRI increasingly is employed clinically as part of the pre-operative assessment for patients undergoing neurosurgical intervention. Localizing neural tissue involved in language, motor, visual and auditory function plays a critical role in assessing the risk of developing a postoperative deficit, which can aid in both informed consent as well as procedural planning. Consistently acquiring accurate and beneficial results requires proficiency in both the performance and interpretation of these studies.

Conclusions
Radiologists often play a very active role in the work up and treatment of neurosurgical patients, and this is especially true for fMRI. Understanding the basic tenets for this emerging technique is essential for putting theory into clinical practice.

eEdE-09
6:30AM - 3:00PM
Extra cerebral intracranial cavernous malformations: MRI findings in 27 patients.

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Purpose
To review imaging/clinical findings in patients with extracerebral, intracranial cavernous malformations (CM).

Materials and Methods
From our TF database we extracted 26 patients with extracerebral, intracranial CM. All had MRI with at least precontrast T1 and T2 images and post-Gd T1. Thirteen of 26 patients underwent resection with confirmation of diagnosis.

Results
In our series, CM were type 2 (n=21), type 4 (n=4) and type 5 (n=2). Twenty-five had MRI features that suggested or made the correct diagnosis. All dural-based CM were symptomatic and resected (50% of all CM were symptomatic). Patients age and lesion sizes varied widely; most CM occurred in males. Associated venous anomalies were less common than reported with intracerebral CM (14% versus 20-30%). Exact prevalence of extracerebral, intracranial CM could not be established as this was a retrospective review.

Conclusions
Extracerebral CM are not uncommon and their MRI features allow one to make a definitive diagnosis in most but not all lesions.

eEdE-13
6:30AM - 3:00PM
FMRI in presurgical workout: review of 15 years of experience and new perspectives

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Purpose
BOLD functional magnetic resonance imaging (fMRI) is an important and already standard instrument in the presurgical evaluation of brain surgery. First used mainly for epilepsy, it is used today extensively for localization of eloquent area for brain tumors and other conditions. In the last 15 years we have used fMRI for language lateralization, localization of motor, sensitivity, and visual primary cortex, with cumulative experience with advantages, limitations and pitfalls. In this review we discuss those, as well as additional improvements with diffusion tensor imaging (DTI) and tractography, resting state, and electroencephalography recorded synchronously with the fMRI (EEG-fMRI).

Materials and Methods
From 1998 to 2008 we used one 1.5T Magneton Vision (Siemens, Erlangen, Germany) MRI equipment, and from 2008 until now on 3T Achieva (Philips, Best, The Netherland). Around 100 normal control subjects have been studied for research, besides almost 300 patients, mostly for epilepsy surgery. Wada test was performed for language lateralization comparison. Intra-operative electrical mapping of cortical function besides patient follow up were used as gold standard for eloquent area identification.

Results
The task-related approach is limited by patient mental status and their ability to perform the task. This limitation might be overcome using resting-state fMRI. Diffusion tensor imaging (DTI) is a structural method that allows function inference because of its capacity to delineate functional systems. EEG-fMRI is a complex method due to artifacts, but appears to be a very promising tool in the study of epileptic discharges.

Conclusions
In spite of limitations related to the capacity of patient cooperation, hyper vascular gliomas causing neurovascular uncoupling and reduced fMRI signal with pseudo-lateralization, arterial venous malformations induced hemodynamic effects, hemorrhage and other magnetic field susceptibility artifacts, we found relevant benefits using fMRI in the presurgical workout.
Language lateralization

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eEdE-15

Functional and Dysfunctional Anatomy of Visual Cortex

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Purpose
To demonstrate functional brain anatomy and deficit localization of vision cortex, using an interactive quiz and tutorial format.

Materials and Methods
An interactive quiz and tutorial format is used to teach localization of visual cortical functional anatomy. Cadaver brain images and overlaid illustrations foster a 3-dimensional (3D) understanding of cortical functional anatomy and deficit localization.

Results
Visual field topography is preserved on the retina, through visual pathways, and on the visual cortex. Functional brain mapping reveals the retinotopic organization of the visual cortex and can be used to understand and predict the location of scotoma. Divergent hierarchical and parallel processing of visual stimuli attributes generates the perception of color, form, motion, and position. A dorsal processing stream provides information to the parietal visual area or the "Where Area" for higher visuospatial and attention processing. A ventral processing stream provides information to the ventral temporo-occipital visual area or the "What Area" for visual object and color recognition processing. Each processing stream has multiple functional substreams and numerous interconnections. In addition to obvious visual field deficits, the exhibit provides neuroimagers the ability to predict and localize higher order deficits of the dorsal stream such as hemispatial neglect, ocular motor apraxia, optic ataxia, impaired spatial relations, and akinetopsia, as well as deficits of the ventral stream including visual object agnosia, prosopagnosia (face recognition), pure word alexia, achromatopsia (color recognition), color anomia (naming colors), and visual amnesia.

Conclusions
An understanding of visual system functional cortical anatomy and deficit locations can be predictive at cross-sectional imaging and functional brain mapping. A thorough understanding of visual cortex functional anatomy and dysfunction is a desirable standard for practicing neuroimagers.

eEdE-78
6:30AM - 3:00PM
Gadolinium Contrast Equilibrium: Understanding Interplay Balance of Relaxivity, Concentration, Ionicity and Stability

O b o y k e 1 , V w a l u c h 1 , M S h i r o i s h i 2 , M L a w 3
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Purpose
To review considerations for gadolinium contrast administration of brain and spine as far as the interplay of gadolinium contrast properties Relaxivity, Concentration, Ionicity and Kinetic Stability as it relates to Anatomical Lesion Detection, MR Angiography (MRA), Permeability (Dynamic Contrast Enhancement) Imaging, Susceptibility/Perfusion (Dynamic Susceptibility Contrast) Imaging and Field Strength Dependence as it relates to Signal to Noise (SNR) and Contrast to Noise (CNR) balance.
Materials and Methods
Literature review of cross-over studies of different gadolinium agents for MRI and MRA was performed including review of FDA submissions for gadolinium contrast approval and evidence-based literature and clinical series. Phantom literature also was reviewed.

Results
Evidence-based literature indicates in cross-over studies effects on improved lesion detection/anatomy visualized with MRI and MRA but with a balance on time of bolus and imaging and a more complex interplay at 3.0T of decreasing signal of all gadolinium agents with a balance of differences in background tissue signal at 3.0T versus 1.5T that creates apparent increased awareness of apparent increased signal at 3.0T. Ionicity appears to have some effect on diffusibility in spine imaging and effects on MR spectroscopy peaks. Effects of relaxivity and concentration and ionicity on permeability/perfusion imaging continue to be addressed.

Conclusions
Further studies need to be performed to more fully address the interplay of gadolinium contrast properties of relaxivity, concentration, ionicity and kinetic stability as it relates to Anatomical Lesion Detection, MR Angiography, Permeability (Dynamic Contrast Enhancement) Imaging, Susceptibility/Perfusion (Dynamic Susceptibility Contrast) Imaging and Patient Safety Considerations.

eEdE-51

6:30AM - 3:00PM

Genetic Disorders and Syndromes with Central Nervous System Tumors

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Purpose
Several hereditary tumor syndromes have central nervous system (CNS) manifestations. It is essential to recognize the presentations of these tumors and the specific CT/MRI/PET imaging characteristics. This review will focus on the neuroimaging of an array of CNS neoplasms in hereditary syndromes, characteristic features, epidemiology, genetics, molecular biology, and possible treatment options.

Materials and Methods
Literature review of common and rare genetic conditions associated with nervous system involvement. CT/MRI/PET images of patients with CNS neoplasms seen at University of Iowa Hospitals & Clinics are gathered and discussed.

Results
Multiple hereditary tumor syndromes have CNS manifestations, and those include:
- Neurofibromatosis type 1 and 2
- Tuberous sclerosis complex
- Von Hippel-Lindau Disease
- Cowden syndrome/
- Li-Fraumeni syndrome
- Multiple endocrine neoplasia syndromes
- Turcot syndrome
- Gorlin-Goltz syndrome
- Carney complex
- Familial glioma
- Melanoma-Astrocytoma syndrome

These entities also have varied genetic makeup and pathways that may be associated with similar tumors in exclusive diseases; i.e., astrocytomas seen in both Li-Fraumeni and Turcot syndromes. Unique neoplasms that are specific to a syndrome will be highlighted such as dysplastic cerebellar gangliocytoma in Cowden syndrome.
and subependymal giant cell astrocytoma in tuberous sclerosis complex. Classical and atypical clinical and imaging presentations will be described in these various tumors affecting the brain.

Conclusions
This exhibit will aid the radiologist in recognizing different presentations and CNS findings seen in neuroimaging of genetic tumor syndromes. The genetics and molecular biology of these hereditary tumors are in many cases related to and predispose patients to sporadic nervous system tumors. Understanding of the tumorigenesis and imaging may guide the final therapy in these syndromes and, ultimately, patient outcome.

Geometric Modeling as a Foundation for Head CT Interpretation

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Purpose
To provide the radiologist with a pattern approach to head CT interpretation based on templates of interconnected geometric shapes. The viewer is encouraged to think from general to specific and consider spatial relationships. Cases will demonstrate the utility of this framework to everyday practice.

Materials and Methods
Utilizing graphic software, we construct transparencies of geometric shapes which are superimposed over sequential normal and abnormal axial CT images. Larger shapes are subdivided successively into smaller ones. Selective colorization is based on variable tissue densities and anatomical considerations. The assorted shapes and variations thereof have zero (circular) to six (hexagonal) vertices. Circular constructs include ovals (thalamí), sectors (posterior fossa), lenses and lunes (extra-axial spaces). We present a broad array of challenging cases from our Level I trauma center to demonstrate how a geometric approach can elucidate subtle findings.

Results
Shapes are the foundation of how we perceive the world. Studies have shown that building blocks can help children better absorb math and language concepts; art schools emphasize simplifying the body into component geometric forms. Similarly shapes can serve as a scaffold for interpreting neuro-anatomy. The axial sections of the original CT and our model are homeomorphic to each other, therefore one can be modified readily into the other. Each slice represents a new packing problem, in which we optimize the arrangement of nonoverlapping shapes. Mathematical concepts essential to our model are symmetry and connectivity (the latter concerning the number of neighbors adjacent to a single shape). Distortion of one shape by pathology will predictably affect all surrounding shapes.

Conclusions
While interpreting head CTs, radiologists often overlook the big picture and instead are too quick to focus on minor or insignificant details. This novel geometric framework, based on component inter-related shapes, can assist in lesion detection, increasing the radiologist's accuracy and confidence.
Color Codes and Shapes

Geometrical shapes and colors can help clarify understanding of head CT interpretation. The genu and splenium of the corpus callosum (yellow) are represented by annular sectors. The cortex (red), arachnoid (green), dura (brown) and calvarium (light blue) can be simplified as ovoid simple annuli. The internal, external and extreme capsules, together with the basal ganglia, are sector shapes contained within a single larger sector (pink). The caudate and thalamus (both blue) are ovals and are bounded laterally by the ventricles, represented by crescent (lune) forms (purple).
Purpose
To improve accuracy of MRI interpretation in patients with epilepsy, focusing on subtle epileptogenic lesions and MRI protocol optimization.

Materials and Methods
By focusing on commonly overlooked, subtle anatomical lesions in patients with epilepsy and ensuring that epilepsy protocols are optimized for assessment of these abnormalities, radiologists can generate more accurate and useful imaging reports. Protocol optimizations which we will focus on, include high resolution coronal T2-weighted imaging through the whole brain and not just a limited hippocampal field of view, high resolution 3D T1-weighted imaging, and volumetric sagittal flair T2 sequence. We will present examples based on cases that initially were misinterpreted, including subtle neuronal heterotopias and cortical dysplasias, small middle cranial fossa encephaloceles, sulcation abnormalities, and under-reported findings in temporal lobe epilepsy such as anterior temporal lobe volume loss and gray-white matter blurring, as well as demonstrate improved detection of cortical malformations with 3T versus 1.5T imaging.

Results
The presence of a lesion on MR imaging is a major factor that affects the candidacy of a patient for surgical intervention and the prognosis for seizure freedom after epilepsy surgery. Detection of subtle epileptogenic lesions on MRI requires both optimized imaging sequences that adequately depict the abnormality as well as a meticulous search pattern by the interpreting radiologist that includes evaluation for commonly overlooked lesions. Unless contraindicated for patient safety, epilepsy imaging ideally is performed on a 3T MRI scanner because some malformations of cortical development as well as evaluation of the gray-white matter interface are assessed more adequately at higher magnetic field strengths.

Conclusions
By making radiologists more aware of the spectrum of MRI findings that may be seen in patients with epilepsy, particularly subtle and often overlooked findings, and optimizing epilepsy imaging protocols, radiologists can generate more accurate and useful reports, improving patient care.

eEdE-71

Great Expectations: The Multi-modal Intracranial Imaging Appearances in Post-treatment Gliomas

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Purpose
This educational exhibit will review the post-treatment intracranial imaging appearances in patients with low and high grade gliomas. These tumors represent over 80% of primary intracranial malignancies. Fewer than 5% of patients with the most aggressive form, glioblastoma, survive 5 years after diagnosis. Medical, surgical and oncologic treatments are employed including steroid therapy, surgical debulking or complete resection, radiotherapy, combined chemoradiotherapy and novel treatments such as antiangiogenic drugs. These treatments manifest a wide spectrum of imaging appearances, the interpretation of which, can be
challenging. We aim to showcase the diagnostic pearls and pitfalls of characterizing these complex cases.

Materials and Methods
We reviewed imaging studies of patients with histologically confirmed and treated low and high grade gliomas, chosen from a prospectively collected surgical database over a 7-year period from Bart's Health NHS Trust, a tertiary neurosurgical referral center. The pretreatment and post-treatment follow-up studies that were evaluated from our picture archiving and communication system (PACS) included pre and postcontrast CT, standard pre and postcontrast MRI, diffusion-weighted imaging, MR perfusion, MR spectroscopy and FDG-PET/CT. In addition, we also evaluated intra-operative MR studies performed through our academic health science partner UCL Hospitals NHS Trust. All studies had been reported by a consultant neuroradiologist and reviewed at the neuro-oncology multidisciplinary team meeting with documented clinical decisions.

Results
Patients with WHO Grade I-IV gliomas were identified and the treatment-related appearances were reviewed. We will provide a pictorial review of the imaging correlates of the following therapeutic approaches: a. Medical management with steroid therapy - decreasing edema. b. Surgical intervention including: - post-biopsy imaging characteristics including complications such as hemorrhage, infection and bony changes; - post-debulking findings; - post complete-resection appearances; - intraoperative MRI findings to determine the extent of surgical resection. c. Oncologic treatment-related findings including: - postradiation change (white matter signal abnormality, radiation necrosis, microhemorrhages); - chemo-radiotherapy effect particularly pseudoprogression. We explore the imaging characteristics that may help to differentiate pseudoprogression from true progression using MR spectroscopy, perfusion and PET imaging); - Effects from novel treatments such as antiangiogenic therapeutics, particularly pseudoresponse; - the radiological appearances of chemotherapy wafer implants.

Conclusions
The post-treatment imaging appearances of intracranial gliomas create diagnostic challenges for the multidisciplinary team of radiologists, neurosurgeons and oncologists. Residents also are expected to recognize and interpret these complex cases. An understanding of the variable imaging findings following medical, surgical and oncologic treatment will improve diagnostic confidence and streamline further patient management.
Imaging of radiation necrosis in a patient with a Grade II Astrocytoma treated with high dose radiotherapy contrast B) MR perfusion cerebral blood volume map C) FDG-PET and D) Single voxel MR Spectroscopy
(Filename: TCT_eEdE-71_Multimodalimagingofradiationnecrosis.jpg)

eEdE-43

Idiopathic Intracranial Hypertension - A review of imaging manifestations and interventional treatment
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Purpose
To present protean presenting symptoms and neuroradiological imaging findings of idiopathic intracranial hypertension and to review the current role of venous sinus stenting including the technical challenges and complications of this procedure.

Materials and Methods
The presented material for this review was obtained from a prospectively maintained neuroendovascular database and from the personal teaching files of the senior authors. Images will be imported without patient demographics through an AGFA-based RIS/PACS system.

Results
The exhibit will review the well recognized imaging findings of posterior scleral indentation, empty sella and narrowing the transverse dural venous sinuses. Less well recognized presenting symptoms and imaging findings also will be shown such as pulsatile tinnitus, lateral sphenoid cephaloceles and other sites of CSF leaks. Neurointerventional treatment strategies will be presented with a particular focus on dural venous sinus stenting. Both pre and post procedure imaging will be available for review. Preservation of vision will be emphasized as the main indication for venous sinus stenting and new techniques such as optical coherence tomography will be shown as a reproducible method of assessing treatment response. Technical issues discussed will include the pitfalls of venous sinus manometry under general anesthesia, challenges of stent trackability, secondary collapse of adjacent segments of dural venous sinus or superior sagittal sinus and trigeminal nerve referred pain.

Conclusions
The exhibit aims to improve and refresh knowledge on the classical and less typical findings of idiopathic intracranial hypertension as well as address neurointerventional treatment strategies and their pitfalls.

eEdE-21

Illustrating Neuro-Behcet disease

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Purpose
Review the different MRI findings in patients with Neuro-Behcet disease. Introduce the pathophysiology of neurological manifestations of Behcet disease. Present their follow up with adequate treatment.

Materials and Methods
Selection of MRI images of Neuro-Behcet patients explored in our institution between 2007 and 2014. Cases are presented in order to highlight the useful elements for diagnosis and discuss differential diagnoses.
Results
Neurological manifestations of Behcet disease can be divided into two major forms: parenchymal and vascular. Parenchymal abnormalities are concentrated in the brainstem, basal ganglia and diencephalon with classical involvement of the internal capsule. MR imaging shows extensive FLAIR hyperintensities or pseudo-tumoral lesions. Susceptibility-weighted imaging can be used to assess the venous origin of the lesions. Myelitis is a rare finding. Brainstem atrophy can be observed in the chronic stage. Vascular lesions include cerebral venous thrombosis and arterial aneurysms.

Conclusions
Neuro-Behçet syndrome should be considered in the setting of neurological disorders in patients diagnosed with Behcet disease. However, one third of cases are inaugural forms. In that situation, recognition requires a good knowledge of clinical manifestations and morphological lesions to initiate adequate therapies. We reviewed the different types of MRI findings and present key points for diagnosis and differential diagnosis.
Imaging Characteristics of Reversible and Irreversible Causes of Cranial Neuropathies

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Purpose
Cranial nerve pathology frequently is encountered in clinical neuroradiology. Complex cranial nerve anatomy and numerous adjacent key structures can be affected by various pathology. Due to overlap in imaging findings, a systematic approach is required to formulate a relevant differential diagnosis and aid clinicians in arriving at the correct diagnosis. This educational exhibit presents a case-based review utilizing age, gender, anatomical location, imaging characteristics, etc. to formulate an algorithm that will aid in more precise diagnosis of cranial pathology. In addition, treatment, prognosis and follow-up guidelines will be discussed briefly.

Materials and Methods
● Review cranial nerve anatomy.
● Case-based review of reversible and irreversible causes of cranial neuropathies highlighting key imaging findings that would narrow the differential diagnosis.
● Diagnostic algorithm can assist in navigation and interpretation of cranial neuropathies.

Results
Common and uncommon presentations of reversible cranial neuropathies will include infectious (HSV, Lyme, etc.) and inflammatory (MS, ADEM, NMO, Lupus, etc). This will be compared and contrasted with irreversible causes of cranial neuropathies that may result from neoplasm (lymphoma, leukemia, squamous cell carcinoma, etc.) with an emphasis on key findings (on CT, MRI, PET MRI) differentiating these entities.

Conclusions
A systematic approach is required to narrow the differential diagnosis of cranial lesions. At completion of this educational exhibit, the viewer will be able to provide more accurate assessment of regional pathology, guide clinical management and recommend appropriate imaging follow up.
Young Female s/p left CN 8 Schwannoma
p/w left sided CN 6 Palsy

(Filename: TCT_eEdE-31_CN6infarct.jpg)
NOTE:

- Bilateral **Trigeminal Ganglion** are involved from Meckels cave extending into ovale
- **CN 3** just above meckels are involved bilaterally
- **V1** and **V2** are involves as well

 Imaging findings, pathology and pathophysiology of hepatic encephalopathy with emphasis on diffusion-weighted imaging

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Purpose
Hepatic encephalopathy (HE) is an alteration in brain function in the setting of severe liver disease which ranges from minimal or low grade HE to severe HE with or without hyperammonemia. This exhibit will demonstrate pathology, pathophysiology and multimodal imaging findings of HE with emphasis on diffusion-weighted imaging (DWI).

Materials and Methods
A pictorial essay of various grades and etiologies of HE will be utilized demonstrating multimodal imaging findings (CT, MRI, DWI, MR spectroscopy) correlating with the pathophysiology. Gross pathology and histology slides will illustrate the radiopathologic correlation.

Results
Diffusion-weighted imaging has been shown to demonstrate characteristic findings in acute HE with abnormalities ranging from the frontoparietal white matter, internal capsule, corpus callosum, thalami, basal ganglia, brain stem, cingulate and insula to diffuse cortical involvement. The severity of the findings on DWI has been shown to correlate well with plasma ammonium levels and there is suggestion that it may correlate well with the clinical outcome. Variable ADC values within these regions are related to the amount of cytotoxic effects in early lesions and the amount of interstitial edema or gliosis in chronic lesions.

Conclusions
Hepatic encephalopathy is a clinical diagnosis of which the radiologist can play a very useful role. The various findings of HE should be recognized. Particularly, the findings and severity of findings on DWI correlates well with plasma ammonia levels with potential prognostic implications.
Imaging of bevacizumab treated brain: traditional and emerging concepts

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Purpose
In addition to antiangiogenic effects and possible antitumor effects, recently bevacizumab also
has been linked to "persistent diffusion restriction" (1), the physiologic basis of which is not
clearly understood. On this education exhibit we will review different patterns of imaging
manifestations induced by bevacizumab with emphasis on how to differentiate bevacizumab-
induced changes from tumor growth.

Materials and Methods
We will review traditional treatment-related changes in the brain (based on RANO criteria) in the
setting of bevacizumab treatment: complete response, partial response, stable disease and disease
progression. We also will review "persistent diffusion restriction". We also will demonstrate
dynamic nature of the "persistent diffusion restriction" (stable, improved and progressed) over
more than 1 year while tumors remain stable according to RANO criteria.

Results
Response of tumors to bevacizumab is extremely variable. According to RANO criteria (based
on enhancing lesions, nonenhancing T2/FLAIR, steroid use and clinical conditions) tumor can
demonstrate complete or partial response, tumor progression or stable disease with bevacizumab
mono- or combination therapy. Cases in each category will be included. Persistent diffusion
restriction is a recently described imaging abnormality secondary to bevacizumab use. We will
demonstrate stable, improved and progressed persistent diffusion restriction (Figure: enlargement
of areas of persistent diffusion restriction in a patient with glioblastoma multiforme treated with
bevacizumab) in stable tumors (according to RANO criteria). Patchy areas of T1 hyperintensity
also accompany persistent diffusion restriction on precontrast T1-weighted sequence. Precontrast
T1, gradient recalled echo sequence and perfusion-weighted sequences would be included in all
the cases to further characterize the individual patterns.

Conclusions
Bevacizumab is associated with wide variety of imaging appearances. Some of the imaging
appearances can be explained by the traditional concepts of evaluation of treatment effects while
some of the effects are not. This educational exhibit reviews all these changes induced by
bevacizumab and provides a practical guideline for interpretation.
Imaging of Neuro Oncology Patients in the Emergency Setting

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Purpose
Neuro-oncology patients require special consideration while being evaluated with imaging in the acute setting. This begins with selection of the appropriate imaging study and protocol for these patients, followed by considering pathologic entities that are specific to patients with a history of a central nervous system malignancy.

Materials and Methods
Depending on the tumor pathology, treatment history, and the clinical symptoms, the appropriate study and protocol must be selected to avoid common pitfalls.

Results
A brief summary of the imaging findings and pathophysiology of disease entities specific to neuro-oncology patients will be described. These could be tumor related, treatment related or due to other causes. For example, hemorrhage, hydrocephalus, leukencephalopathy from radiation and chemotherapy, SMART syndrome, cranial nerve palsies due to metastatic spread, pituitary dysfunction, infarcts and venous sinus thrombosis due to hypercoagulability, and diffusion restriction due to Avastin are among other pathologies that will be included. We also will include the imaging findings like peri-ictal pseudoprogression or dural enhancement due to lumbar puncture which could mimic progression. Additionally, there will be a discussion of specific imaging sequences to reach the appropriate diagnoses.

Conclusions
Patients presenting in the acute setting with known history of a primary neurologic malignancy require special consideration when proceeding with diagnostic workup, as it may differ from patients with no history of malignancy. Emphasis will be placed on selecting the correct imaging protocol, as well as including differential considerations that are specific to oncology patients.
18 year-old male with history of a left parieto-occipital multiforme following surgical resection, radiation, and chemotherapy who presents with acute onset of headache and a new neurological deficit.

- T2 FLAIR image demonstrates subtle gyral swelling within the left occipital region. Within the same region, there is leptomeningeal enhancement on the post contrast image.
- These findings in the clinical setting are consistent with stroke attacks after radiation therapy (SMART syndrome).

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**eEdE-05**

**Imaging of Neuromodulation— What Neuroradiologist Should Know.**

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Purpose
1. To discuss with illustrations the indications, techniques, imaging appearance, and complications with commonly used neurostimulators. 2. To discuss the MR safety and guidelines for these devices.

Materials and Methods
Neuromodulation is the electrical or physical modulation of a nerve to influence the physiologic behavior of an organ. We retrospectively studied MRI, CT and plain radiograph of brain, spine, neck and pelvis of 321 patients from PACS system who underwent neuromodulation treatment for various disorders. All the studies were evaluated under following headings: techniques, accuracy of the device placement, imaging appearance, and associated complications.

Results
In this exhibit we present with illustrations the indications, techniques, imaging appearance, and the complications of commonly used stimulators: 1. Deep brain stimulators: for treatment-refractory movement disorders such as Parkinson's disease, essential tremor, and dystonias. Deep brain stimulator (DBS) applications are being explored for depression, Alzheimer disease, and addictions. 2. Spinal cord stimulation: for failed back surgery syndrome, refractory angina, peripheral vascular disease, phantom limb pain, spinal lumbar stenosis, post-thoracotomy pain syndrome, chronic head and neck pain, and chronic visceral abdominal pain. 3. Vagus nerve stimulation: is a well established treatment of medically refractory epilepsy. 4. Sacral neuromodulation: Lower urinary tract dysfunction (overactive bladder and nonobstructive urinary retention). 5. We also discuss the various complications of NM. 6. Finally we discuss the MRI compatibility of these devices.

Conclusions
1. For last decade, application of the various neuromodulation techniques have gained wide acceptance. Most commonly used neuromodulators are deep brain stimulators (DBS), spinal cord stimulators (SCS), vagal nerve and sacral nerve stimulations for various neurological disorders. 2. It is important for radiologist to understand the normal appearance, expected postoperative changes and diagnose the complications as soon as possible. This exhibit is an insight into imaging of neuromodulation.
Sacral nerve stimulation

A significant amount of research has focused on the effect of sacral nerve stimulation on afferent sensory nerve fibers, with the dominant theory being that electrical stimulation of somatic afferent fibers modulates voiding and continence reflex pathways in the central nervous system (CNS). The control of sensory input to the CNS is thought to work through a reflex mechanism. Sacral nerve stimulation long has been a reliable form of treatment for various types of lower urinary tract dysfunction including overactive bladder and urinary retention.
Vagus nerve stimulation (VNS) is a safe and cost-efficient therapy for the treatment of refractory epilepsy. It has few side-effects, guaranteed compliance, no drug interactions, and is effective in all age classes.
Cerebritis and cerebral abscess in the right frontal lobe due to infected DBS

Diffuse meningitis, subdural empyema due to infection of the bilateral DBS

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eEdE-86b

Imaging of Pineal Region Lesions: A Practical Algorithmic Approach

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Purpose
1. Review the anatomy of the pineal gland and surrounding structures. 2. Review the differential diagnosis of pineal region lesions. 3. Approach the lesions with an algorithmic approach to delineate the correct diagnosis. 4. Review the pathologies focusing on characteristic imaging features.

Materials and Methods
Radiological images and relevant clinical information was extracted from our PACS station and electronic medical record system at our hospital network. The representative images were retrieved to review a spectrum of the CNS lesions confined or determined to have originated from the pineal region.

Results
Lesions of the pineal region include a diverse group of entities to include germ cell tumors, pineal parenchymal tumors, neoplasms arising from nearby anatomical structures (lipomas, meningiomas, astrocytomas, etc.), metastases and congenital lesions. With the exclusion of congenital lesions, pineal tumors account for 3% of all pediatric primary brain tumors and less than 1% in adults, and thus are rare occurrences. Few of these tumors have a truly pathognomonic imaging pattern. Thus, histologic verification and laboratory correlation may be necessary in most cases. However, careful evaluation and theoretical familiarity with the morphologic features, attenuation, and signal intensity characteristics may help with establishing an appropriate differential diagnosis. This educational exhibit will review the epidemiology, pathophysiology, basic clinical features and characteristic imaging findings. An algorithmic approach is used to aid in narrowing down the differential diagnosis of pineal lesions.

Conclusions
Lesions of the pineal region include a diverse group of rare entities to include benign and malignant etiologies. Proper differentiation among these pathologies may prove to be difficult. Knowledge of the variety of lesions that occur in the pineal region, their imaging appearances, and their clinical features assists in narrowing the radiologic differential diagnosis and optimizing patient treatment. In this educational exhibit, we present an algorithmic approach based on the imaging features to help differentiate these lesions.

Imaging of Skull Base Tumors - A Systematic Approach to a Complex Problem

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Purpose
Imaging of the skull base is challenging due to its complex anatomy, diverse pathology and numerous vital structures. Skull base tumors are particularly challenging, as imaging often guides appropriate management. The purpose of this educational exhibit is to provide a brief and concise description of common tumors presenting at the skull base, while offering a systematic approach to imaging, focusing on anatomical location, tumor behavior and extension, as well as involvement of eloquent structures.
Materials and Methods
The initial portion of the exhibit will describe the role that imaging (mainly MRI and CT) plays in the evaluation of skull base tumors as well as a general tumor classification based on anatomical location. Advantages of particular imaging protocols also will be discussed. This section will be expanded by offering a systematic approach to evaluating skull base tumors from an imaging perspective, emphasizing the complementary roles played by CT and MRI. Tumor behavior (benign versus aggressive), tumor extension and integrity of eloquent structures will be discussed. Secondly, these points will be enforced by several examples of skull base tumors illustrating the former points.

Results
Throughout this educational exhibit there will be drawings, CT, MRI and PET images to convey the previously mentioned points. Each presented case will have images illustrating the imaging findings on at least two different imaging modalities.

Conclusions
The skull base is a highly complex anatomical region. Understanding this detailed anatomy is essential to identifying and understanding the pathology that may be present at this location. This educational exhibit offers a review of anatomy and several common tumors involving the skull base and provides a straight-forward and concise systematic approach to aid in detection and correct diagnosis.
Imaging Pearls for Differentiating Pineal Lesions

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Purpose
Pineal region pathology is relatively common and has a broad differential diagnosis. The purpose of this educational exhibit is to present an algorithmic approach to pineal region lesions with emphasis on patient clinicopathologic findings and imaging features.

Materials and Methods
Pineal region pathology is relatively common and has a broad differential diagnosis. A systematic approach therefore is required in narrowing the differential for various pineal lesions. It is important to consider not only the pertinent imaging findings, but also the patient's demographics and available history in order to improve diagnosis accuracy. In this case-based exhibit, we will present an algorithmic approach to pineal region lesions with emphasis on patient clinicopathologic findings and imaging features.

Results
Using quiz format key differential diagnostic points will be highlighted in the discussion of each case. Systematic review will include the following categories and cases: • Germ Cell Tumors – germinoma, teratoma, malignant NOS. • Pineal Parenchymal Tumors – pineocytoma, pineoblastoma, pineal parenchymal tumor of intermediate differentiation, trilateral retinoblastoma. • Neoplasms of adjacent tissues – tectal glioma, meningioma, Lymphoma. • Metastasis. • Papillary tumors of the pineal region. • Non-neoplastic – pineal cyst, pineal lipoma, arachnoid cyst, epidermoid cyst, neurocysticercosis, cavum velum interpositum.

Conclusions
Pineal region pathology is relatively common and has a broad differential diagnosis. Correct diagnosis can be obtained with an algorithmic approach to pineal region lesions utilizing characteristic clinicopathologic findings and imaging features.
Case #10: 43 y/o female with visual changes

**Pineal Lipoma**

- Typically **asymptomatic**
- Congenital malformation of meninx primitive
  - Associated anomaly of corpus callosum, cephalocele, or spinal dysraphism in 1/3
- Lobulated **midline** extra-axial mass with fat attenuation/intensity across modalities/sequences
  - No enhancement
  - Variable calcification
  - May encase vessels and cranial nerves → resection difficult
- Histology: Mature non-neoplastic adipose tissue

(Filename: TCT_eEdE-68_pinealcaselipoma.jpg)
40 year old male presents following seizure

**Epidermoid Cyst**

- **Ectodermal inclusions**
- **Intradural (90%), primarily in basal cisterns**
- **Extradural (10%): skull and spine**
- **Lobulated cauliflower-like mass with “fronds”**
  - Insinuates cisterns and encases neurovascular structures
- **Chemical meningitis and CSF seeding with rupture**
- **CT**
  - > 95% hypodense (CSF-like); rare "dense" variant
- **MRI**
  - T1W: typically slightly hypointense
  - T2W: isointense (65%) to c/w CSF
  - FLAIR: usually incomplete rim enhancement
  - T1W+: minimal rim enhancement
  - DWI: markedly reduced
- **DDx:** arachnoid cyst, neuroepithelial cyst, dermoid cyst

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*eEdE-26*

**Imaging Review of Common and Uncommon Brain Stem Lesions: Differential Diagnoses and Imaging Pitfalls**

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Purpose
The diagnosis of brain stem lesions is not straightforward because of the imaging similarities and wide range of etiologies. The purpose of this educational exhibit is to review the imaging appearance of brain stem lesions. We will demonstrate the spectrum of brain stem pathology by presenting anatomy, vascular anatomy, clinical symptomatology and imaging findings of common and uncommon brain stem lesions in an interactive format. We discuss the differential diagnoses and pitfalls.

Materials and Methods
We reviewed the cases of brain stem lesions at our institution and selected representative cases and their images for presentation. The exhibit will consist of a case-based review covering the wide range of pathology such as ischemia, vasculitis, neoplasm, demyelination, degeneration, infection, toxic metabolic, congenital, vascular, and others. Various imaging modalities will be presented, including CT, MRI (DWI, DTI, SWI, perfusion, spectroscopy), and FDG PET.

Results
Usual and unusual cases include 1) ischemia with typical and atypical distribution; 2) vasculitis, primary angitis, SLE and Behcet; 3) neoplasm, glioma, metastasis, lymphomas and other tumors: 4) demyelination, multiple sclerosis, acute demyelinating encephalomyelitis, and neuromyelitis optica; 5) infection, abscess, tuberculosis, progressive multifocal leukoencephalopathy; 6) toxic metabolic, posterior reversible encephalopathy syndrome (PRES), osmotic myelinolysis, radiation-induced changes, leukodystrophies; 7) primary or secondary degeneration; 8) congenital anomalies; 9) vascular malformations; 10) and others, including Bickerstaff encephalitis, sarcoidosis, paraneoplastic brain stem encephalitis, Hashimoto encephalitis, chronic lymphocytic inflammation with pontine perivascular enhancement response to steroids (CLIPPERS), hemophagocytic lymphohistiocytosis, and Erdheim-Chester disease. The clinical presentation and imaging features on various modalities will be described to highlight the approach to reach the correct imaging diagnosis.

Conclusions
Familiarity with the imaging features of brain stem will help the radiologist to formulate an appropriate differential diagnosis. A review of common and uncommon brain stem lesions will help to broaden the differential when these lesions are encountered in clinical practice.
Imaging Spectrum of CNS complications of Hematopoietic Cell and Solid Organ Transplantation.

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Purpose
Neurologic complications are common after solid organ transplantation (SOT) and hematopoietic cell transplantation (HCT), and affect 30-60% of transplant recipients. The aim of this educational exhibit is to: 1. Review the common neuroimaging studies used to image neurologic complications after SOT and HCT with emphasis on new imaging techniques; 2. To emphasize a practical imaging approach based on the timeline and etiology of central nervous system (CNS) abnormalities, and neurologic complications related to transplantation of specific organs.

Materials and Methods
We reviewed MRI findings in patients with neurologic complications of SOT and HCT. These cases include infections, drug therapy-related complications, vascular processes, metabolic abnormalities, post-transplantation lymphoproliferative disorders (PTLD), neoplasm, and complications specific to the type of transplantation. The diagnosis was based on MRI, histopathology (biopsy), clinical records and biochemical laboratory results.

Results
The lesions will be classified based upon the interval from transplantation procedure: early<1 month, 1-6 months and >6 months. Further differentiation will be based on etiology: 1. Infections (viral, bacterial, fungal, parasitic CNS infections); 2. Neurologic complications related to drugs: CNS vasculitis, posterior reversible encephalopathy syndrome, leukoencephalopathy, thrombotic microangiopathy, pseudotumor cerebri; 3. Metabolic derangements: hepatic encephalopathy, acute hyperammonemiac encephalopathy, central pontine myelinolysis; 4. Cerebrovascular complications: ischemic stroke, intraparenchymal brain hemorrhage, subdural hematoma, vasculitis of the CNS; 5. Post-transplant malignancies: PTLD of CNS, solid brain tumors, melanoma brain metastases. In addition, differentiation will be based on complications specific to the type of transplantation: bone marrow/stem cell, lung, heart, liver, and kidney.

Conclusions
It is important to consider various etiologies in the work up of patients with neurologic complications after transplantation. By utilizing a methodical approach we aim to provide the neuroradiologist a framework for the strategic role of neuroradiology in the diagnosis and response to treatment, in concert with clinicians to optimize patient care and treatment outcome.

Imaging Spectrum of IgG4-related Disease Involving the Head and Neck Region

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Purpose
We aim to present a case-based review series of IgG4-related disease involving the head and neck region.

Materials and Methods
Description of content organization: 1) Brief review of CT and MRI temporal bone anatomy. 2) Review clinicopathologic spectrum of IgG4-related disease. 3) Discuss spectrum of imaging and pathologic findings in IgG4-related disease in the head and neck region. 4) Review mimics with
emphasis on key findings differentiating these entities. 5) Treatment, prognosis and follow-up recommendations will be discussed.

Results
IgG4-related disease is a systemic inflammatory process with a spectrum of presentation depending on specific organ involvement. A significant proportion of patients have years of asymptomatic disease involvement until they present with signs of organ injury secondary to compressive mass lesions, frequently termed "pseudotumor." We will present a case-based series of IgG4-related disease involving the head and neck region and highlight key clinical and imaging features.

Conclusions
First, recognized in the early 2000s for its presentation as a form of autoimmune pancreatitis, IgG4-related disease spectrum is now known that the disease can affect nearly every organ system. Involvement of the head and neck is still seldom reported in literature perhaps because affected patients are labeled as having an "inflammatory pseudotumor". Recognizing this presentation of IgG4-related disease is critical as early treatment allows for prompt treatment with B-cell depleting therapy which can cure the patient and prevent complications such as vision loss, hearing loss, vestibular dysfunction, etc.

![Pathology Image]

**Microscopic Description**
- H & E of biopsy specimens indicated a florid inflammatory response composed of mononuclear cells with areas of fibrous reaction.
- Immunohistochemically, 60% of plasma cells stained positive for IgG4 subtype.

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Imaging Spectrum of Paraneoplastic Syndrome and Mimics

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Purpose
1. Pictorial review of central nervous system (CNS) anatomy highlight areas involved in paraneoplastic syndromes. 2. Case-based review highlighting common and uncommon causes of paraneoplastic syndrome. 3. Discuss differential diagnoses (physiologic process, congenital, infection, inflammation, trauma, vascular and/or malignancy) that can mimic imaging findings.

Materials and Methods
Common and uncommon presentations of paraneoplastic syndrome will be reviewed involving the brain and spine. Additionally, we will discuss mimics that may result from neoplasm
(lymphoma, leukemia, etc.), infection (HSV, Lyme, etc.), inflammation (MS, ADEM, Lupus, etc.) with an emphasis on key findings (on CT, MRI, PET MRI) differentiating these entities.

Results
1. Discuss common clinical and laboratory findings seen in the various paraneoplastic syndromes. 2. Review characteristic imaging findings of various paraneoplastic syndromes. 3. Discuss diagnostic limitations of imaging findings and present an algorithmic approach that can assist in arriving at the correct diagnosis.

Conclusions
Paraneoplastic syndrome is not an uncommon cause of encephalitis. Knowledge of its clinical presentation, pathophysiology and immunology is essential in making the diagnosis. Although the differential diagnosis is broad, it can be narrowed utilizing age, clinical features, imaging characteristics (e.g., location, enhancement pattern, PET MRI findings, etc.) and pathology correlation. By the conclusion of this presentation, the viewer should have a better understanding of paraneoplastic syndrome and associated imaging findings, and should be able to aid in the work up, guide any potential biopsy/tissue sampling and imaging follow up.

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Imaging Spectrum of Post Therapy Related Disorders: A Primer for the Neuroradiologist

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Purpose
A wide range of treatment-related effects result in specific neurologic symptoms and signs with typical neuroimaging features. Even to the most seasoned neuroradiologist, elucidating therapy-related side effects distinct from disease and common mimics can be challenging. Our goal is to provide a pictorial survey of common medication-induced and therapy-related neuroimaging manifestations, discuss their pathophysiology and common pitfalls in imaging and diagnosis.

Materials and Methods
The review presents several case-based medication- and therapy-related side effects seen in neuroimaging, with emphasis on utilizing clinical management and imaging features to assist in the diagnosis.

Results
A case-based review is utilized to depict scenarios encountered on a routine basis in general and neuroradiology practices, such as hemorrhagic conversion following administration of tissue plasminogen activator (tPA) in the treatment of stroke to the more challenging cases of pseudoprogression and pseudoregression in temozolomide and bevacizumab therapy in glioblastoma multiforme treatment protocols (1). In patients with multiple sclerosis, it is necessary for the radiologist to be aware of the patient's medical treatment, in particular, whether it includes specific immunosuppressive therapies in order to diagnose progressive multifocal leukoencephalopathy (2). Another subset of patients on long term immunosuppressive therapy with anti-TNF for spondyloarthropathy are susceptible to develop areas of demyelination (3). Finally, HIV patients with central nervous system immune reconstitution inflammatory syndrome (CNS IRIS) following HAART treatment requires the astute radiologist to be aware of recent therapy initiation as well as the CD4 count (4).

Conclusions
A working knowledge of both the clinical management of the patient and treatment-induced imaging abnormalities is essential in the accurate interpretation and diagnosis from the most routine to most challenging of clinical situations. We provide a template for the general radiologist and subspecialist to employ in order to provide value to our clinical colleagues and more importantly, patients.

eEdE-24

Immune Mediated Dementias

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Purpose
Although most dementias are due to neurodegenerative or vascular disease, it is important to
diagnose immunologically mediated dementias quickly because they can be both rapidly progressive and readily treatable. They usually affect function of limbic and cortical structures, but subcortical involvement also can occur. Because of the variety of symptoms and the rapid course, these dementias present a particular challenge to the clinician and may require evaluation and intervention in the inpatient setting. Diagnostic work up typically reveals evidence of an autoimmune process and, in some cases, cancer. In contrast to the neurodegenerative processes, many of the immunologically mediated dementias respond to immunomodulatory therapy.

Materials and Methods

Advances in immunology have significantly improved our understanding of the various autoimmune diseases. Over the past three decades, we have formed a better understanding the role of various antigens and antibody reactions in the pathogenesis of different idiopathic or unknown etiologic diseases. Along with the body's other organs, the brain can either be a primary or secondary target of various autoimmune disorders. A myriad of autoimmune disorders can affect brain, and it would be impossible to encompass them in a single chapter. We will focus on the most prevalent immune mediated cognitive decline and dementia. The hallmarks of these disorders are a rapidly progressive fluctuating course, the detection of autoantibodies in the peripheral blood or CSF and indications of inflammation in the CSF such as pleocytosis, elevated protein level, and increased immunoglobulin G index.

Results

Largely these groups can be classified into two categories: diseases with specific antigen/antibody and diseases without specific antigen/antibody but with evidence of cellular inflammation (Table 1) (1). Diseases with specific antigen/antibody include: 1) Paraneoplastic neurologic disorders, 2) multiple sclerosis, 3) Hashimoto's encephalopathy (HE), 4) gluten sensitivity (GS) dementia, 5) systemic lupus erythematosus (SLE), 6) Sjögren's encephalopathy dementias, 7) autoimmune-mediated channelopathies [e.g., anti–voltage-gated potassium channel encephalopathy (anti–VGKC-E)], and 8) anti–glutamic acid decarboxylase (anti–GAD) syndrome. Examples of without specific antigen/antibody with evidence of cellular inflammation diseases include: 1) Behçet's disease, 2) sarcoidosis, and 3) primary angiitis of the central nervous system (PACNS). Paraneoplastic neurologic disorders: Hashimoto's encephalopathy; and primary angiitis of the central nervous system.

Conclusions

The immune-mediated dementias typically require urgent diagnosis and treatment with immunosuppressants or the underlying etiology. Increased awareness of the immune-mediated dementias and their comorbid symptoms should lead to prompt diagnosis and treatment of these fascinating and mysterious conditions.
Improving MR Diagnosis of Dural Venous Sinus Thrombosis: A Quality Assurance Project

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Purpose
MR venography in isolation or in conjunction with conventional MRI sequences has largely replaced invasive angiography for first line diagnosis of dural venous sinus thrombosis (DVST). However, many pitfalls still exist in the MR diagnosis of DVST which result in additional imaging studies and delays in management. The purpose of this project is to evaluate the advantages, disadvantages, and diagnostic pitfalls of various available MR imaging techniques of dural venous sinus imaging.

Materials and Methods
We evaluated different methods of dural venous sinus imaging used at our institution and in the existing literature to identify advantages and disadvantages in both technical factors (image acquisition, need for gadolinium, post-processing) as well as diagnostic yield/accuracy.
Results
A wide variety of MR techniques is utilized for imaging of the dural venous sinuses and protocols vary from institution to institution. Our own departmental experience demonstrates several instances of false positive diagnoses of dural venous thrombosis where subsequent imaging demonstrates venous patency. Choosing an optimal imaging protocol may reduce the incidence of false positives. Traditionally, time-of-flight techniques have been utilized for venous imaging and their reliance on MR flow phenomena for contrast generation introduces flow-related artifacts. Phase contrast techniques derive contrast generation from phase manipulation such that moving spin magnetization is non-zero. As phase contrast technique is sensitive to a velocity range, a priori selection of a velocity-encoding (Venc) value introduces user error as an additional complexity. Contrast-enhanced MR venography utilizes gadolinium contrast in order to affect selective T1-shortening of the blood pool. Though contrast-enhanced techniques are less susceptible to imaging artifact, acquisition timing becomes an important factor for diagnostic yield.

Conclusions
Venous sinus thrombosis is a common disorder with nonspecific symptoms that is potentially lethal, but treatable. Several different MR imaging techniques exist for evaluating the dural venous sinuses, and knowledge of the intricacies of the available methods is vital for diagnostic accuracy.

Intracranial cystic lesions: A “cyst-o-matic” approach to identification with pathologic correlation

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Purpose
The purpose of this exhibit is to provide an interactive case-based review of intracranial cystic lesions with a focus on CT and MR, while discussing the etiologies, differential diagnostic considerations, and pathologic correlation when possible.

Materials and Methods
We present a comprehensive spectrum of intracranial cystic lesions and interesting variants from cases collected over the last 3 years from everyday neuroradiology practice at a busy university medical center.

Results
Cases will be presented as an interactive learning session with images, image description, key facts, differential diagnosis, and with gross pathology and/or histology when possible. Many cystic lesions can be diagnosed from the characteristic imaging appearance while others can be narrowed to a small differential. Knowledge of the appearance and distinguishing features will be highlighted. Some of the cases that will be presented include neuroglial cyst, neurocysticercosis, neurenteric cyst, ependymal cyst, epidermoid cyst, dermoid cyst, arachnoid cyst, craniopharyngioma, hemangioblastoma, cystic schwannoma, Rathke's cleft cyst, porencephalic cyst, colloid cyst, choroid plexus cysts, enlarged perivascular space, and pineal cyst.
Conclusions
This educational exhibit will present common and uncommon intracranial cysts as a review to better recognize the diagnosis or formulate a short relevant differential diagnosis when encountered.

- Circumscribed 2.5 cm cyst in the right inferior frontal lobe.
- Homogeneous signal intensity following CSF with low T1 and high T2.
- There is no restricted diffusion, internal or peripheral enhancement, solid components, or surrounding vasogenic edema.
- The cyst does not communicate with the adjacent right lateral ventricle or extend to the right frontal cortex.
- Imaging findings are consistent with a Neurogial cyst

(Filename: TCT_eEdE-63_Neurogialcyst1.jpg)
Introduction to Segmentation, Registration and Volume Analysis for Imaging Genomics

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Purpose
In the current Radiomics era, extraction of multidimensional -omics data from medical MRI images depend on clearly defining the pathological lesions using segmentation techniques. In this exhibit we strive to define a methodology to create a uniform basis for delineating the enhancing portion, necrotic portion and the nonenhancing edema/invasion portion in Glioblastoma.

Materials and Methods
3D Slicer (www.slicer.org) is a free open source software platform for medical image processing and 3D visualization of image data was used for segmentation, registration and three-
dimensional visualization of multimodal image data. FLAIR was used for segmentation of edema while postcontrast T1 WI was used for segmentation of enhancing tumor and the necrosis. A brief summary of different modules available in Slicer is listed below. The "Volume" module: This Module loads, saves and adjusts the display parameters of volume data. I. Registration: Different scans might be recorded at different angles, use different number of slices and might sometimes even have a different voxel thickness. To solve that problem we need to register the two scans, so that the two scans correspond and are rigidly aligned to each other. II. Segmentation: Segmentation Methodology: The segmentation was carried out in a simple hierarchical model of anatomy, proceeding from the peripheral to the central, three different structures were segmented and later modeled, namely, edema, tumor and necrosis, respectively. III. Editor: The overall goal is to efficiently and 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 model. Results The volumetric data of the segmented regions can be retrieved from "The Label Statistics" module. These volumetric data are used for further imaging genomic mapping. The Label maps also can be used as an input for other image processing platforms for feature extraction. For e.g. Conclusions This exhibit gives a brief summary and assessment about semi-automated segmentation. Semi-automated segmentation provides the advantage of higher accuracy compared to completely automated methods, especially if performed or supervised by an experienced neuroradiologist.

**eEdE-59**

**Journey through Metastatic Melanoma of the Head and Neck**

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Purpose
1) Describe the magnetic resonance imaging (MRI) findings of malignant melanomas, especially their signal intensity characteristics based on its content. 2) Identify the different sites and pattern of involvement of the central nervous system (CNS). 3) To analyze the imaging pattern of malignant melanotic lesions following chemo and radiotherapy.

Materials and Methods
An elaborate search was made for metastatic melanoma of the CNS, including head and neck from the database available on PACS from 2005-2013. All cases including complications, their post-treatment images were evaluated and based on the findings, this poster has been designed.

Results
Discussion: 1) MR imaging protocol for screening of malignant melanomas. 2) MR imaging features of the classical melanotic and amelanotic patterns with emphasis on atypical patterns following chemo and radiotherapy. 3) Distribution of malignant melanoma lesions in both the...
intracranial and extracranial structures of the head with co-relation to clinical features. 4) Spinal imaging with special attention to Primary Meningeal Melanosis.

Conclusions
1) Malignant melanomas have a wide spectrum of appearance and involvement of the intra and extracranial structures. 2) Although brain is the most common site of metastasis in the head and neck, metastatic melanoma can involve essentially any structure including the spinal cord. 3) This pictorial review from our institution will better familiarize radiologists with typical and atypical imaging features and locations of malignant melanoma on MRI when screening patients.
Extensive leptomeningeal enhancement with involvement of the Vth and VII-Vilth nerve complex from metastatic melanoma.

Extensive metastatic disease involving the sacral nerve roots, extending to the cauda equina and the conus.
Metastatic melanoma to the Temporalis muscle
Leptomeningeal Neoplasm and Mimics.

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Purpose
To explore imaging findings of leptomeningeal process and understand the potential differential diagnosis.

Materials and Methods
First part of this educational exhibit will be the review of anatomy and physiology of meninges. Second part will demonstrate the variety of cases with leptomeningeal process discussed with pathology correlation. To differentiate possible mimics, cases of non-neoplastic leptomeningeal disease will be discussed in two main categories of infection and inflammatory disease.

Results
Leptomeningeal spread of neoplasm occurs when neoplastic cells enter cerebrospinal fluid (CSF) pathways, causing infiltration of the subarachnoid space of the brain and spinal cord. Definitive diagnosis is established by the demonstration of malignant cells in the CSF. However, in certain circumstances the pattern of MRI findings on brain or spinal MRI may indicate the diagnosis. Early diagnosis and treatment may delay neurologic progression and can lead to survival and improvement of neurologic function in certain patients. This exhibit will provide a pictorial review of leptomeningeal neoplasms including but not limited to carcinomatosis, myelomatosis, gangliogliomatosis, medulloblastomatosis, hemangioblastomatosis, meningiomatosis, melanocytosis, and lymphomatosis. Also several cases of inflammatory leptomeningeal disease including sarcoidosis, Rosai-Dorfman, and rheumatoid meningitis will be reviewed. In the infection category, leptomeningeal involvement in cryptococcus, coccidiomycosis, tuberculosis, and bacterial meningitis will be discussed.

Conclusions
Timely diagnosis of leptomeningeal neoplasms is important. MR imaging plays an essential role in the diagnosis. This educational exhibit will be a comprehensive collection of cases to enhance radiologists' knowledge about this type of central nervous system (CNS) neoplasm and its mimics.
Lesions of the Scalp

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Purpose
The purpose of this exhibit is to: 1. Review the anatomy of the scalp. 2. Review the variety of lesions involving the scalp in adults and children. 3. Discuss the features of the lesions on imaging.

Materials and Methods
Content/organization: Introduction, review of scalp anatomy, pictorial case-based review of common and uncommon etiologies and imaging features of benign and malignant scalp lesions, distinguishing features on MRI and CT, and radiologic differential diagnosis based on appearance, references.

Results
Multiple types of lesions can occur in the scalp. Malignant masses include squamous cell carcinoma, melanoma, and angiosarcoma. Benign masses include angiofibromas, hemangiomas, calcified hematomas, dermoid cysts, and pilomatricomas. It is important to understand these benign lesions to prevent unwarranted follow-up imaging or unnecessary concern.

Conclusions
At the end of this exhibit, the viewer will be aware of scalp anatomy, the wide variety of benign and malignant scalp lesions in adults and children, and know which lesions merit further evaluation or follow up.
Purpose
The diagnosis of various neurological disorders that manifest as regional cortical lobar atrophy can be difficult even for experienced neuroradiologists. The purpose of this exhibit is to illustrate imaging findings and clinical features that help characterize various disorders involving lobar atrophy as a primary component of the disease, in order to improve diagnostic accuracy.

Materials and Methods
The self-assessment style module will first present clinical and radiological patterns that differentiate various patterns of lobar atrophy in an interactive format. The module then will allow participants to test themselves on diagnosing novel case exemplars based on these differentiating features presented throughout the exhibit.
Results
Key examples of various neurological disorders presenting with lobar atrophy will be presented in an interactive case-based format. Discussion of typical and less typical diagnostic features will be highlighted along with discussion of their differential diagnoses. The cases discussed will include: Inflammatory, including Rasmussen Encephalitis. Neurodegenerative: o Frontotemporal lobar degeneration (FTLD), including its three subtypes of semantic dementia, nonfluent aphasia, and behavior variant FTD. o Alzheimer dementia, o Corticobasal degeneration, o Dementia with Lewy Bodies, o Vascular dementia. Epilepsy-associated: o Volume loss associated with long-standing epilepsy, o Volume loss associated with anti-epileptics. Congenital/Developmental: o Sturge-Weber syndrome, o Dyke-Davidoff-Masson, o Cortical dysplasias.

Conclusions
Although the overlap of cortical lobar atrophy between different neurological disorders on imaging can be substantial, differentiating between these disorders is critical for appropriate prognosis and treatment. Familiarity with certain pathognomonic features, for example "knife-blade" gyri in FTLD (Figure part A) or calcifications in Sturge-Weber syndrome (Figure part C), as well as other typical patterns of cortical atrophy (see Figure for examples), are important for radiologists making complex diagnostic distinctions. Clinical features relating to particular patterns of atrophy are described. Finally, advanced methodologies such as volumetric analyses and PET imaging also will be discussed in the context of differentiating these entities.
Managing the Magnet: A Prequel to Pushing the Scan Button

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Purpose
The goal of this exhibit is to educate the reader about differences and advancements in coil technology, address MRI safety issues and discuss time-saving strategies for effective scanning.

Materials and Methods
· In the first part of the exhibit, we will describe different types of coils utilized in neuroradiology with focus on their advantages and disadvantages in different clinical scenarios.
· In the second part of the exhibit, we will elaborate on MRI safety issues that all radiologists should be aware of.
· In the third and last part of the exhibit, we will discuss time-saving strategies, both those that currently are in clinical practice and those that show promise for the future.

Results
Often the radiologist interpreting an MRI study is not aware of the technological options available for scanning, especially the newer advances in coil technology such as 32-channel head coils. While the choice of appropriate coils for different clinical applications often is performed by the MR technologist, it is important for the radiologist to be aware of and be able to suggest alternatives. For example, using a regular spine coil alone may not be sufficient for assessing patients with suspected sacrococcygeal teratomas; an additional pelvic coil that can image the internal organs in the pelvis and the pre-sacral soft tissue component more effectively would be required for a comprehensive exam. Radiologists often are questioned by clinicians about safety issues in specific scenarios, which they may not be familiar with. For example, not many radiologists are aware that devices deemed safe for 1.5T scanning may not be safe for open field 1.0T scanning due to difference in direction of the magnetic field. We will focus on MRI safety in this exhibit and discuss zoning, safety of different devices, terminology (MRI safe versus conditional) and specific absorption rate. Acquiring diagnostic quality images in a timely manner has become crucial with increasing volumes. In the last section of the exhibit, we will describe commonly used strategies such as parallel imaging and also discuss future applications of compressed sensing.

Conclusions
By viewing this exhibit, the reader will enhance his/her understanding of the essentials of MRI coil technology, safety issues and timely scanning, all of which happen before the scan hits their workstations for interpretation.
More Than Just Three Pairs of Stalks: Comprehensive Interactive Case Review of Bilateral Cerebellar Peduncle Abnormalities

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Purpose
The differential diagnosis of neurologic diseases exhibiting bilateral superior, middle, and/or inferior cerebellar peduncle abnormalities is broad and may not be familiar to many radiologists. The goal of this exhibit illustrates important imaging and clinical features that help differentiate various diseases that exhibit bilateral cerebellar peduncle abnormalities.

Materials and Methods
The anatomy and vascular supply of cerebellar peduncles and associated fiber tracts will be reviewed. An interactive case series will illustrate key features of various neurologic diseases with bilateral cerebellar peduncle abnormalities, along with relevant differential diagnosis, to raise awareness and improve diagnostic accuracy.

Results

Conclusions
Although various neurologic diseases that exhibit bilateral superior, middle, and/or inferior cerebellar peduncle abnormalities may not be familiar to many radiologists, correct diagnosis often is critical for appropriate prognosis and treatment. This exhibit aims to provide a comprehensive review of key imaging and clinical features of these neurologic diseases and relevant differential diagnosis to improve awareness and diagnostic accuracy.
Figure. A. Anatomy of cerebellar peduncles on T1 MPRAGE image; SCP – superior cerebellar peduncle, MCP – middle cerebellar peduncle, ICP – inferior cerebellar peduncle. B. Bilateral SCP FLAIR hyperintensities (arrows) and optic nerve atrophy (not shown) in 29 years old woman; Diagnosis – neuromyelitis optica. C. Bilateral MCP T2 hyperintensities (arrows) and cerebellar atrophy in 81 years old man; Diagnosis – progressive supranuclear palsy. D. Bilateral ICP (arrows) and multiple supratentorial hyperintensities (not shown) on proton density imaging in 37 years old woman; Diagnosis – multiple sclerosis.
MR Imaging of Post-Treatment Changes in the Brain in Immunocompromised Patients

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Purpose
Disease processes result in a spectrum of imaging findings in the brain. As the field of medicine advances, novel approaches to the treatment of disease are developed. Many of these treatments also result in a unique imaging pattern that is important to recognize as a radiologist. This study will present a subset of these iatrogenic post-treatment imaging changes which are seen in immunocompromised patients.

Materials and Methods
A retrospective search of MR brain studies in the hospital's PACS was performed. Those studies demonstrating imaging findings consistent with iatrogenic post-treatment change in immunocompromised patients were identified for inclusion in this study. The goal of this exhibit is to: - Demonstrate and describe both common and uncommon MR imaging changes in the brain which occur in immunocompromised patients after receiving various forms of treatment. - Provide a brief review of these and other common treatments which have similar imaging characteristics.

Results
Different post-treatment conditions demonstrate a variety of imaging characteristics.

Conclusions
Familiarity with patterns of post-treatment change in the brain is essential for the accurate interpretation of MR imaging in immunocompromised patients. In this exhibit, sample cases of immunocompromised patients who had previously undergone treatment were presented and the salient features of their MR imaging studies then were described.
MRI of Autoimmune Encephalitis: An Interactive Tutorial

W Zucconi, V Zohrabian, R Bronen
Purpose
To update and engage the learner in an interactive tutorial on autoimmune encephalitis (AIE). The activity is intended for those with a beginning or intermediate level of understanding of this topic.

Materials and Methods
Novel memory aids and "clickable" items (questions, findings within MRI images, etc.) are embedded within the presentation in an interactive format to provide immediate feedback. Clinically proven cases of AIE are used for the exercise. Cases of clinically proven alternative diagnoses with similar imaging features also are included. A literature review was performed and salient points presented.

Results
Advances in the understanding of the pathophysiology and incidence of AIE necessitate rapid dissemination to the radiology community. Autoimmune encephalitis may account for over 20% of encephalitis cases. From a radiologist's perspective, it is useful to separate those causes involving the limbic system from those which do not. Differentiation also is made between causes of AIE which are commonly paraneoplastic and those that are not associated with tumors.

Conclusions
Awareness of the imaging features of AIE and familiarity with clinical data will allow radiologists to offer the diagnosis of AIE and direct patient work up, which could lead to earlier treatment and improved outcomes.
Example 1: Intracellular Antigen AIE (anti-Ma2 encephalitis)

27 y/o male with testicular cancer

6 months later with limbic and hypothalamic pathology

Examples 2 and 3: Anti-NMDA Encephalitis

2: Unilateral (L) insula, bilateral amygdalae

3: Bilateral symmetric hippocampal disease

Multiple faces of meningiomas: radiological-pathological correlation
Purpose
Meningiomas are the most common extra-axial primary brain tumor. These tumors have varied radiographic and pathologic presentations. This exhibit aims to provide a comprehensive overview of meningiomas from detection to treatment.

Materials and Methods
We will review imaging findings of meningiomas on CT and MRI (DWI, DTI, PWI, MRS), and correlate with histologic subtypes. We will examine patterns of extension and discuss issues regarding treatment, prognosis and recurrence.

Results
Meningiomas arise from arachnoidal cap cells and can express mesenchymal and epithelial characteristics. Classically, CT demonstrates extraaxial mass, though they may arise in the spinal canal, intraventricular, intraosseous, or be extracranial in the head and neck. On noncontrast exams, they are hyperattenuating and 25% contain calcium. On MRI, meningiomas are typically isointense to gray matter on T1 and T2, avidly enhance with contrast, and demonstrate a 'dural tail sign'. There are 15 histologic subtypes, as well as cystic meningiomas: Grade I (meningothelial, fibrous, transitional, psammomatous, angiomatous, microcystic, secretory, lymphoplasmacyte-rich, metaplastic), Grade II (atypical, clear-cell, chordoid), and Grade III (anaplastic, rhabdoid, papillary, any high grade features). The radiographic findings on CT and MRI vary by subtypes and recognizing variations in tumor-brain interface, capsular enhancement, heterogeneity, associated edema and the ADC and FA value can predict the subtypes. Differential diagnoses include hemangiopericytoma, metastasis, solitary fibrous tumor, meningeal angiomatosis, sarcomas and gliomas. Patterns of extension include cavernous sinus, en-plaque meningioma, intra-orbital, nasal cavity, and carotid or masticator space. Though typically benign, treatment is determined by size, symptomatology, and grade. Options include surgery, radiation, hormonal therapy, and chemotherapy. Postsurgical grading (Simpson grading system) again relies on a combination of pathology and MRI, with prognosis dependent on histologic grade and extent of resection.

Conclusions
Understanding meningiomas from presentation through treatment is essential in assisting clinicians and guiding patient care.
Multiple Sclerosis: A Review of Conventional and Not-So-Conventional MR Imaging Techniques

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Purpose
The central role of MRI in the diagnosis and monitoring of multiple sclerosis (MS) patients is well established, and conventional MRI findings of MS are well known to practicing neuroradiologists. Many neuroradiologists, however, may be less familiar with newer MRI techniques developed for their value in improving understanding of the underlying pathophysiology of MS. The purpose of this exhibit is to both provide an image-rich review of conventional MRI findings in MS (including less common imaging appearances) and introduce learners to newer MRI techniques.

Materials and Methods
Users will navigate an image-rich presentation which will illustrate a broad range of brain and spine MRI findings in patients with MS. Several cases of MS with a range of both typical and
atypical features on conventional MRI sequences will be presented. In addition, multiple newer techniques will be introduced to the user; the accompanying discussion will emphasize their role in elucidating the underlying pathophysiology of MS, monitoring treatment response, and providing prognostic information.

Results
Multiple sclerosis is the most common inflammatory demyelinating disease of the central nervous system and is one of the most common causes of neurological disability in young adults. Conventional MRI findings have been integrated into the McDonald Criteria, the prevailing clinical standard for diagnosis of MS, and also allow measurement of disease activity and progression. Over the past several years, various MR techniques and applications have been developed in an attempt to better understand the complex processes underlying the clinical manifestations of MS. These techniques include (but are not limited to) use of double inversion-recovery sequences, imaging at higher field strengths, magnetization transfer MR imaging, diffusion tensor imaging, and perfusion-weighted MR imaging. Though not yet introduced into routine clinical evaluation, some of these advanced MR techniques currently are being investigated for their possible role in assessing treatment response, particularly in the setting of clinical trials.

Conclusions
This presentation will both provide a useful review of both conventional MRI findings in MS and introduce users to newer MR techniques with an emerging role in evaluation of MS.
Mystery of Connectional Neuroanatomy Explained via 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 principle of tractography. 3. Describe principles of connectional neuroanatomy through correlative line drawing, which include normal anatomy and function of the major white matter fiber tracts of the brain. 4. Illustrate the major fiber tracts via the utilization of tractography.

Materials and Methods
Illustrations will be provided to demonstrate the major fiber tracts. Multiple MR images of the brain based on diffusion data and fiber tracts will be displayed.

Results
Diffusion tensor imaging (DTI) utilizes the motion of water molecules in tissues allowing full characterization of molecular diffusion in the three dimensions of space. Diffusion anisotropy (DA) effects can be extracted fully and utilized to provide details on tissue microstructure. The two most common scalar metrics that can be generated are fractional anisotropy (FA) and mean diffusivity (MD), which are used to generate images of the diffusion data. Tractography is performed using data from DTI to allow mapping of the white matter tracts in the brain. White matter fiber tracts are an integral function of brain functioning, since they modulate the distribution of signal from the gray matter. They essentially act as a relay and coordinating communication between different brain regions. White matter fiber tracts traditionally have been classified into three categories: Association fibers interconnect cortical areas in each hemisphere. Projection fibers interconnect cortical areas with deep nuclei, brain stem, cerebellum, and spinal cord. Commisural fibers interconnect similar cortical areas between opposite hemispheres.

Conclusions
Diffusion tensor imaging has shown useful applications in clinical neuroimaging. Immediate benefits from knowledge of tract anatomy include surgical planning, understanding of tumor spread, and anticipation of clinical deficits related to injury to those tracts. Understanding fiber tracts also forms the foundation for more advanced functional imaging.

Neurological Applications of Focused Ultrasound

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Purpose
The purpose of this exhibit is to familiarize neuroradiologists with high intensity focused ultrasound (HIFU), an emerging therapeutic tool with promising research and clinical applications. The presentation will include a discussion on the physical principles of HIFU as well as current and potential therapeutic applications in neurological disease.

Materials and Methods
The exhibit will review the physical principles of HIFU and its utility in treating neurological disorders. A graphical representation of possible biological effects caused by the rate of energy deposition will serve as an outline of possible therapies. Potential clinical applications to be discussed include thermal ablation, enhanced drug delivery and neuromodulation.

Results
The utility of HIFU is based on energy deposition via acoustic wave propagation. The rate of energy deposition is manipulated via the intensity and the duty cycle. Unique advantages of HIFU in the treatment of neurological disease include its noninvasive nature and high accuracy, as a focal point on the order of a few millimeters can be achieved. The role of intracranial HIFU has expanded in recent years as previous limitations are overcome, including acoustic distortion from the calvarium. Thermal ablation of neurological tissues is caused by a high intensity continuous exposure. HIFU thermal ablation has been used in treatment of solid tumors and symptomatic treatment of several neurological diseases. When high intensity exposures are applied in pulsed mode, temperature elevations are lower and mechanical effects predominate, which can be employed to increase the permeability of the blood-brain barrier allowing improved delivery of drugs and other agents. Low intensity pulsed focused ultrasound can be employed for neuromodulation, being preferable to existing neuromodulation techniques that are more invasive or offer limited resolution.

Conclusions
The noninvasive nature and ability to focus energy on the order of millimeters compares HIFU favorably with other therapeutic modalities. Clinical applications of HIFU in neurological disease are still being developed as understanding of its biological effects improves.

Neuroradiological findings in sickle cell disease excluding moyamoya.

M Castillo

Purpose
To review lesions other than moyamaya resulting from sickle cell disease (SCD).

Materials and Methods
From our TF we reviewed all SCD cases and identified those with complications other than moyamaya which form the basis of this review.

Results
We were able to identify the following complications: spinal cord and bone infarctions, skull
infarctions, extramedullary hematopoiesis in paranasal sinuses, intraventricular and microhemorrhages, intracranial aneurysms, superficial siderosis, PRES, and extracranial carotidstenoses. Imaging findings of all are presented.

Conclusions
Outside of moyamoya, manifestation of SCD are varied and most can be explained by hypoxia and arterial wall damage.

eEdE-54
6:30AM - 3:00PM

Neurosurgical Operative Approaches: What the Neuroradiologist Needs to Know

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Purpose
Imaging plays a key role in the pre-operative and postoperative evaluation of neurosurgical patients, and neuroradiologists should be facile with the various approaches utilized in intracranial operations. This exhibit will demonstrate neurosurgical approaches for operations such as cranial decompression, tumor resection, and aneurysm clipping. Our goal is to highlight the most common neurosurgical approaches including anatomical considerations, imaging appearance, and imaging of potential complications.

Materials and Methods
The context will be set by a brief description of the overall goals of operative approaches as well as a brief description of general operative equipment and technique. General imaging considerations and potential complications inherent in all cranial approaches such as hemorrhage and infection will be discussed briefly. For the majority of the exhibit, specific neurosurgical approaches, including both open and endoscopic techniques, will be discussed individually. Anatomical descriptions will be provided, highlighted by specific postoperative imaging case examples. Indications for each specific approach will be cited, as well as potential complications unique to each particular approach.

Results
Understanding the postoperative imaging appearance of various neurosurgical approaches enables neuroradiologists to communicate with referring neurosurgeons using their own language, which is useful in building rapport and confidence in the radiologist. By knowing preoperative indications and anatomical considerations for each approach, neuroradiologists will be better able to craft useful reports to aid surgeons in approach selection. In addition, by knowing the expected postoperative appearance for specific approaches, as well as complications unique to each approach, neuroradiologists will be better able to monitor a patient's postoperative course and provide useful feedback to referring neurosurgeons.

Conclusions
Imaging plays a key role in the pre-operative and postoperative evaluation of neurosurgical patients, and neuroradiologists should be familiar with the various operative approaches utilized by our neurosurgical colleagues, including potential complications specific to each approach. This exhibit will provide a useful resource to aid neuroradiologists in this goal.

eEdE-64

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Purpose
Lesions of the sella frequently are seen in neuroradiology, and greater than 90% are adenomatous lesions. However, it is important to understand that not all pituitary lesions are adenomas as the imaging diagnosis may have profound effects on patient management. There is a broad differential for nonadenomatous lesions of the sella that extends far beyond craniopharyngioma, meningioma, and Rathke's cleft cyst. The purpose of this exhibit is to review the anatomy of the sella and to review the wide differential of nonadenomatous lesions of the sella with relevant individual clinical imaging cases (clinical presentation and images).

Materials and Methods
A retrospective review of neuroradiology cases at the University of Texas Health Science Center at San Antonio was performed to identify cases of nonadenomatous pituitary lesions based on imaging characteristics, some with confirmed pathologic tissue diagnosis. Additionally, a review of literature of pituitary lesions was performed.

Results
Patient imaging cases of nonadenomatous lesions of the sella were identified and stratified into four categories: Congenital/Anatomical, Neoplasm, Vascular, or Inflammatory/Infectious. The following lesions were identified and are discussed in detail with pictorial review: 1. Congenital Anatomical: Rathke's cleft cyst, arachnoid cyst, ectopic posterior lobe, sellar spine, cephalocele, transected stalk, empty sella, epidermoid cyst. 2. Neoplasm: meningioma, craniopharyngioma, chiasm astrocytoma, germ cell tumor, schwannoma, hypothalamic hamartoma, lymphoma, metastasis. 3. Vascular: kissing carotids, carotid-cavernous fistula. 4. Inflammatory/Infectious: sarcoidosis, histiocytosis, lymphocytic hypophysitis, pituitary abscess.

Conclusions
Not all lesions of the sella turcica are adenomas, and there is a wide differential for nonadenomatous lesions of the sella including congenital/anatomical, neoplastic, vascular, and inflammatory/infectious lesions. It is important for radiologists to understand the common presentations and imaging findings of these lesions to avoid misdiagnosis and guide patient management.

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Outlaws in the Saddle: Tumors and Cancer-Related Diseases of the Pituitary

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Purpose
With reference to pituitary cases seen at a tertiary referral center, the purpose of this exhibit is to
review the following. 1. Difficulties in imaging unusual pituitary adenomas. 2. Imaging appearance of pituitary carcinoma. 3. Pituitary disease due to primary cancers at other sites.

Materials and Methods
We present interesting imaging examples of the following, along with relevant clinical information. 1. Ectopic adenoma, invasive adenoma, EN type 1. 2. Pituitary adenoma as neuroendocrine tumor. 3. Effects of adenoma treatment. 4. Metastases of pituitary carcinoma. 5. Immunotherapy-induced hypophysitis. 6. Metastasis to the pituitary including leptomeningeal metastasis.

Results
The main educational points discussed are listed. 1. Imaging protocol for giant adenoma. 2. Avoiding mistaken identity due to similar histologic appearance of pituitary adenoma, olfactory neuroblastoma and sinonasal neuroendocrine carcinoma. 3. Difficulty identifying pituitary carcinoma in the sellar phase. 4. Association of metastasis to the pituitary with diabetes insipidus. 5. Treatment of immunotherapy-induced hypophysitis with steroids rather than withdrawal of effective agent.

Conclusions
Clinical knowledge aids in facing challenging diagnoses with respect to the pituitary.

eEdE-45

Pearls and Pitfalls in Neuroradiology of Cerebrovascular Disease - The Essentials with MR and CT

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Purpose
The focus of this educational exhibit, presenting pearls and pitfalls in imaging of the brain, is also in a more broad sense that of clinical neuroradiology itself. Recognition of characteristic findings on both MR and CT of the disease processes we are likely to encounter in clinical practice is key. The basis for this presentation is clinical case material, specifically excellent images and characteristic findings, demonstrating the points in question, from both modalities.

Materials and Methods
Of the four major disease categories (neoplastic, vascular, inflammatory, and congenital), vascular disease is the most common. Vascular disease itself is divided into two major subgroups, ischemia and structural vascular anomalies (aneurysms and vascular malformations). Cerebrovascular disease often is accompanied by intracranial hemorrhage, with the imaging appearance of the latter thus also important to understand. This exhibit presents 18 carefully chosen vascular disease imaging 'cases', focusing on less common presentations, the pitfalls in recognition and dating of hemorrhage, and important "Aunt Minnie" findings involving the vessels themselves and lesions therein.

Results
With regard to ischemia, several of the less commonly involved arterial territories are illustrated, specifically including the posterior cerebral artery, anterior cerebral artery, posterior inferior cerebellar artery and superior cerebellar artery. The spectrum of lacunar infarcts then is
presented, along with the imaging appearance of intraparenchymal hemorrhage (including pitfalls in terms of temporal evolution, on both CT and MR). This section concludes with an illustration of the sometimes confusing appearance of late subacute infarction on MR, together with an illustration of extension of an infarct in the setting of a prior chronic infarct. Transitioning to the topic of vessel abnormalities, characteristic imaging findings including pulsation artifacts and flow voids are illustrated, together with partial thrombosis. The exhibit concludes with discussion of several less common entities, all with characteristic and easily recognizable imaging presentations, including specifically myxomatous emboli, carotid cavernous fistula, and venous thrombosis with venous infarction.

Conclusions
Pearls and pitfalls regarding the interpretation of MR and CT in patients with cerebrovascular disease are presented, focusing on entities seen in clinical practice, but occurring less frequently and thus often leading to confusion. This selected group of cases covers the less commonly involved arterial territories (for ischemia), the varied appearance of hemorrhage, and key imaging findings in aneurysms and vascular malformations.
Pictorial review of intracranial MRV techniques, pitfalls, and common pathologies involving the cerebral venous system

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Purpose
Several MR venography (MRV) methods are available to image the intracranial venous system, which can be difficult to evaluate due to artifacts, variant anatomy, and overlapping signal intensities of venous flow and thrombosis. MR venography techniques and pitfalls of each method are reviewed. The imaging appearance of pathologies involving the dural venous sinuses is illustrated.

Materials and Methods
A retrospective review of MRV studies was performed to obtain illustrative cases of different MRV methods, diagnostic pitfalls, and pathologies of the cerebral venous system. Particular attention is focused on two noncontrast-based techniques: two-dimensional time of flight (TOF) pulse and 3D velocity sequences. We discuss the advantages and disadvantages of each technique and highlight their pitfalls. We illustrate the appearance of venous thrombosis, stenosis, and occlusion. The following etiologies involving the cerebral venous system are addressed: intracranial hypertension, hypercoagulable states, meningioma, and hemangiopericytoma.

Results
A pictorial summary of noncontrast-based MRV methods, their pitfalls, and the imaging appearance of cerebral venous pathologies is provided.

Conclusions
Familiarity with different MRV techniques and their pitfalls will assist in the accurate imaging interpretation of the intracranial venous system. Correlating imaging findings on different MRV sequences can avoid diagnostic pitfalls associated with all imaging techniques. Knowledge of the typical and subtle imaging features of common pathologies of the cerebral venous sinuses will lead to prompt diagnosis and treatment, which can improve prognosis.

Practice Guidelines for the Evaluation and Treatment of Pituitary Incidentalomas: A Case-based Imaging Review

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Purpose
To increase awareness within the neuroradiology community of the evidence-based current clinical guidelines for evaluation and treatment of pituitary incidentalomas provided by The Endocrine Society.

Materials and Methods
The Endocrine Society appointed a Task Force to formulate evidence-based guidelines for the evaluation and treatment of pituitary incidentalomas, a common clinical issue which usually is
first brought to attention by radiologists. We plan to present the Task Force evidence-based recommendations through an interactive case-based approach in which readers will be able to test their knowledge by choosing recommendations and management options for real cases and comparing their selections to the official Task Force guidelines.

Results
The Endocrine Society recommends that all patients with a pituitary incidentaloma undergo a history and physical examination, laboratory evaluations for hormone hypersecretion and hypopituitarism. Those with lesions abutting the optic nerves or chiasm on MRI also should undergo visual field examination. Patients may be referred for surgery if they have a visual field defect, a lesion abutting the optic nerves or chiasm, pituitary apoplexy with visual disturbance, if the incidentaloma is a hypersecreting tumor or a prolactinoma which failed high doses of a dopamine agonist. Patients not meeting criteria for surgical removal should be followed with clinical assessments, neuroimaging (magnetic resonance imaging at 6-month intervals for macroincidentalomas, yearly for microincidentalomas, and thereafter less frequently if unchanged in size), visual field examinations for incidentalomas that abut or compress the optic nerve and chiasm (6 months and yearly), and endocrine testing for macroincidentalomas (6 months and yearly) after the initial evaluations.

Conclusions
Keeping abreast of existing clinical guidelines is vital for radiologists to effectively translate imaging findings into best practices. Pituitary incidentalomas are encountered very commonly in neuroradiology clinical routine and awareness of evidence-based guidelines is essential to increase the value and impact of our practice.

Pre-Operative Planning for Intracerebral Tumors - a Video Report of What the Surgeon Needs to Know

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Purpose
The purpose of this exhibit is to convey our assessment of a decision support software that is used to improve the content and presentation of pre-operative brain tumor reporting.

Materials and Methods
A software program, deformable anatomical templates* (DAT), was fit over the patient's images and deformed (if needed) to account for any mass effect. This annotated map is accessed easily by manually circling the area of interest. This provided an organized list of all anatomical structures within and around the area of interest. The function, pattern of glioma spread, clinical deficits caused by damage, and related items are available in a text box. These custom annotated images were converted to a 3D format and videotaped. The video then was emailed to the surgeon's smartphone to reach out to the neurosurgeons wherever they are in their busy schedule.

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Results
Examples of videotaped preoperative plans are provided in selected case examples of gliomas.
located: 1) in or near the motor-sensory cortex; 2) in and around the visual tracts; 3) in and around the speech area.

Conclusions
Tools are available now which can significantly improve the preoperative evaluation of patients undergoing surgery for intracerebral tumors and modernizing the communication of critical information to the neurosurgeons.


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Purpose
To present the most common imaging findings of primary central nervous system (CNS) lymphomas on conventional magnetic resonance imaging (MRI) as well as proton MR spectroscopy, diffusion-weighted imaging, dynamic susceptibility contrast imaging (DSC) and dynamic contrast-enhanced (DCE) studies.

Materials and Methods
We retrospectively reviewed the clinical charts and neuroimaging studies in all patients diagnosed with primary CNS lymphoma in the last 20 years. MR imaging was performed on a 1.5T GE Signa Horizon and 1.5T General Electric (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), dynamic susceptibility contrast imaging (DSC) and dynamic contrast-enhanced (DCE) studies were obtained in some patients, and gadolinium chelates were administered in all. A neuroradiologist with 19 years experience (BL) evaluated all the images. The diagnosis was confirmed by therapeutic response to therapy, biopsy and surgical resection in some cases.

Results
The most common neuroimaging features in primary CNS lymphomas were: 1- Predilection for the supratentorial compartment; 2- Predilection for the periventricular white matter, subependymal regions, deep gray nuclei and corpus callosum; 3- Presentation as round well circumscribed solid lesions instead of infiltrative; 4- Isointense to the cortex on the T2; 5- Solid enhancement; 6- Restricted diffusion; 7- Very high choline along with presence of lipids and lactate in the spectroscopy; 8- No elevation of the blood volume; 9- No significant elevation of the permeability; 10- Significant reduction in size or disappearance after steroid therapy.

Conclusions
Primary CNS lymphomas are a very common brain tumor in the adult. Knowledge of the main imaging findings of these tumors is essential for appropriate diagnosis and treatment. Findings on advanced MRI techniques, such as proton MR spectroscopy, diffusion-weighted imaging, dynamic susceptibility contrast imaging (DSC) and dynamic contrast-enhanced (DCE) studies also may help distinguish these lesions from other aggressive brain neoplasms in the adult.
Scalp Trauma in Adults: CT and MR Imaging

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Purpose
Traumatic scalp injuries in adults are common. While the imaging features of scalp injuries related to birth trauma has been well described in infants, imaging of traumatic scalp lesions in adults has not been adequately described in the literature. We aim to present the relevant scalp gross and imaging anatomy and CT and MRI imaging appearance of various traumatic scalp injuries. We also describe the clinical relevance of such injuries.

Materials and Methods
We prospectively selected cases of traumatic head injury with scalp injury visible on CT and/or MRI from July 2014 to February 2015 (ongoing) for cases with teaching value with regards to scalp injury. For a subset of patients, we took intra-operative photographs to correlate with gross anatomical findings.

Results
We present several examples of the following types of cases on CT and MRI with clinical and surgical anatomical correction: 1) Subcutaneous swelling/bruising; 2) Intramuscular hematoma (temporalis muscle); 3) Subcutaneous emphysema; 4) Subcutaneous hematoma; 5) Subgaleal hematoma; 6) Subperiosteal hematoma; 7) Scalp foreign bodies (glass, wood, metal), with benign calcifications for comparison.

Conclusions
Traumatic scalp injuries are common in adults. Understanding their anatomical basis and imaging appearances will assist radiologists in making more accurate and useful diagnostic reports.

Sensorimotor Anatomy Tutorial and Presurgical Brain Mapping Scenarios

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Purpose
To empower neuroradiologists with a thorough understanding of sensorimotor functional and dysfunctional anatomy and apply it in presurgical brain mapping scenarios.

Materials and Methods
Cadaver brain images and overlaid illustrations foster a 3-dimensional (3D) understanding of sulcal anatomy, cortical functional anatomy, and deficit localization. Correlative normal brain MRI and functional brain mapping promote a 2D understanding of sensorimotor brain anatomy.
Six presurgical brain mapping case scenarios then are presented which require application of sensorimotor conceptual thinking. This exhibit focuses specifically on primary sensorimotor, pre-motor, supplementary motor, and higher order sensory functional and dysfunctional anatomy.

Results
Recognizing sulcal and gyral landmarks on cross-sectional imaging is essential to understanding functional anatomy and applying this knowledge to radiologic practice. Identifying sulcal landmarks and comparing the same across hemispheres can localize functional gyral anatomy of primary sensorimotor, pre-motor, supplementary motor, and secondary somatosensory systems. Advanced imaging techniques (fMRI and DTI) in presurgical brain mapping complement this knowledge of the sensorimotor system at standard imaging to empower the neuroradiologist to help guide neurosurgical decision-making. It is only with exposure to presurgical brain mapping case scenarios can one gain the confidence to avoid pitfalls and contribute to optimal patient outcomes.

Conclusions
A thorough understanding of the sensorimotor system can improve diagnostic accuracy at cross-sectional imaging in daily practice and improve neurosurgical outcomes in the setting of functional brain mapping. Increased utilization of presurgical brain mapping underlies the importance of understanding sensorimotor implications in brain mapping scenarios. A mastery of this material is a desirable standard for practicing neuroradiologists.
Simultaneous Multi-Slice (Slice Accelerated) Diffusion EPI

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Purpose
Simultaneous multi-slice (SMS) accelerated diffusion-weighted echo planar imaging employs an innovative acquisition and reconstruction scheme that allows multiple slices to be acquired simultaneously. The approach offers a substantial decrease in image acquisition time, or alternatively improved spatial/diffusion resolution. The advent of this technique is analogous to that of multi-slice 2D imaging, and as such may represent one of the major innovations in this decade with widespread clinical utility. This educational exhibit covers briefly the theory behind the approach, advantages and limitations, and applications in brain imaging using clinical source material.

Materials and Methods
Image acquisitions in both normal volunteers and patients are used to illustrate the breadth of capabilities, and current limitations, with simultaneous multi-slice diffusion EPI in brain imaging at 3T. Scan parameters were standardized for these comparisons, in order to highlight the differences due to acquisition technique. In this scan approach, multiple slices are acquired simultaneously using blipped CAIPIRINHA technique with the individual slices then reconstructed using a slice GRAPPA method. Slice acceleration with axial imaging, as applied, requires a phased array coil with sufficient elements in the z-direction, which in this instance was accomplished by use of a 32-channel head coil. Nine different scan techniques were compared, with single shot nonaccelerated and readout segmented EPI serving as reference standards.

Results
The SMS accelerated diffusion EPI sequence used in this study was evaluated with slice acceleration factors of 2 or 3. Using higher acceleration factors (4), a slight decrease in SNR was observed. The utility of SMS accelerated diffusion EPI is demonstrated both in neoplastic disease (with restricted diffusion in higher grade portions of a lesion) and ischemia, by allowing - with equivalent image quality - scan acquisition time to be shortened or slice thickness to be reduced. A SMS acceleration of 2 led to a scan time reduction from 1:23 (min:sec) to 0:50, with the required reference scan acquisition preventing a true factor of 2 reduction in scan time. Combining a SMS acceleration of 3 with a reduction in slice thickness, 2 mm sections through the entire brain could be acquired, with image quality (and SNR) comparable to the 4 mm single slice standard diffusion EPI acquisition. The scan time for this approach was 1:32, compared to 1:23 for the standard scan.

Conclusions
Simultaneous multi-slice accelerated imaging offers a marked reduction in the time required for data acquisition, with the approach to image acquisition and reconstruction explained in the current educational exhibit for DWI of the brain. In this specific application, thin section (2 mm) DWI of the entire brain can be acquired in a scan time and with image quality equivalent to 4 mm imaging with conventional single slice, single shot DWI. Applicability also exists relative to shortening the scan time of longer, higher image quality scans, such as readout segmented DWI.
Subtle Intracranial Critical Findings from a Level-1 Trauma Emergency Department that Should Not be Missed

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Purpose
- Show a variety of cases from our level-1 trauma emergency department that have subtle critical intracranial findings.
- Review relevant intracranial anatomy to correctly interpret imaging in an acute care setting.
- Apply strategies to help in interpreting head CTs and MRIs more accurately, focusing in easily missed diagnosis.

Materials and Methods
A series of cases from our level-1 trauma emergency department showing subtle critical intracranial findings will be presented as unknowns. The reader will be urged to detect the findings in a timely fashion before the image disappears. This approach not only will simulate the time constraints when reading in an emergent setting, but also will make it possible to show a wide variety of cases. Cases will include: subarachnoid hemorrhage, extra-axial hemorrhagic collections, intraventricular hemorrhage and acute infarcts, all presenting in subtle ways. Imaging modalities will include CT and MRI.

Results
When reading head CTs or MRIs from the emergency department the radiologist must have a systematic approach in order to be succinct, generate a valuable report, handle the busy radiology department and ultimately provide good patient care. One way to achieve this goal is to get familiar with different presentations of common cases from the emergency department such as subarachnoid and intraventricular hemorrhage, infarcts and extra-axial hemorrhagic collections. In this educational exhibit, the reader will be able to evaluate multiple cases in a timely fashion, simulating the environment when reading for a busy emergency department.

Conclusions
It is critical to detect subtle intracranial imaging findings that impact patient management. Being exposed to different presentations of common cases from the emergency department helps the radiologist to achieve this goal.
Purpose
Susceptibility-weighted phase imaging (SWPI) is generated from the previous acquisition of SW imaging processing after submitted to a filtering process. Deoxyhemoglobin and ferritin are paramagnetic in nature and produce strong susceptibility effects, while calcium is diamagnetic, showing a lower susceptibility effect than iron. The ferromagnetic properties of these two components can be exploited in order to differentiate small venous structures, blood breakdown products and iron accumulation from lesions with calcifications. Our purpose is to demonstrate how SWPI may differentiate these entities and its ability to reveal the existence of calcification without need for CT.
Materials and Methods
After reviewing our institution teaching files, we selected examples that aim to address how the phase shift induced by calcification is opposite to that found with paramagnetic substances like deoxyhemoglobin, methemoglobin, hemosiderin and ferritin, illustrating the clinical applications of SWPI, the conditions in which it is most useful, as well as, its limitations and artifacts.

Results
There are several conditions in which SWPI is a useful tool in clinical practice. The most relevant are the differentiation of microcalcifications from microbleeds from small vascular lesions and to identify the calcium components or bleeds in tumors, as well as, to improve the sensitivity of detection of subtle subarachnoid hemorrhage. However, it is important to be aware of its and artifacts with the most common being aliasing which limits the visualization of large calcified areas and hematomas as these appear surrounded by heterogeneous signal which masks the underlying entity.

Conclusions
We present the usefulness and limitations of SWPI demonstrating its potential as a powerful imaging tool in the detection, characterization and differentiation of paramagnetic and diamagnetic components in the brain.
Fig. 1 – Bilateral vestibular schwannomas. Axial Susceptibility-weighted Phase imaging showed multiple hypeintense intratumoral signals suggestive of microhemorrhage.

Fig. 2 – Meningioma. Axial Susceptibility-weighted Phase imaging showed multiple intratumoral signal suggestive of microcalcifications in the right frontal convexity.

Teaching Interpretation of CTA Using Full Scans in An ibook Presentation

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Purpose
Interpretation of CTA is difficult to teach using standard instruction media such as books because it is essential to display the entire stack of images in order to teach detection skills. The project examined the possibility of using an ibook format to create a useful teaching tool.

Materials and Methods
This ibook focus is on teaching interpretation of CTA of patients with aneurysms and AVMs. Jpeg image stacks from CTA scans that illustrate important teaching points were converted into movies and then imported into the ibook. Key images from the stack were illustrated using graphics that appeared in the movies. Interactive images also were used for static images to illustrate details of anatomy. Six chapters were created. These include chapters on basics of CTA, saccular aneurysms, identification of the dural ring, fusiform and pseudo aneurysms, CTA pitfalls, and artifacts.

Results
ibook is relatively new display format for books that is offered as free software to authors by Apple. While it does require some training to learn to use the ibook author software since it differs in significant ways from Powerpoint or Word, it is possible to acquire the necessary skills without classroom training using online advice and ebooks such as "Take Control of ibook Author". The ability to offer a free textbook with remarkable online accessibility offers a powerful tool for radiology education and should be integral to training residents and fellows to interpret cross-sectional imaging.

Conclusions
ibook is a very useful and free format that allows importation of full cross-sectional scans and wide access for teaching cross-sectional imaging skills.
Learn to Read CT Angiography

BY ALEX MAMOURIAN MD

(Filename: TCT_eEdE-47_ScreenShot2014-12-10at113401PM.png)
The Evolution of Intracranial Blood Products

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Purpose
A brief survey of residents and fellows at a large residency training program revealed that identifying different ages of blood products on computerized tomography (CT) and magnetic resonance imaging (MRI) has largely become an exercise in rote memorization and mnemonic use. As this has occurred, conceptual understanding of the basis for imaging characteristics of various stages of blood products has diminished. This electronic educational exhibit will provide an explanation of the natural evolution of intracranial blood products. The stages cellular components progress through and their corresponding CT image characteristics will be explained. Similarly, the stages of hemoglobin and its magnetically active byproducts will be explained along the effect exerted on MRI characteristics. Our aim is to improve the viewer's ability to critically examine an intracranial hemorrhage on both CT and MR imaging modalities and help them understand the factors responsible for the changing imaging characteristics in addition to accurately identifying hemorrhage age, particularly on MRI.

Materials and Methods
A retrospective review of images from a large tertiary referral center will be performed to obtain original CT and MR images for all stages of hemorrhage (from hyperacute to chronic). Additionally, a literature search will be performed to provide a strong scientific basis to explain the stages of intracranial hemorrhage and the corresponding imaging characteristics. Emphasis will be placed on the stages of cellular components and heme and their degradation products.

Results
After viewing this presentation, the viewer will have a better understanding of the underlying concepts explaining the varying imaging appearance of evolving blood products. They will be able to apply this knowledge to more accurately estimate hemorrhage age and decrease the reliance on mnemonic devices.

Conclusions
A fundamental understanding of the basic concepts underlying CT and MR image appearance of various stages of evolving blood products is valuable to every radiologist both clinically and academically.

The Evolving Landscape of Post-Therapy Brain Tumor Imaging

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Purpose
Advances in the treatment of brain gliomas have resulted in prolonged survival and better overall
patient outcomes, however new treatments also are resulting in new and complex radiological manifestations in the post-treatment setting. Accurate recognition and classification of post-treatment imaging patterns is critical for the optimization of clinical management decisions. The practicing neuroradiologist should be familiar with current concepts and imaging patterns in neuro-oncology.

Materials and Methods
In this educational exhibit, we review key concepts of brain tumor therapy and the general approach to post-treatment imaging. We begin with an overview of the current standard of care. We then introduce and define key concepts related to first-line brain tumor therapy including pseudoprogression, true tumor progression, and radiation necrosis. Illustrative case examples are presented to highlight important imaging appearances, with an emphasis on specific radiological features which inform clinical decision-making. The contribution of advanced imaging techniques such as MR perfusion, diffusion-weighted imaging, MR spectroscopy, and positron emission tomography in this setting is addressed. Modern consensus criteria for evaluating brain tumor progression (RANO criteria) are introduced and reviewed, with emphasis on key differences and advantages over the McDonald criteria. Subsequently, we introduce and define key concepts related to second-line brain tumor therapy, including the principles of antiangiogenic therapy and the radiological features of pseudoresponse. Finally, we provide an overview of emerging and experimental brain tumor therapies, using illustrative case examples to demonstrate new and never-before-seen imaging appearances.

Results
In general, the differentiation of tumor progression from treatment effects requires the integration of clinical, radiological, and molecular data. Therefore, optimal care requires a multidisciplinary team-based approach with input from radiologists, neurosurgeons, radiation oncologists, neuropathologists, and neuro-oncologists. Radiologists can provide invaluable contributions by identifying and communicating specific radiological manifestations which help differentiate the underlying pathologic process.

Conclusions
Ongoing advances in brain tumor therapy are changing the landscape of post-treatment brain tumor imaging. A multiparametric imaging approach integrating advanced neuroimaging techniques has shown promise for improved characterization of post-treatment imaging patterns, however this remains an active area of research and will likely require more prospective testing as well as standardized quantitation. The practicing neuroradiologist should be aware of current concepts in brain tumor treatment and brain tumor imaging to optimize patient care.
eEdE-46

The Many Faces of Posterior Reversible Encephalopathy Syndrome

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Purpose
Posterior reversible encephalopathy syndrome (PRES) is a radioclinical entity associating nonspecific neurological symptoms (headache, seizures, impairment of alertness, visual disturbances...) occurring in evocative clinical condition (hypertension, eclampsia, immunosuppressor agents, systemic lupus erythematosus...). In the acute stage, the typical imaging finding is a vasogenic edema predominant in the subcortical parietal-occipital white matter (1). The purpose of this pictorial review is to illustrate the atypical presentations of PRES and present key radiological elements to assert diagnosis.

Materials and Methods
We selected interesting imaging findings of PRES among patients explored in our institution between 2009 and 2014. These cases are presented in order to highlight the useful elements for radiological diagnosis. Clinical context and evolution are reported for each case.

Results
Vasogenic edema in the subcortical parietal-occipital white matter was the most common finding. We also observed, edema in the frontal regions, basal ganglia, corpus callosum, brainstem and cerebellum. Lesions could be asymmetric or unilateral (1). Edema was typically vasogenic but patients presented with cytotoxic lesions (1). Intracranial hemorrhages (microhemorrhage, subarachnoid hemorrhage or intraparenchymal hematoma) (2) could be associated. Gyriform contrast enhancement, in relation to the disruption of the blood-brain barrier (3) and leptomeningeal enhancement (4) were observed. Imaging abnormalities usually were reversible after treatment of the causative agent, regardless of the diffusion abnormalities.

Conclusions
Atypical imaging presentation should not reject the diagnosis of PRES in the appropriate clinical situation. A good knowledge of various aspects of PRES allows the radiologist to consider this diagnosis.
The Many Faces of Primary Central Nervous System Lymphoma

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Purpose
To illustrate a wide range of radiological features of primary central nervous system lymphoma (PCNSL), with companion cases to pinpoint other diseases with similar presentation and diagnostic pitfalls.

Materials and Methods
We present a case series of five patients with biopsy-proven PCNSL who demonstrated a wide spectrum of radiological and clinical presentations. Ten companion cases are included to show various entities that PCNSL can mimic and pinpoint pitfalls in differential diagnosis. Clinical presentation, imaging, and pathology reports from 15 patients presenting to an urban tertiary care center were reviewed (11 females and 4 males; 21-87 years old). CT, MRI and MR perfusion and spectroscopy images from the patients are presented for the purpose of this exhibit.

Results
Primary central nervous system lymphoma (PCNSL), a rare extra-nodal non-Hodgkin's lymphoma, dramatically increased in incidence throughout the 1980s and early 1990s (1) followed by a plateau and decrease during the latter half of 1990s (2). Its clinical presentation is characterized by nonspecific neuro-psychologic symptomatology and typically does not present with the characteristic B-symptoms of systemic lymphoma (3). Neuroimaging and histopathology therefore play an important role in the diagnosis. The radiologic features of PCNSL can overlap with other disease processes including infections (toxoplasmosis, tuberculosis, abscess), tumefactive demyelination and primary and metastatic neoplasms. This exhibit illustrates the common and unusual clinical and radiologic presentations of PCNSL and other entities with similar neuroimaging features to provide a focused approach to the diagnosis.

Conclusions
Primary central nervous system lymphoma can have unusual presentations and mimic other disease entities. This knowledge helps to provide a clinically useful differential diagnosis and guide management.
eEdE-41

The Many Presentations of Reversible Cerebral Vasoconstriction Syndrome (RCVS), A Great Masquerader.

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Purpose
Reversible cerebral vasoconstriction syndrome (RCVS), a transient disorder of cerebral arterial auto regulation, can have a myriad of clinical presentations and may mimic aneurysm rupture, stroke, migraine and posterior reversible encephalopathy syndrome. The initial imaging can show a variety of findings, many of which are seen in other processes as well. The underlying and often subtle findings on vascular and parenchymal imaging can be difficult to piece together, especially when the entity is not a differential consideration in the search pattern. Our aim is to describe the entity of RCVS and demonstrate the common and uncommon imaging findings seen on CT, MRI, CT angiography and conventional digital subtraction arteriogram.
Materials and Methods
A multimodality pictorial review of cases from our institution is presented, which includes findings seen on noncontrast head CT, CT angiogram, MRI, MR angiogram and conventional digital subtraction arteriogram. Diagnosis of RCVS was confirmed by imaging demonstration of reversibility of arterial constriction.

Results
The findings in confirmed cases of RCVS, include indirect signs such as transient cerebral edema, convexal subarachnoid hemorrhage, intraparenchymal hemorrhage and cerebral infarction. Direct signs of single or multivessel arterial spasm can be seen on CTA and confirmed on catheter angiogram. The arterial spasm is reversed after systemic or intrarterial administration of calcium channel blocker. Mimics of RCVS consists of conditions such as diffuse atherosclerotic arterial narrowing, vasculitis, posterior reversible encephalopathy, cerebral edema secondary to venous congestion and vasospasm secondary to aneurysmal subarachnoid hemorrhage.

Conclusions
Multiple imaging findings of RCVS are shown in different imaging modalities. Familiarity of radiologist with the imaging findings of this entity is of critical importance to direct appropriate and timely clinical management. Atypical subarachnoid hemorrhage, unexplained cerebral edema and hemorrhage, as well as single or multivessel diffuse narrowing with a relatively normal appearing brain should raise suspicion of RCVS.

The value of high resolution CT images in the evaluation of skull fractures

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Purpose
To demonstrate how reliable high resolution CT images in depicting occult skull fractures not seen but suspected on the standard 5 mm thick brain CT images.

Materials and Methods
In this pictorial, we intend to compare between the standard 5 mm thick CT images and the reconstructed high resolution CT images of the skull bones to visualize occult fractures according to our clinical encounter. The request to reconstruct high resolution CT images is based on the indirect radiological findings seen on the standard 5 mm thick images such as soft tissue swelling, presence of fluid in the mastoid air cells and nasal cavities as well as small epidural hematomas and unexplained small air bubbles/pneumocephalus.

Results
Traumatic head injuries can result in serious morbidities and mortalities. Cross-sectional imaging such as CT scan is an important diagnostic tool in the assessment for head injuries including skull fractures. In our institution, all head examinations requested by emergency physicians will be performed using GE Lightspeed 64 scanner and the routine unenhanced CT protocol which includes 5mm axial images along with 3mm coronal and sagittal reformats in both soft tissue and bone windows. After reviewing the images and a suspicion of underlying fracture is made, reconstructed high resolution images of 0.625 mm in all three planes will be performed. Based
on our observations, the high resolution CT images made a difference in confirming the doubts of undetectable fractures on the initial 5mm thick images. A collection of cases comparing the standard and the high resolution images including the indirect traumatic radiological signs will be shown through this pictorial.

Conclusions
High resolution CT images confirm the presence of skull fractures that are undetectable with the standard thick images.

eEdE-04

This Is Your Brain, On Drugs.

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Purpose
This electronic educational exhibit is a case-based overview of central nervous system (CNS) abnormalities induced by the administration of various pharmaceutical agents, as well as recreational drug use.

Materials and Methods
Case-based overview demonstrating the imaging abnormalities associated with various drug agents, including anti-epileptics, antibiotics, antineoplastic agents, immunosuppressants, and analgesics. A review of the mechanisms and indications for each agent will be presented in addition to the imaging findings.

Results
MR imaging signal abnormalities associated with various pharmaceutical agents occasionally are encountered, particularly in the inpatient setting, and if unrecognized can confound diagnosis of primary CNS abnormalities. Furthermore, the clinical symptoms and imaging abnormalities associated with various drugs often are reversible after cessation of the offending agent. An understanding of the adverse effects of these medications, as well as their mechanisms and intended use, is an important part of a neuroradiologist's knowledge base.

Conclusions
The CNS imaging abnormalities induced by various pharmaceutical agents often are witnessed in patients with significant morbid disease, and can in some cases exacerbate their clinical situation. If unrecognized, they can lead to misdiagnosis or suboptimal management. Comprehensive knowledge on this topic is an important factor in the role neuroradiologists can play in the clinical arena.

eEdE-20

Tracing the Thalamo-Limbic Connections of the Human Brain Using High Spatial Resolution Diffusion Tensor Tractography on 3T.

A Kamali¹, R Riascos-Castaneda², S Jasti¹, S Mirbagheri³, K Hasan⁴
Purpose
The purpose of the current study is to demonstrate the feasibility of parcellation and quantification of major thalamo-limbic connections of the human brain noninvasively using fiber tractography by deterministic approach and high spatial resolution diffusion tensor imaging (DTI) data on 3T.

Materials and Methods
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 3.0T 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
Thalamo-limbic connections of the human brain have a fundamental role in the limbic circuitry. Lack of adequate neuroimaging sensitivity and spatial resolution, so far, impeded depiction of small limbic structures such as the thalamo-limbic connections such as the amygdalothalamic and mammillothalamic pathways within the human brain. Diffusion tensor tractography of white matter connections between the deep gray matter structures is challenged by the signal-to-noise ratio (SNR) due to overestimation of anisotropy at low SNR and partial volume averaging upon using large voxel volumes. To overcome these problems, recent DTI tractography studies have used 7T and 9T scanners for visualizing the neuronal fiber trajectories in primate central nervous system. To our knowledge, the current study is the first to present the major thalamo-limbic connections of the human brain using high spatial resolution DTI measurements on 3T. The thalamoamygdaloid tract and the mammillothalamic tract are clearly distinguishable in relation to the amygdala, thalamus, and hippocampus nuclei. Using high spatial resolution specially reduced slice thickness (1mm) in this study reduced the partial volume effect as well as incoherency due to the fiber crossing within each voxel and we were able to reconstruct these fine limbic trajectories of the human brain. 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 amygdala and thalamic nuclei.

Conclusions
In this report we demonstrate for the first time, in vivo 3D reconstruction of the major thalamo-limbic connections using high resolution diffusion tensor tractography on 3T.
**Figure 1.** 3D reconstruction of amygdalo-thalamic tract (pink) and the amygdalofugal tract (red)

(Filename: TCT_eEdE-20_Imagesofthalamolimbic-1.gif)
Figure 2. a and b, 3d reconstruction of the amygdalothalamic tract (light blue). C, cingulum (green), fornix (dark blue) on T1-W and color-DTI images.
Figure 3. 3D reconstruction of limbic pathway map. Fornix (yellow), and stria terminalis (amygdalofugal tract (pink) and anterior commissure (red), uncinate fasciculus (green))

(Filename: TCT_eEdE-20_Imagesofthalamolimbic-3.gif)

eEdE-06

Unforgettable images: A multimodality pictorial review of dementia

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Purpose
Dementia refers to the deterioration in memory, thinking, language, judgement and behavior. Differentiating one type of dementia from another is a clinical challenge. The purpose of this exhibit is to help radiologists recognize characteristic imaging patterns that may be unique to a particular dementia, which can help guide clinicians to make the correct diagnosis. Anatomical imaging with computed tomography (CT) or magnetic resonance imaging (MRI) is usually the initial imaging modality for the work up of dementia, although functional neuroimaging techniques, including single positron emission computed tomography (SPECT) and positron emission tomography (PET), may document the earliest manifestations of dementia pathology.

Materials and Methods
All images are gathered from Baystate Health System. The exhibit will review the characteristic imaging features and compare and contrast different anatomical and functional neuroimaging modalities for the evaluation of dementia. Each case will include a brief history/clinical presentation and will highlight the relevant neuroanatomy and pathology, discuss important imaging findings and identify potential diagnostic pitfalls.

Results
Common causes of dementia include Alzheimer disease (AD), Frontotemporal dementia (FTD), Lewy Body dementia (LBD), Parkinson disease (PD) and Multi-infarct dementia (MID). Structural imaging is used to rule out treatable causes for the patient's symptoms or suggest the presence of comorbidities that may exacerbate dementia symptoms. The findings can be very nonspecific and include cerebral atrophy, evidence of cerebral disease, microhemorrhages, and ventriculomegaly. Functional imaging techniques with SPECT and PET can provide more specific patterns of pathology, looking at regional hypoperfusion and hypometabolism, respectively. The classic appearance of AD is symmetric decrease in the posterior temporoparietal lobes. Frontotemporal dementia may show decreased uptake in the frontal and temporal lobes. Lewy Body dementia and PD may look like AD, but also will show occipital lobe involvement. Multi-infarct dementia/vascular dementia can show scattered cortical defects or decreased uptake in major vascular territories. Amyloid imaging with PET radiotracers such as with F18-Florbetapir (Amyvid), can evaluate for AD by assessing the degree of beta amyloid plaque. Other molecular imaging techniques such as I-123 Ioflupane (DaT scan), can evaluate for PD and LBD by assessing for dopaminergic deficits in the striatum.

Conclusions
Often structural changes depicted on CT and MRI are preceded by changes in cerebral blood flow and metabolism. Patterns of hypoperfusion and hypometabolism may be more specific for one form of dementia versus another. Molecular imaging techniques can identify specific biomarkers, such as beta amyloid plaque deposition or dopaminergic deficit, which can help differentiate between certain dementia types. As there is an increasing reliance on neuroimaging as part of a comprehensive evaluation of dementia, it is important that the interpreting radiologist recognizes common patterns and imaging characteristics to suggest the correct diagnosis.
Figure 1(A-D). Alzheimer’s Disease. Axial FLAIR MRI (A) and axial CT (B) demonstrating bilateral temporal lobe atrophy. (C) F-18 FDG PET demonstrating hypometabolism in bilateral temporal and parietal regions, with sparing of the occipital lobes. (D) F-18 Florbetapir PET scan demonstrating marked cortical uptake in addition to the nonspecific binding of the radiotracer.
Unraveling the Fornix and Stria Terminalis Connections of the Human Brain

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\textsuperscript{1}Johns Hopkins University, Baltimore, MD, \textsuperscript{2}Johns Hopkins Hospital, Baltimore, MD, \textsuperscript{3}Johns Hopkins Medicine, Baltimore, MD, \textsuperscript{4}UMDNJ Cooper University Hospital, Camden, NJ, \textsuperscript{5}Johns Hopkins University Hospital, Baltimore, MD, \textsuperscript{6}University of Texas Health Science Center-Houston, Houston, TX, \textsuperscript{7}the University of Texas Medical School at Houston, Houston, TX

Purpose

In the current study we demonstrate for the first time the tractography of major 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 3T.

Materials and Methods

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 3.0T 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\textsuperscript{-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 major limbic structures using high spatial resolution DTI tractography on 3T. The fornix and stria terminalis are the central limbic connections 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 the stria terminalis. The fornix and stria terminalis tracts are clearly distinguishable in relation to the amygdala, hypothalamus, and hippocampus nuclei. Using high spatial resolution especially reduced slice thickness (1mm) in this study, reduced the partial volume effect as well as incoherency due to the fiber crossing within each voxel, and we were able to reconstruct and show even the small limbic trajectories 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 amygdala nuclei.

Conclusions

In this report we demonstrate for the first time, in vivo 3D reconstruction of the major limbic circuits using high spatial resolution diffusion tensor tractography on 3T.
Results

Figure 1. 3D superior View of limbic pathways on T1 W map. Cingulum (green), and fornix (blue)
Figure 2. 3D view of limbic pathways T1 W map. Fornix (yellow), and stria terminalis (black)
Figure 3. 3D superior View of fornix (yellow), and stria terminalis (black)

Utility of Image-based Diagnostic Algorithm in Evaluating Sellar Region Pathology: Case-Based Review

A Chaudhry¹, R Gupta², L Woroch³, A Filatov⁴, R Peyster², L Bangiyev²

¹ [Department or Institution] ² [Department or Institution] ³ [Department or Institution] ⁴ [Department or Institution]
Purpose
Sellar region pathology is relatively common and has a broad differential diagnosis. A systematic approach therefore is required in narrowing the differential for various sellar region lesions. It is important to consider not only the pertinent imaging findings, but also the patient's demographics and available history in order to improve diagnosis accuracy. The purpose of this educational exhibit is to present an algorithmic approach to sellar region lesions with emphasis on patient clinicopathologic findings and imaging features.

Materials and Methods

- Review anatomy of the sella and parasellar regions.
- Case-based review of sellar and parasellar pathology highlighting key imaging findings that would narrow the differential diagnosis.
- Diagnostic algorithm can assist in navigation and interpretation of sellar pathology.

Results
Lesions in the sellar and pararasellar region frequently are encountered in clinical neuroradiology. Complex anatomy of this region contains numerous key structures which can be affected by various pathology. Although 'SATCHMO', a commonly used mnemonic, may help remember differentials, due to overlap in imaging findings, it has limited diagnostic utility. This educational exhibit presents a case-based review utilizing age, gender, anatomical location, imaging characteristics, etc. to formulate an algorithm that will aid in more precise diagnosis of regional pathology. In addition, treatment, prognosis and follow-up guidelines will be discussed briefly.

Conclusions
A systematic approach is required to narrow the differential diagnosis of sellar and parasellar lesions. At completion of this educational exhibit, the viewer will be able to provide more accurate assessment of regional pathology, guide any potential biopsy and appropriate follow up.
Invasive Pituitary Adenoma

- Clival invasion is rare but potentially significant complication of pituitary macroadenoma.
- Difficult to detect on MR imaging, easily seen on CT.
- Risk factor for clival invasion:
  - Female sex
  - Large tumor volume
  - Null-cell subtype
  - Larger tumors correlated with null-cell subtype, incidence of clival invasion, and extent of invasion.
- Associated with a significantly higher ratio of operative complications and mortality.

Volumetric Resonance Imaging Evaluation: New Horizons

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Purpose
To prepare an educational exhibit on the workflow for volumetric MRI quantification in patients with Alzheimer dementia, multiple sclerosis and in medically intractable epilepsy.

Materials and Methods
The information will be presented in an interactive teaching module that explains the workflow for volumetric quantification of hippocampal volume and whole brain volume in Alzheimer disease, whole brain volume in patients with multiple sclerosis (MS) and cortical thickening analysis in pediatric patients to identify epileptogenic foci such as focal cortical dysplasia, polymicrogyria, etc. This project has progressed temporally, starting with MS patients and gradually incorporating Alzheimer disease and pediatric epilepsy patients. To produce the volumetric data, MR scans are anonymized and moved to the Radiology Department supercomputer for parcelation and segmentation via the FreeSurfer software suit. Whole brain, gray matter, and white matter volume are calculated and normalized via a comparison of subject intracranial volume to intracranial volume of a supernormal cohort. After normalization, the large ROIs are compared to a loess regression weighted against age generated with the supernormal cohort. Standard deviations and percentiles of specific subjects are calculated from the aforementioned loess regression. For volumetric maps, MR scans are anonymized and moved to the Radiology Department supercomputer for parcelation and segmentation via the FreeSurfer software suit. Thickness values for each vertex on the pial layer are extracted from FreeSurfer assessor files, and not normalized against the supernormal group. A weighted loess regression is generated for every vertex in the FreeSurfer surface using the supernormal data set, and the z-score (number of standard deviations away from the mean) is calculated for the vertices of a subject's surface. The z-score then is mapped to the individuals brain and displayed. To date, there are 177 patients with MS volumetry analysis, 94 patients with hippocampal volumetry analysis and a cohort of between 30-40 pediatric patients ready for cortical volume analysis.

Results
Tools that more accurately diagnose early manifestations of Alzheimer disease, such as hippocampal and whole brain volumetry, are critical in patient management. Likewise, evaluation of general cortical atrophy in multiple sclerosis patients can identify subjects that present with subtle or no clinical symptoms, but that could benefit from early aggressive symptons if they demonstrate quantifiable and progressive brain volume loss. Finally, surgical excision of epileptogenic lesions results in marked improvement to complete resolution of epileptic episodes. A color-coded volumetric map that easily can demarcate abnormal cortical areas would have a significant impact on patient management and outcomes.

Conclusions
Volumetric MRI analysis is a powerful tool that improves diagnostic accuracy, and in the case of Alzheimer disease, multiple sclerosis and epilepsy, it can be used for longitudinal evaluation of disease progression and for identification of pathology.
Participant who was first imaged at the age of 63, and was at that time, cognitively normal. Over the course of 5 years, he had 3 imaging visits, with serial decreases in hippocampal volume. By age 68, his hippocampal volume was below the 5th percentile and at that time was given a diagnosis of Alzheimer’s dementia.
52 year-old female with relapsing remitting MS currently on Aubagio. Visual evaluation on anatomical MR not strikingly abnormal. However, patient has advanced symptoms, unable to walk without assistance of a walker. Whole brain volume in the 2nd percentile for age.
What radiologists should know about brain death: Radiologic signs of a nonradiologic diagnosis

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Purpose
Brain death is a clinical diagnosis which can sometimes be difficult to make. Early diagnosis is important to expedite organ transplantation, provide closure for loved ones, and prevent unnecessary negative medical interventions. Radiologists can play an important role in recognizing and expediting the diagnosis. This educational exhibit will review the pathophysiology, pathology, and demonstrate the utility of multimodal imaging findings in the diagnosis of brain death.

Materials and Methods
The clinical diagnosis and pathophysiology of brain death will be reviewed. Characteristic findings of brain death will be reviewed with imaging modalities including transcranial Doppler (TCD), cerebral angiography and scintigraphy, CT, CTA, CT perfusion, MRI and MRA. Gross pathology and histopathology slides will show the radiopathologic correlation of brain death.

Results
Brain death is the sequelae of massive, irreversible brain injury initiating complex molecular
mechanisms that eventually lead to cerebral edema and cessation of intracranial flow. Electroencephalogram (EEG), TCD, cerebral angiography and scintigraphy are approved ancillary tests for the diagnosis. However, other modalities have been shown to correlate with brain death, and these findings must be recognized by the radiologist. CT and MRI show diffuse brain edema and transtentorial herniation. Diffusion-weighted imaging (DWI) demonstrates prominent diffusion restriction which pathologically represents cytotoxic edema in all cellular structures. Susceptibility-weighted imaging (SWI) shows prominent dark cerebral veins. MR angiography (MRA) and CTA demonstrate the absence of intracranial flow as conventional angiogram. CT perfusion (CTP) demonstrates diffusely decreased cerebral blood volume and cerebral blood flow.

Conclusions

Brain death is a clinical diagnosis, however the diagnosis is not always clear. The radiologist can play an important role in reaching the diagnosis and must be aware of the imaging findings characteristic of brain death.
“Life Cycle of a Glioma” - From a Molecular Genomic Perspective

M Nagarajan\textsuperscript{1}, R Gaddikeri\textsuperscript{1}, K Sharbidre\textsuperscript{1}, M Jhaveri\textsuperscript{1}, A Srinivasan\textsuperscript{2}

\textsuperscript{1}Rush University Medical Center, Chicago, IL, \textsuperscript{2}University of Michigan, Ann Arbor, MI
Purpose
1. To discuss key genomic and epigenetic signatures which occur during various stages of development of a glioma. 2. To review specific anatomical and physiologic MRI features associated with various genetic alterations. 3. To highlight the clinical impact of the MRI findings in management of gliomas.

Materials and Methods
Various genetic alterations that occur during different phases of a glioma are discussed. Impact of these genetic alterations on the behavior of the gliomas and the associated MRI features are illustrated. Clinical impact of such imaging features is explored.

Results
1. Overview of genetic alterations such as specific mutations, deletions and gene upregulations which occur during inception, growth and transformation of gliomas with emphasis on high grade gliomas. 2. Importance of prognostic and predictive biomarkers such as MGMT hypermethylation, EGFR overexpression, 1p/19q deletion, IDH1/IDH2 mutation, etc. 3. Correlation with MRI findings such as contrast enhancement, necrosis, infiltration, diffusivity, etc. as well as with MR perfusion. 4. Impact of MRI in management such as accurate surgical targeting of aggressive areas, decision on type of treatment - radiotherapy, chemotherapy, specific antibodies, vaccine, etc. and assessment of treatment response.

Conclusions
1. Characteristic genetic alterations occur during the lifespan of a glioma and many of these are associated with specific MRI features. 2. MR imaging can act as a surrogate for prognostic and predictive biomarkers and thus can play a critical role in management of gliomas.

eEdE-11
6:30AM - 3:00PM

“The expected and unexpected”-Initial experiences in a de novo fMRI program

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Purpose
Functional MRI (fMRI) is an effective tool to detect cortical activation of eloquent areas in the brain such as motor and language regions using the principle of BOLD contrast imaging. There are, however, instances where the activation of eloquent regions produced by a common paradigm does not match expectations. The purpose of this exhibit is to review unexpected patterns of BOLD activation due to patient challenges, variant or asymmetric anatomy, and to demonstrate the utility of fMRI in surgical planning for tumor resection or biopsy in a de novo fMRI program.

Materials and Methods
Retrospective review of fMRI and brain MRI examinations was performed for pre-operative planning at a tertiary referral center with a de novo fMRI program. Expected and unexpected patterns of activation were demonstrated. We will present cases focusing on language and motor paradigms with appropriate cortical activation, faint/absent language activation in an illiterate, non-English speaking patient and right-sided Broca/Wernicke area activation. Shared examples
will address discerning Broca’s area from tongue motor activation, bilateral Broca/Wernicke area 
activation, two dominant areas of Broca activation, asymmetric motor activation (toe motion), 
and motor cortex lesion effects.

Results
Although fMRI can be helpful to identify eloquent areas of motor and language cortex in 
compliant patients for pre-operative planning for tumor resection, epilepsy surgery and treatment 
of vascular malformations, there are occasions when unexpected patterns of activation may be 
encountered. While initially confounding these may ultimately be within the realm of normal 
anatomical variation.

Conclusions
Our exhibit demonstrates initially misleading variants of cortical activation that may be 
encountered, and should be recognized correctly by the neuroradiologist to assist in pre-operative 
planning.

Monday
6:30AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exp Hall A (Level 1)-2

Electronic Educational Exhibit (eEdE) - Head & Neck
eEdE-103

A 3 Dimensional Clinicoanatomic Atlas of the Six Important nerves of the Cervicothoracic 
Continuum

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Purpose
Patients with lesions in the apex of the lung often undergo unnecessary imaging and surgeries on 
the shoulder and cervical spine. Therefore, it is important to demonstrate the anatomical basis for 
the clinical presentations of lesions that damage one or more of the six nerves, which traverse the 
base of the neck and the apex of the chest.

Materials and Methods
The nerves of the cervicothoracic continuum were divided by location into six numbered 
compartments. Each of them are shown in the accompanying axial postoperative contrast- 
enhanced CT of a left-sided symptomatic Pancoast tumor.

Results
Tumor extension into the anteromedial compartment (1) damaged the recurrent laryngeal nerve 
(a branch of the vagus) and paralyzed the ipsilateral vocal cord causing hoarseness, bovine cough 
and dysphonia. Tumor in the posteromedial compartment (2) damaged the sympathetic chain and 
produced an ipsilateral Horner syndrome. Tumor involving the spinal nerve compartment (3) of 
the cervical plexus produced ipsilateral root-specific motor/reflex and/or dermatomal sensory 
changes. Tumor extension into the compartments below each rib (4) damaged intercostal nerves 
and resulted in a strip of numbness below each rib. Tumor in the anterolateral compartment (5),
which is located around the brachial vessels, caused a peripheral neuropathy that was mistaken for lesion in the shoulder. Tumor in the anterior compartment (6) damaged the phrenic nerve, which caused an ipsilateral elevation of the paralyzed diaphragm.

Conclusions
Knowledge of location and symptoms of the six nerves of the cervicothoracic continuum can prevent unnecessary and costly imaging and/or surgery on the shoulder and cervical spine.

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eEdE-106

Achieving Clear Vision: A Case Based Review of Pathologies Along the Visual Pathway

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Purpose
The ophthalmologic exam and patient symptoms often localize visual pathway pathology to a
specific location. For the interpreting radiologist to correctly protocol a study and tailor a
differential diagnosis, he/she needs a basic understanding of the ophthalmologist's note and the
patient's clinical symptoms. The goal of this case-based exhibit is to review the complex
anatomy of the visual pathway, clinical and ophthalmology findings, and focus on the radiologic
differential diagnoses in each anatomical area.

Materials and Methods
In this exhibit, we have divided the visual pathway into the following segments: globe, optic
nerve, optic chiasm, optic tracts, optic radiations, occipital cortex, brainstem nuclei, and
extraocular muscle cranial nerves. Readers first will analyze the clinical presentations such as
afferent pupillary defect, visual field deficits, Parinaud's syndrome, 1 ½ and 8 ½ syndromes, and
trochlear nerve palsy, etc. After deciding upon the appropriate imaging protocol, readers will
learn to focus on different pathologies occurring along the visual pathways: for example, cranial
nerve schwannoma, osseous lesions, stroke, and surgical complications. This quiz format will
highlight the appropriate protocol for particular clinical symptom(s) and the key imaging
features.

Results
It is estimated that a single human retina transmits information to the brain at the speed of an
Ethernet connection (1). Couple this astounding amount of information with the highly complex
interworkings of the globes, optic pathways, cranial nerves, brainstem reflexes, sympathetic and
parasympathetic nervous systems, smooth and skeletal muscle, and vascular system and it
becomes readily apparent how even the most minor of derangements in any one of these areas
can manifest clinically, often times dramatically so. Each case presented illustrates the
correlation between lesion location, clinical presentation, and imaging findings in order to
understand and simplify this complex anatomy.

Conclusions
Visual disturbances, cranial nerve palsies, and the findings documented from the
ophthalmologist's exam can lend significant diagnostic value to the radiologist with a good
understanding of these pathways. Without this knowledge, radiologists may fail to see subtle
lesions simply because they do not know "where to look." In this project we explore this
complex anatomy, through radiological illustration of discrete lesion location in specific clinical
presentations. In maintaining a connection between the clinical presentation of the patient and a
basic understanding of the anatomy of vision, radiologists can better help our patients, assist our
fellow clinicians, and maintain our value as members of this particular healthcare team.

eEdE-132

6:30AM - 3:00PM

Aggressive Sinonasal Malignancies (ASNM): Pathologic Basis of Imaging Findings &
Treatment Implications

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Houston, TX, 3University of Texas Houston Department of Pathology, Houston, TX, 4Michael E.
DeBakey VA Medical Center, Houston, TX.
Purpose
Sinonasal malignancies are entities with heterogeneous and distinct histologic features. The theme of this presentation is focused on aggressive sinonasal malignancies (ASNM), in an attempt to elucidate the histopathologic basis of their imaging findings and biologic behavior. Furthermore, the implications of imaging features and histopathology on the treatment approach for each unique case are presented.

Materials and Methods
A clinical case-based approach illustrating the histopathologic basis of imaging findings is undertaken, specifically how these may impact treatment decisions.

Results
In our clinical practice, plasmablastic lymphoma, natural killer T-cell lymphoma, high grade neuroendocrine neoplasm, sinonasal undifferentiated carcinoma (SNUC), and rhabdomyosarcoma are just a few examples of sinonasal malignancies with aggressive biologic behavior. While these are heterogeneous with varying histopathology, most share the common denominator of a dismal outcome.

Conclusions
A solid understanding of histopathology aids in the imaging analysis of ASNM. Imaging features and histopathology both impact treatment strategy.
An Imaging Review of Postoperative Complications of Skull Base Surgery

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Purpose
To review the imaging features of complications following skull base surgery - anterior, middle and posterior cranial fossa.

Materials and Methods
This review focuses on the imaging appearances of various complications of skull base surgery, both traditional neurosurgical as well as minimally invasive endoscopic techniques.

Results
Skull base surgery has evolved over the years and surgeons are treating more complex conditions that previously would not have been treated employing newer techniques. Imaging plays an important role in evaluation of complications that arise during these complex surgical procedures. These can be categorized into perioperative, subacute and delayed. The perioperative complications discussed are vascular injury, neural injury and CSF leak. The subacute complications include CSF leak, intracranial hypotension, infections, venous sinus thrombosis and migration of bone wax or fat packing. The late complications include development of meningoencephalocoele, loculated posterior fossa collections and delayed infection. CT and MRI are complementary in the evaluation of skull base. Vascular imaging is essential for evaluation of vascular injury.

Conclusions
Imaging plays an important role in the assessment of postoperative skull base. This exhibit is a comprehensive review of the imaging appearances of various complications of skull base surgery.

CT Venogram images show low density filling defect (arrow) in the sigmoid sinus extending into the jugular bulb following retrosigmoid approach to posterior fossa craniotomy. The attenuation of the filling defect was that of fat, in keeping with migrated bone wax.

(Filename: TCT_eEdE-128_Picture1.jpg)
Atlas-guided 4DCT detection and classification of parathyroid adenomas

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Purpose
The purpose of this communication is to familiarize the reader with the precise location of parathyroid adenomas on 4DCT (multiphase computed tomography) and the landmarks that surgeons use to find and classify them.

Materials and Methods
The 4DCT scans and surgical reports were reviewed in 100 cases of parathyroid tumors. The cases were sorted by location and size at surgery and on imaging. The cases were grouped into seven surgical classifications (A-G) by an experienced neuroradiologist based on 4DCT imaging findings. 4DCT images were superimposed on deformable anatomical atlas accompanied with detailed descriptive text and three-dimensional depiction of parathyroid adenoma relative to adjacent vital structures such as thyroid gland. Landmarks like thyrothymic ligament and recurrent laryngeal nerve were added to the anatomical atlas and helps guide the radiologist to visualize these structures. In addition, it aids the surgeon in pre-operative planning and prevent accidental injury to the recurrent laryngeal nerve.

Results
Image-based atlas superimposed on 4DCT and 3D visualization of the neck and parathyroid adenomas help pre-operative surgical planning and help surgical classification of parathyroid adenomas. Landmarks like thyrothymic ligament and recurrent laryngeal nerve that are added to the anatomical atlas help guide the radiologist to visualize these structures. It also aids the surgeon in pre-operative planning and prevent accidental injury to the recurrent laryngeal nerve.

Conclusions
The information presented in this atlas format can be used to improve the surgical planning of parathyroid adenoma.

Brain Herniation into an Arachnoid Granulation: an Uncommon Entity with Variable Clinical and Radiographic Manifestations

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Purpose
Arachnoid granulations are invaginations of the arachnoid membrane that extend through gaps in the dura, protruding into the dural venous sinuses and occasionally the bone. Spontaneous herniation of brain parenchyma also can occur through these invaginations, but there are very few reports and little analysis of this in the current literature. We present seven cases of patients
with brain herniation into an arachnoid granulation, illustrating the variability in location, appearance, and clinical presentation.

Materials and Methods
Seven cases of brain herniation into an arachnoid granulation were identified on MRI, one case confirmed by pathology. Clinical records were reviewed in an attempt to identify the presence or absence of symptoms attributed to this finding.

Results
Six cases involved herniation of the cerebellum, either into the transverse sinus, posterior temporal bone, torcula, or occipital bones. One involved herniation of the temporal lobe into the transverse sinus. No direct correlation was made between the symptoms and the presence of this finding in five of seven cases (57%). Two patients (29%) experienced symptoms of hearing loss, tinnitus, and CSF otorrhea, attributed to the location of the arachnoid granulations rather than the presence of brain herniation. However, one patient (14%) experienced diplopia and headache at the time of diagnosis, with focal signal abnormality and enhancement in the cerebellum adjacent to the herniated brain. These findings were thought to be related to transient incarceration and ischemia, with documented improvement on follow-up MRI examination.

Conclusions
Arachnoid granulations are very common, but herniation of brain parenchyma into an arachnoid granulation rarely is reported. While the majority of cases are likely incidental, the spectrum of symptomatic manifestation appears to be broad. It is important to recognize this entity to avert lack of recognition or confusion with other pathology.
Clinical Applications of Diffusion-Weighted Imaging in Skull base and Neck pathologies

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Purpose
Diffusion-weighted imaging (DWI) is an established MRI technique in neuroimaging. However, DWI has found increasing applications and interest in several areas of diagnostic dilemmas in the skull base and neck pathologies. Diffusion-weighted imaging in the evaluation of skull base and neck pathologies has lagged behind somewhat because of the technical limitations involved in imaging bone, air, and soft tissue interfaces. However, DWI with its inherent fat saturation enhances the conspicuity of the lesions with nulling of the fat and free water in the head and neck area. This study aims to review the various areas of DWI in skull base and neck pathologies and discuss the clinical applications.

Materials and Methods
Diffusion techniques: Single shot EPI DWI with two or three parallel imaging factors enables to acquire less distortion images. Saturation pads in the neck area also is useful to reduce the artifacts. New diffusion techniques including HASTE DWI, RESOLVE multishot DWI, BLADE DWI and reduced FOV DWI will be demonstrated. Clinical applications: Wide clinical applications of DWI in skull base and neck areas will be demonstrated. Its quantitative methods and pitfalls will be discussed. Imaging and pathologic correlations: various pathologies like cellularity, cytotoxic edema and extracellular space (matrix, necrosis, interstitial edema) helps to explain the diffusion behavior of various skull base and neck pathologies.

Results
Skull base lesions: DWI has shown characteristic features unique to various skull base lesions like epidermoid/dermoid/cholesteatoma, cholesterol granuloma, mucocele, abscesses, and benign or malignant lesions. Cholesteatomas: In follow-up imaging of postsurgical cases of cholesteatoma, DWI detects any residual or recurrent cholesteatoma as high signal lesion. Skull base and neck neoplasms: DWI plays an important role in differentiation of benign from malignant skull base and neck tumors and in differentiation of response from recurrence of tumor. Even in malignant tumors, it can sometimes differentiate squamous cell carcinoma from lymphoma based on ADC values. Benign and malignant lymph nodes: An important challenge in skull base and neck region is separating benign and malignant nodes and DWI contributes even further by differentiating lymphoma from squamous cell carcinoma. Sinus diseases: DWI is an added technique that provides quantitative values in differentiation of benign and malignant nasal and paranasal tumor. Infections: Quantitative diffusion techniques have found value in masticator and other head and neck space infections.

Conclusions
Diffusion-weighted imaging is an essential armamentarium in the various skull base and neck pathologies not only in tumors, but also in various non-neoplastic pathologic processes. An understanding of the techniques and limitations helps to improve the confidence of
neuroradiologists in interpreting the gamut of head and neck diseases and monitoring response to treatment noninvasively.

**eEdE-149**

**Congenital Temporal Bone Lesions: An Embryologic Approach.**

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Purpose
1. To understand the basic anatomy and embryological development of the temporal bone. 2. To correlate different stages of arrest in embryologic development with common congenital temporal bone abnormalities. Selected rare temporal bone malformations also will be covered.

Materials and Methods
A literature search was performed to find the most common congenital temporal bone abnormalities and the embryologic development of the temporal bone. Illustrative cases were taken from our institution that displayed common congenital temporal bone malformations. CT, MRI, and 3D reconstructions will be used to display selected malformations and anatomy. Graphical illustrations will be used to demonstrate key embryologic concepts.

Results
The external and middle ear develop from the first and second branchial arches, first branchial cleft and the adjacent mesenchyme. The structures in the external and middle ear include the external auditory canal, middle ear cavity and ossicles, excluding the footplate of the stapes and annular ligament. Malformations involving the external ear have been reported to occur in anywhere from 1:3000 to 1:10,000 births and commonly occur with middle ear malformations. The inner ear structures, however, are derived from the otic placode, and so arise from a separate embryologic precursor when compared to the middle and external ear. Type 2 incomplete partition is the most common cochlear malformation. In cochlear aplasia the cochlear promontory is absent, which is an important differentiating factor between this entity and labyrinthitis ossificans. Differentiation between these two entities is important to determine if the patient is a candidate for cochlear implant placement. Specific malformations that will be covered include but are not limited to: Aural dysplasias, ossicular malformations, congenital cholesteatoma, semicircular canal malformations, cochleovestibular malformations (Type two incomplete partition) and vestibular aqueduct enlargement. Illustrative cases involving rare congenital syndromes including Apert syndrome, Klippel-Feil, and Goldenhar syndromes also are demonstrated.

Conclusions
Congenital temporal bone anomalies should be considered as an underlying cause for early sensineural or conductive hearing loss. Knowledge of the embryologic development of the temporal bones is helpful for understanding the pathophysiology of congenital hearing loss and also attunes the radiologist to commonly associated developmental anomalies. Identification of common congenital temporal bone malformations is important as some are amenable to surgical correction.

cEdE-117

CT and MRI imaging of intra orbital extra bulbar tumors for deciding clinical approach

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Purpose
A broad variety of tumors involve intra-orbital extrabulbar cavity. Basically there are four types
of clinical approaches for intra-orbital extrabulbar tumors: Observation with imaging follow ups, total removal of tumor, biopsy of tumor to decide therapies, and others. To show the key findings to determine the clinical approaches is one of the essential roles for imaging (1-3). In this pictorial essay, we classify intra-orbital extrabulbar tumors along with their clinical approaches and clarify CT and MR imaging characteristics of them.

Materials and Methods
We retrospectively reviewed 54 cases with intra-orbital extrabulbar tumors experienced in our hospital from 2007-2014, and classified them into groups along with the clinical approaches: 1. Observation with imaging follow ups or total removal of tumor, 2. Biopsy of tumor to decide therapies, 3. Others. Typical CT and MR imaging findings of them were investigated.

Results
Clinical Approach 1. Observation with imaging follow ups or total removal of tumors. Most of the benign tumors were in this group: Venous malformation, infantile hemangioma, lymphangioma, schwannoma, neurofibroma, epidermoid, dermoid, pleomorphic adenoma. Tumors located in intracanal or extracanal-extralacrimal gland location except for pleomorphic adenoma, which affected lacrimal gland. They were well circumscribed round or oval mass on CT or MRI except for lymphangioma, infantile hemangioma and neurofibroma. On T2-weighted images, they showed homogenous or mixed hyperintensity. Clinical Approach 2. Biopsy of tumor and following treatment decided by pathologic findings. Lymphoproliferative disorders and other malignant tumors were in this group: malignant lymphoma, reactive lymphoid hyperplasia, leukemia, IgG4 related disease, adenoid cystic carcinoma and metastatic tumors. They were both in intra and extraconal-intralacrimal gland location, often diffusely involved orbital cavity including extra-ocular muscles and bilateral lacrimal glands. They showed homogenous hypo-intense on T2-weighted images, and hyperintense on DWI, except for adenoid cystic carcinoma, which showed mixed hyperintense on T2-weighted images. Metastatic tumors often were with bony destruction. Clinical Approach 3. Others. Different clinical approaches were chosen for optic glioma and optic nerve sheath meningioma because these might cause optical impairment either by tumor progression or by therapeutic intervention. Both are in intraconal location, and extend along optic nerve.

Conclusions
CT and MRI imaging bring key findings to decide clinical approach for intra-orbital extrabulbar tumors. Well circumscribed intraconal or extraconal tumors showing hyperintense on T2-weighted on MRI need observation with imaging follow ups or total removal of tumors. Tumors with diffuse extension in orbital cavity, especially with involvement of extra-ocular muscles and/or both lacrimal gland showing hypointense on T2-weighted images and hyperintense on DWI need biopsy to decide following therapies. Tumors extending along optic nerve need different clinical approaches.
Clinical Approach 1.
Observation with imaging follow-ups or total removal of tumors

- Benign tumors
- Well-circumscribed round or oval mass
- Homogenous or mixed hyper intensity on T2WI

(Filename: TCT_eEdE-117_Figure1.jpg)
Clinical Approach 2.
Biopsy of tumor to decide therapies

- Lympho-proliferative disorders and other malignant tumors
- Diffuse T2WI & DWI hypo-intense lesion involving extraocular muscles and/or bilateral lacrimal glands

(Filename: TCT_eEdE-117_Figure2.jpg)
Clinical approach 3. Others

- Optic glioma and optic nerve sheath meningioma
- Intra conal location, and extending along optic nerve
development of iterative reconstruction algorithms also have increased the complexity of prescribing the best possible exam for each patient.

Materials and Methods
Clinically relevant CT physics is reviewed, with emphasis on the special challenges encountered in the head and neck. The most commonly modified CT parameters are defined and discussed, including typical ranges and scanner limitations. The interactions between these parameters and the relevant outcomes of artifact, noise, speed of exam, and contrast enhancement are reviewed and demonstrated.

Results
There is a complex interplay between CT parameters such as kVp, ma, rotation time, pitch, and reconstruction algorithm and the desired outcome of a study demonstrating limited radiation dose, motion, artifact, and noise. These parameters also should be adjusted to ensure adequate tissue contrast and contrast enhancement. With careful selection of CT parameters based on the indication and patient size, the required dose can be minimized while ensuring reliably diagnostic images. National and international normative data also are available to serve as a guide to expected dose levels for each exam.

Conclusions
This exhibit reviews the fundamentals of clinically relevant CT physics, as well as the contrast kinetics of neck imaging, to enable the reviewer to more confidently create and adapt head and neck CT protocols in association with ongoing changes in technology and clinical practice.

eEdE-155b

Demystifying Non-squamous Cell Neoplasms of the Head and Neck: A Pictorial Review

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Purpose
Although nonsquamous cell neoplasms are rare among head and neck lesions, they do exist. The purpose of this exhibit is to illustrate and review the imaging characteristics of nonsquamous cell neoplasms of the head and neck on multidetector computed tomography (MDCT) and magnetic resonance imaging (MRI) studies.

Materials and Methods
A retrospective review of pediatric and adult nonsquamous cell neoplasms imaged at a tertiary referral center between 2009 and 2014 was performed with radiological and pathological correlation. Images of each entity will be presented with any distinguishing imaging features, diagnostic pearls, pitfalls, treatment and prognosis discussed.

Results
A spectrum of primary nonsquamous cell head and neck neoplasms were found in our adult and pediatric population including but not limited to: osteosarcoma, schwannoma, malignant triton tumor, esthesioneuroblastoma, and hemangiopericytoma of the nose; rhabdomyosarcoma and osteosarcoma of the masticator space; adenoid cystic carcinoma and mucoepidermoid carcinoma of the palates; lymphoma of the tonsil and nasopharynx; lymphoma and Kaposi's sarcoma of the tongue; carcinoid and chondrosarcoma of the larynx; and nonsquamous cell cutaneous neoplasms. Metastases to the head and neck also were reviewed.
Conclusions
It is crucial for neuroradiologists to be familiar with the imaging features of pediatric and adult nonsquamous cell neoplasms which have distinct outcome and treatment planning.

A rare case of a lingual Kaposi sarcoma (A) with a corresponding gross (B) and a sinonasal malignant Triton tumor (C) with a corresponding histological slide (D) (rhabdomyoblast: blue arrow, schwannoblast: white arrow)
Detecting Neck Node Metastases in Head & Neck Squamous Cell Cancers: How far have we reached?

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Purpose
1. To review literature on the best imaging method/methods to detect neck node metastases in head and neck squamous cell cancers (HNSCC). 2. To identify the clues and pitfalls in detecting neck node metastases with each imaging method. 3. To provide a detailed checklist of features to be studied in neck nodes in cases of HNSCC with various imaging methods.

Materials and Methods
Numerous imaging methods have been studied to detect metastases in the neck in HNSCC. This exhibit will collate evidence from literature including meta-analyses evaluating ultrasound (US), US-guided fine needle aspiration (gFNA), CT, MRI, diffusion-weighted and dynamic contrast-enhanced MRI, PET CT and Sentinel node biopsy for detecting neck node metastases in HNSCC and identify the best imaging method supported by literature currently. Features suggestive of metastatic nodes on each imaging method will be described along with pitfalls of each method.

Results
Neck node metastases is the single most important prognostic factor for head neck squamous cancers. Average incidence of occult metastases in neck nodes is about 15% in all HNSCC. Expectations of imaging to identify these have fuelled investigation into numerous imaging methods. Several retrospective studies, few prospective studies and few meta-analyses provide evidence regarding US, US gFNA, CT, MRI including advanced MRI and PET CT and conclude that all these methods have comparable sensitivity and specificity to detect metastatic neck nodes. However many of the studies involve both the clinically negative and positive necks while ideally the accuracy of imaging needs to be tested in the clinically negative neck. Currently none of the methods are comparable to surgical staging of the neck (neck dissection) in the clinically negative neck. Sentinel node biopsy has been evaluated in oral cancers and has a promising role to detect neck node metastases. Despite these limitations, the radiologist should be a) aware of clues that suggest metastatic nodes on various imaging methods and b) also provide information to decide resectability of nodes and to optimally plan radiation therapy in the clinically positive neck.

Conclusions
This exhibit aims to familiarize the radiologist with the clinicians' issues in staging the neck, an evidence-based review of the accuracy of various imaging methods, the clues and pitfalls in imaging for neck nodes and a checklist for reporting on neck nodes in HNSCC.

eEdE-111

Doctor, What is Wrong with My Eye? Common and Uncommon Extraocular Lesions of the Orbit. A Case-Based Tutorial.

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Purpose
Orbital lesions can be a diagnostic challenge for the radiologist. It is important to consider both common and uncommon entities when faced with these cases. One needs to consider congenital, vascular, infectious/inflammatory, neoplastic, and miscellaneous lesions. The purpose of this tutorial is to teach the reviewer the most common lesions of the orbit, several important uncommon orbital lesions, and the discriminating imaging features of these entities.

Materials and Methods
Reviewers are challenged with both common and uncommon extraocular orbital lesions utilizing a case-based, computer-interactive, tutorial approach. A series of unknown cases is presented. Each case includes representative images that illustrate key diagnostic findings for the disease entity. A multiple choice question accompanies each case. The reviewer then is given the correct answer, followed by a brief discussion highlighting salient clinical and imaging features.

Results
Congenital lesions include manifestations of neurofibromatosis type I (optic nerve gliomas) and dermoid cysts. Vascular lesions include capillary hemangiomas, cavernous malformations, orbital varices, carotid-cavernous fistulas, optic nerve infarctions, and venolymphatic malformations. Infectious/inflammatory lesions include thyroid associated orbitopathy, pseudotumor, optic neuritis, and subperiosteal abscesses. Neoplastic lesions include optic nerve sheath meningiomas, metastases, and V1 schwannomas (as a manifestation of NF2). Finally, miscellaneous bony lesions include orbital roof osteomas, histiocytosis, metastatic neuroblastoma, and fibrous dysplasia.

Conclusions
After reviewing this interactive, case-based, educational exhibit, the reviewer will be able to identify common and uncommon extraocular lesions of the orbit and describe their discriminating imaging features. Orbital lesions offer a diagnostic challenge to the radiologist. When faced with these cases, a working knowledge of the most common lesions and their imaging appearances is essential in order to arrive at the correct diagnosis or sufficiently narrow the differential.
Dynamic Contrast-Enhanced MR Imaging Applications in Head and Neck Tumors

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Purpose
Dynamic contrast-enhanced magnetic resonance imaging (DCE MRI) has been used for the diagnosis and for monitoring therapeutic response in tumors. More recently, pharmacokinetic models have been used to extract parameters related to tumor microcirculation by using DCE MRI in head and neck tumors. The purpose of this exhibit is to describe and illustrate feasibility and evaluation of quantitative permeability values derived from DCE MRI in different head and neck tumors.

Materials and Methods
Head and neck tumors from different histopathology of the supra-infrahyoid neck, salivary glands, oral cavity, paranasal sinuses and metastatic lymph nodes were included. Dynamic contrast-enhanced MRI following intravenous administration of 0.01mmol/kg of gadodiamide was performed for each patient at 3T. All data sets were transferred to a workstation for image evaluation. For quantitative DCE MRI evaluation, after an image coregistration, a pooled arterial input function obtained from the vertebral artery, in regard of the gadolinium concentration, was used for the modeling procedure. For all data sets regions of interest (ROIs) were defined within the tumor, muscle and vertebral artery with the help of conventional images. Additional ROIs were defined for lymph nodes at different stations bilaterally. Ktrans, Kep, Ve then were calculated from DCE MRI respectively. Dynamic contrast-enhanced MRI findings and quantitative permeability data were evaluated.

Results
Dynamic contrast-enhanced MRI findings and permeability measurements showed favorable correlation in tumor depiction. Mean Ktrans, Kep, Ve of the lesion values in patients with head and neck tumors significantly higher than muscle values. Same correlation was found to be present for metastatic lymph nodes compared to reactive ones.

Conclusions
Permeability calculation of DCE MRI is a promising new technique which is expected to help management of treatment and follow up in head and neck tumors.

Ectopic infraorbital nerve in a maxillary sinus septum: significance, prevalence and imaging characteristics

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Purpose
To determine the prevalence of the anatomical variant of an infra-orbital nerve coursing through the maxillary sinus in a bony septum and explain why it is clinically relevant and important to be mentioned in radiology reports for sinus CTs.

Materials and Methods
This was an IRB-approved retrospective study. Five hundred consecutive sinus CTs performed at our outpatient center were reviewed to determine if the variant of the infra-orbital nerve coursing through the maxillary sinus in a bony septum was present. When the variant was present, the
number and length of the bony septum attaching the infra-orbital nerve to the wall of the maxillary sinus was recorded. The location of the septum also was recorded.

Results
Protrusion of the infra-orbital canal (IOC) into the maxillary sinus was identified in 54 patients (10.8%), bilateral in 30 (6.0%) and unilateral in 24 (4.8%). All protruding IOCs were anchored to a wall of the maxillary sinus by at least one bony septum. The mean length of the septum attaching the IOC to the wall of the maxillary sinus was 4.0 mm (range: 1 – 11 mm). One patient had a single bony septum attached to the posterior wall of the sinus; otherwise all patients with posterior septae had additional bony attachments to the anterior wall. No patient had a bony attachment to the medial wall of the sinus. A second septum attached to a protruding IOC was present in nine patients, bilateral in four. A third septum was present in one patient unilaterally. An IOC protruding into the maxillary sinus may be at risk during endoscopic surgery and open procedures such as the Caldwell-Luc procedure. Hence, this variant anatomy should be mentioned in sinus CT reports, especially if surgery is planned. Damage to the infra orbital nerve can lead to pain and parasthesias in the distribution of the nerve on the middle ipsilateral face.

Conclusions
To date, there are only three case reports in the literature describing protrusion of the IOC into the maxillary sinus rather than within the orbital process of the maxilla (orbital floor). We reviewed 500 consecutive patients' sinus CTs and found a prevalence of 10.8% for this variant, using the definition that the entire wall of the IOC had to be separate from all walls of the maxillary sinus on a single image. The distance of protrusion into the sinus is important to note in order to alert the surgeon prior to intervention.
Ectopic thymus: Radiologic evaluation

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Purpose
Ectopic thymus or its atypical extension is a benign entity that may mimic pathologic mass or lymphadenopathy. Our purpose is to review the imaging ectopic thymus.

Materials and Methods
Retrospective review of imaging database with the use of clinical search engine was performed between 2008 and 2014. Five cases were reviewed in light of clinical, radiologic and pathologic findings (when available).

Results

Conclusions
Ectopic thymus and/or its atypical extension can mimic pathologic mass or lymphadenopathy.
Familiarity with this benign entity is important to ensure proper management and prevent unnecessary further investigations.

**Endolymphatic Sac Tumors: A Pictorial Review and Review of the Literature**

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**Purpose**
Demonstrate the characteristic findings of endolymphatic sac tumors (ELSTs) on CT, MRI and angiography. Provide a comprehensive review on ELSTs, including clinical presentation, imaging and pathologic characteristics, surgical staging and management and treatment outcomes.

**Materials and Methods**
The available radiology studies of patients with pathologically proven endolymphatic sac tumors were reviewed, including CT, MRI and angiography. Characteristic imaging findings of ELSTs observed in our patients are demonstrated using case examples and mirrored those discussed in the literature. A comprehensive literature review was performed and the clinical presentation, radiologic and pathologic features, surgical staging and management and treatment outcomes of ELSTs discussed. The principles of postsurgical follow up, including postoperative appearance and radiologic signs of tumor recurrence are demonstrated with case examples.

**Results**
Endolymphatic sac tumors (ELST) are rare papillary adenomatous neoplasms that arise from the endolymphatic sac. Although they are pathologically benign, they are locally destructive and often invade the surrounding petrous bone. The tumors typically present with sensorineural hearing loss, vertigo, tinnitus or aural fullness. They can be sporadic, but often are seen in patients with Von-Hippel Lindau syndrome, in which case they can be bilateral. Early diagnosis of ELSTs is important to avoid complications of locally aggressive tumor growth and early surgical resection usually is curative. CT and MRI have an important role in correctly identifying ELSTs and evaluating their extent for surgical planning. Endolymphatic sac tumors can be mistaken for other pathologies involving the temporal bone including paragangliomas, metastases, chondrosarcomas, chordomas or even unusual arachnoid granulations; however, characteristic imaging findings on CT, MRI and angiography can help differentiate these tumors from other pathologies. Radiology has an important role in presurgical planning as the surgical approach depends on the extent of tumor. Postsurgical follow up also is dependent on imaging to detect local tumor recurrence, which may be asymptomatic.

**Conclusions**
Radiology plays an important role in the diagnosis, presurgical planning and postoperative follow up of endolymphatic sac tumors. Familiarity of the characteristic imaging findings of these tumors is important to assist in accurately differentiating these tumors from other pathologies of the temporal bone and to evaluate for their recurrence after surgery.
Evaluation of Oral Cavity Carcinomas: A Case-Based, Computer-Interactive Tutorial

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Purpose
Review normal anatomy of the oral cavity. Learn the American Joint Committee on Cancer (AJCC) criteria for staging of oral cavity carcinoma. Gain an understanding of how to assess extent of lesions in the various oral cavity sub-sites.

Materials and Methods
Following a brief review of pertinent normal oral cavity anatomy and review of AJCC Tumor-Node-Metastasis (TNM) criteria, we present multiple cases in quiz format of oral cavity carcinoma in each of the top five sub-sites on CT/MR, (1- lower lip; 2- oral tongue; 3- floor of
mouth; 4- gingiva/retromolar trigone; and 5- hard palate). We employ a computer-interactive checklist approach for systematic evaluation of tumors in the various sub-sites and lead the reader through a step-by-step analysis of each tumor.

Results
A simplified computer-interactive checklist is presented to assist the radiologist in systematically analyzing the extent of various sub-sites of oral cavity carcinoma. 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.

Conclusions
The pattern of spread for tumors in these various locations is a challenge 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.
Purpose
The most prevalent ophthalmologic conditions, e.g., diabetic retinopathy, cataract, and glaucoma, are diagnosed with fundoscopy and other ophthalmologic examinations. In contrast to extraocular or visual pathway pathologies where computed tomography (CT) and magnetic resonance imaging (MRI) have a central role in diagnosis, these imaging modalities currently lack adequate resolution for detection of these common ocular abnormalities. However, due to wide utilization of imaging combined with an aging population, many ocular findings are seen on cross-sectional neuroimaging studies, both pathologic and postsurgical. Radiologists should familiarize themselves with the various abnormalities and surgical interventions, not only to recognize these therapies but more importantly to avoid any confusion between expected postsurgical imaging findings and pathology.

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 ocular lesions. Imaging findings, pathology and/or historical data were obtained to establish the final diagnosis. Textbooks, primary and review articles were utilized for reference.

Results
Imaging findings and relevant clinical information of the following entities are discussed:
Neoplasms: choroidal melanoma, retinoblastoma, and metastasis;
Infections: episcleritis;
Detachments: choroidal and retinal;
Structural: coloboma and staphyloma;
Calcifications: drusen, scleral;
Trauma: lens dislocation, globe rupture, foreign body;
Postsurgical: lens implants, scleral banding, silicone injection, glaucoma drain.

Conclusions
This pictorial review aimed at presenting the commonly seen ocular abnormalities in a concise and image-based fashion.
eEdE-97

6:30AM - 3:00PM

Head & Neck Triple Threat: Implications, Manifestations and Complications of HPV, HIV & EBV Infection

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Purpose
While human papilloma virus (HPV), Epstein-Barr virus (EBV) and human immunodeficiency virus (HIV) are systemic infections, prior or current infection with these agents may result in specific head and neck (H&N) disease states.

Materials and Methods
We present a review of the epidemiology, mode of transmission of infection and the mechanism of action of each of these three viral agents along with many case examples of the H&N disease states. We illustrate the many H&N manifestations of disease associated with infection with these viral agents and in particular the wide range of malignant disease: HIV and EBV-related solid, mucosal and lymphoid H&N malignancies and HPV-related H&N mucosal malignancies. In addition we will share cases of H&N infection resulting from HIV-immunodeficiency.
Results
The last 10 years have seen a rapid increase in the incidence of HPV-associated oropharyngeal squamous cell carcinoma (SCCa), and an emergence of other H&N HPV-related mucosal malignancies. The rate of new HIV infections has slowed over this same time period, while EBV infection reaction has remained reasonably stable. Infection with HIV may result in altered immunity resulting in acquired infections of the H&N in addition to other systemic sites. It also may result in the development of H&N malignancies including Kaposi sarcoma and EBV-related lymphoma. Post-transplant lymphoproliferative disease (PTLD) and Burkitt lymphoma also are EBV-related and have specific demographic and imaging features. EBV also is the most commonly identified agent in the causation of nasopharyngeal carcinoma (NPC).

Conclusions
Each of the systemic viral agents HIV, HPV and EBV may manifest with particular H&N disease states. We present a concise review of their epidemiology and mechanisms of action and an understanding of their role in the development and the imaging manifestations of multiple different H&N tumors.

Purpose
This pictorial review illustrates the relevant anatomy and key imaging findings of head neck infectious diseases and the complications that all radiologists must be able to recognize and convey the critical findings to the clinicians. Radiological, clinical and pathological correlation is emphasized.

Materials and Methods
A variety of infectious diseases (bacteria, virus, fungus and protozoa) may involve head and neck structures. The etiologies are different depending on the patients' immune status and sites of infections. Some entities are life-threatening, requiring rapid and accurate interpretations. We present this pictorial review by using computed tomography (CT), magnetic resonance imaging (MRI), pathological and endoscopic findings.

Results
By utilizing anatomical boundaries, the diseases can be classified into upper airway, deep neck space and vascular/parameningeal infections. Upper airway infections include tonsilar/peritonsilar abscesses, epiglottitis, croup, odontogenic infection and acute invasive fungal sinusitis. Deep neck space infections encompass retropharyngeal abscess, Ludwig's angina, acute necrotizing fascitis, and masticator space infection. Vascular/parameningeal infections can be fatal and include septic thrombophlebitis, cavernous sinus thrombophlebitis, and mycotic aneurysms. Miscellaneous entities including skull base osteomyelitis, tuberculous adenitis, cat scratch diseases and their complications also are discussed.

Conclusions
Recognizing the characteristic neuroimaging findings of head and neck infection is critical for neuroradiologists in order to provide accurate diagnoses leading to appropriate treatment.
Imaging Features of Tympanosclerosis

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Purpose
Tympanosclerosis (TS) is a fairly common but radiographically under-recognized cause of postinflammatory ossicular chain fixation and noncholesteatomatous conductive hearing loss. The purpose of this exhibit is to review the imaging features of TS, enabling the radiologist to more effectively approach prospective cases.

Materials and Methods
We will familiarize the viewer with the etiology, clinical manifestations and pathogenesis of TS, emphasizing relevant middle ear anatomy. We also will provide imaging examples detailing the
wide imaging spectrum of TS in a case-based fashion while outlining various treatment strategies available to those so afflicted.

Results
Tymanosclerosis represents submucosal deposition of collagen, calcium phosphate crystals or osseous material within the tympanic membrane, middle ear and occasionally mastoid. It most often occurs as sequelae of chronic suppurative otomastoiditis with a reported association of up to 25% of cases. A history of ventilation tubes and tympanic membrane perforation likewise places patients at risk (1). Clinically significant lesions can be subtle at imaging. Areas of hyperdensity associated with the tympanic membrane, ossicular chain, ossicular ligaments, tendons and middle ear cavity should raise suspicion for TS, particularly in the setting of moderate to severe conductive hearing loss (2).

Conclusions
Radiologists should be aware of the clinical associations of TS and strongly suspect this condition as a potential cause for symptoms, particularly if there is a history of significant conductive hearing loss in conjunction with imaging features of chronic otitis. Reporting both the extent of visible and "hidden" disease, which may otherwise be occult to the referring provider at otoscopy, correlates with favorable treatment outcomes (3, 4).

eEdE-87

Imaging findings in the injuries to the neck muscles– examples with review of anatomy.

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Purpose
Most studies on the trauma to the cervical spine have focused on the injuries to the ligament, disc, bone, and spinal cord. There is hardly any report in the literature on the imaging findings in the injuries to the muscles of the neck. The osseous-ligamentous system contributes 20% to the mechanical stability of the cervical spine, while the remaining 80% is provided by the surrounding neck musculature (1). With increasing use of MRI in the patients with neck trauma, we come across several examples of injury to the neck muscles with or without fractures and the ligaments injuries. The purpose of this exhibit is twofold: 1. To review the imaging findings in the injuries to the muscles of the neck; 2. To review the anatomical aspects of the neck muscles.

Materials and Methods
We reviewed MRIs of the patients with traumatic injuries to the neck over the past 8 years to look for injuries to the muscles. Routine MRI of the cervical spine for trauma in our institution includes spin echo T1 sagittal, fast spin echo sagittal, short tau inversion recovery sagittal, fast spin echo T2 axial and gradient T2 axial sequences.

Results
Plain films have a limited role in the injury to the neck. A subset of patients with neck injury will even have normal CT. In one large meta-analysis involving 464 patients, MRI showed additional findings in nearly 20% of patients that were not seen in the plain films with or without CT (2). In
another large series of 174 patients who underwent MRI for occult injuries of the cervical spine after their plain x-rays were normal, 36% (62) patients had evidence of soft tissue injury. Both these studies concluded that negative MRI should be a confirmation of cleared spine (3). The injury to the soft tissues of the neck can involve the flexor or extensor muscles depending on the nature of injury. The flexion injury causes sprain of the extensors whereas the whip lash injury damages the flexor group. There are also cases of direct injury to the muscles causing contusion. On MR imaging, the most common findings of muscle injury are swelling of the muscle and edema (high T2 signal). In addition to this, patients can present with rupture of muscle fibers, intramuscular hematoma and bleeding, or reactive fluid in the adjacent soft tissues. These changes are seen best on the short tau inversion recovery (STIR) and FSET2 sequences. Our exhibit focuses on the anatomy of the neck muscles (4) and presents examples of different muscles injured in trauma. There are several articles in the literature on the patients presenting with chronic neck pain following trauma who have some degree of dysfunction of the neck muscles. We believe that increased awareness of the injuries to the neck muscle may help in better management and follow up of such individuals.

Conclusions

Injuries to the neck muscles can be an important finding on MRI, which in our opinion often is overlooked. Patient with pain following neck trauma can greatly benefit from correctly identifying various components of neck injury, which can guide appropriate management and follow up.
Imaging Findings of Perineural Tumor Spread Along Peripheral Branches of the Facial Nerve (CN VII)

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Purpose
Imaging findings of perineural tumor spread (PNTS) along the facial nerve main trunk are well established. Many skin cancer patients however suffer from PNTS along one or more peripheral branches of the facial nerve (CNVII). Recognition of such early PNTS is critical as it often is resectable allowing for more favorable patient outcome. The objective of this educational exhibit is to familiarize the radiologist with the imaging spectrum of PNTS along the peripheral branches of CNVII to facilitate its early detection.

Materials and Methods
The anatomy of the peripheral branches of CNVII will be reviewed focusing on its relationship to the superficial muscular aponeurotic system of the face. In addition, CT, MRI and PET/CT images of patients with clinical and/or radiologic findings of PNTS along the different peripheral branches of CNVII will be presented to illustrate the spectrum of imaging findings.

Results
Perineural tumor spread along CNVII is related most commonly to cutaneous squamous cell carcinoma or primary parotid gland malignancies with adenoid cystic carcinomas having the highest propensity for PNTS. PNTS often extends in retrograde direction; however, antegrade growth also has been described but often is overlooked. Radiographic signs of PNTS along the peripheral branches of CNVII include linear thickening and/or enhancement along the superficial muscular aponeurotic system of the face and/or within the anterior parotid gland. PNTS shows variable linear FDG uptake on PET/CT in the same distribution if positive.

Conclusions
After reviewing this educational exhibit, the radiologist will be familiar with the spectrum of imaging findings of PNTS along the peripheral branches of CNVII and will be able to suggest such a diagnosis with higher level of confidence. Early detection of this type of PNTS is critical to allow for early surgical intervention and more favorable outcome.
Imaging of Differentiated Thyroid Cancer: Pre-surgical Planning, Evaluation of Locally Aggressive Disease, and Intra-operative ultrasound.

S Ahmed\textsuperscript{1}, M Ghazarian\textsuperscript{2}, (Debnam\textsuperscript{1}, T Vu\textsuperscript{1}, S Waguespack\textsuperscript{1}, G Clayman\textsuperscript{1}

\textsuperscript{1}UT MD Anderson Cancer Center, Houston, TX, \textsuperscript{2}UT Houston Medical School, Houston, TX
Purpose
There has been a significant increase in the incidence of thyroid cancer in the United States, in part due to increased workup of incidental thyroid nodules. Ten-year survival is greater than 95% for papillary thyroid cancer and greater than 85% for follicular thyroid cancer. However, cases of aggressive thyroid cancer (extrathyroidal extension) demonstrate up to 36% local recurrence and 18% death from disease. The purpose of this exhibit is to describe the role of imaging in surgical planning and evaluation of locally aggressive disease in patients with differentiated thyroid cancer.

Materials and Methods
Over 3000 new patients with diagnosis of differentiated thyroid cancer were evaluated with a multidisciplinary approach (Endocrinology, Head and Neck Surgery, Radiology, Radiation Oncology, Medical Oncology) at a large cancer center over the past 10 years.

Results
Ultrasound is the preferred imaging modality for characterizing the primary tumor for extrathyroidal extension, contralateral/multifocal disease, and lymph node metastasis to the central and lateral compartments. Fifteen/twenty percent of nodal metastasis are clinically occult, and seen only on ultrasound. Ultrasound-guided fine needle aspiration is used to biopsy suspicious nodes in the lateral compartments. Thyroglobulin washout assay is used to document metastasis when biopsy of a cystic node is nondiagnostic. Contrast-enhanced high resolution CT imaging is useful when imaging patients with locally invasive disease (trachea, esophagus, larynx, strap muscles), carotid encasement, internal jugular vein invasion, and also evaluates for mediastinal and lateral retropharyngeal metastasis. Transoral ultrasound-guided biopsy is used to sample suspicious/equivocal lateral retropharyngeal lymph nodes. Intra-operative ultrasound (skin marking, needle localization, biopsy, and confirmation of lesion removal) is helpful in decreasing operative time and achieving complete resection.

Conclusions
Pre-operative comprehensive neck ultrasound, including evaluation of the lateral and central compartment lymph nodes, is essential for patients with differentiated thyroid cancer. Contrast-enhanced high resolution neck CT has a complimentary role in patients with locally aggressive tumor and extensive nodal metastasis.

eEdE-110
6:30AM - 3:00PM

Imaging of Medial Canthus of the Orbit: An Unexplored Territory

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Purpose
1) To revisit detailed anatomy of the medial canthus of the orbit. 2) To list the common and uncommon pathologies. 3) Describe the CT and MRI findings of each of these pathologies. 4) To discuss the relevance of imaging as regards patient management.

Materials and Methods
An elaborate search was made for lesions of the medial canthus of the orbit from the case
database available on PACS from 2005-2013. All cases including their clinical history, imaging findings, complications, surgical details and histopathological findings were reviewed.

Results

Pathologies discussed would include: 1) Lacrimal gland: a) Dacryocystitis associated with orbital cellulitis, b) congenital lacrimal gland mucocele, c) Neoplasms including mucoepidermoid tumors, and melanoma. 2) Orbit: a) Orbital Pseudotumor, b) Dermoid. 3) Nasal Cavity and Paranasal Sinuses: a) Ethmoid mucocele, b) Neoplasms including carcinoma and Inverted papilloma. 4) Systemic Disease: a) Lymphoma, b) Metastasis, c) Langerhans cell histiocytosis, d) Sarcoidosis. 5) Others: a) Basal cell carcinomas, b) Hemangioma, c) Neurofibroma.

Conclusions

1) Medial Canthus of the orbit can be involved by a wide range of pathologies. 2) Careful examination and systematic imaging approach with knowledge of the pathologies is the key to successful patient management. 3) This pictorial review from our institution will familiarize the radiologists with imaging features of common and uncommon lesions involving the medial canthus.
LYMPHOMA INVOLVING THE RIGHT MEDIAL CANTHUS
Small Dermoid/Epidermoid of the left medial canthus
Imaging of non-neoplastic complications of pharmaceutical and drug use in the head and neck

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Purpose
The purpose of this exhibit is to review the head and neck imaging characteristics of a variety of non-neoplastic changes that can result from the use of drugs and pharmaceuticals. The mechanisms by which the findings occur and differential diagnoses will be discussed as well.

Materials and Methods
A variety of drugs and pharmaceuticals can have effects on the head and neck that should be considered upon review of diagnostic head and neck imaging.

Results
The imaging findings of the following conditions will be reviewed: * Thorotrast extravasation * Cocaine-induced nasal sinonasal erosions and dacrocystitis * Ingested crack pipe filter hypopharyngeal burn injury * Crack baby * Chemotherapy-related esophagitis * Radiodine and chemotherapy-related sialadenitis * ACE-inhibitor angioedema * Alcohol-induced sialosis, Madelung disease, maxillofacial trauma * Fetal alcohol syndrome * Betel nut associated inflammatory lymphadenopathy * Prostaglandin-induced periorbitopathy * Fetal coumadin syndrome * Post-transplant lymphoproliferative disorder * Ipilimumab-induced hypophysitis * Bisphosphonate-induced osteonecrosis * Nasal contestant rhinitis medicamentosa.

Conclusions
Familiarity with the spectrum of imaging finding related to complication of drugs and pharmaceuticals in the head and neck is important for guiding imaging interpretation and subsequent patient management.

Imaging of Normal and Abnormal Development of Pharyngeal Arches, Pouches and Grooves.

S Kanekar¹
¹Penn State Milton Hershey Medical Center, Hershey, PA

Purpose
1. To illustrate the normal developmental embryology of the pharyngeal apparatus (arches, pouches and clefts). 2. To discuss with illustrations various developmental anomalies associated with pharyngeal apparatus.

Materials and Methods
Differential diagnosis of the head and neck masses in pediatric patients are extensive and may
include dermoid, teratoma, pseudotumors, ranula, adenopathy and various lesions associated to pharyngeal apparatus. Distinguishing these lesions may be challenging. We retrospectively studied MRI, and CT of 81 pediatric patients from PACS system who had minor, moderate or severe developmental anomalies and masses related to malformation of pharyngeal apparatus.

Results
In this exhibit we present with illustrations the embryology and developmental anomalies related to various pharyngeal arches, pouches and clefts. We discuss these anomalies in context to their development and are enumerated in the table below. ARCHES (5). First arch "mandibular arch". "First Arch syndrome abnormalities involve the eyes, ears, palate, and mandible. Two main syndromes associated are Treacher Collins and Pierre Robin. Second Arch "hyoid arch". Malformed auricle (microtia) and ossicles (stapes, malleus, and incus). Hyoid malformation and muscular asymmetry of the face. Third arch "Hyoid malformations and carotid artery aneurysms". Fourth arch "Laryngeal stenosis, laryngoptosis, chondromalacia, double aortic arch, and pulmonary artery sling". Fifth arch "Anomalies of sternocleidomastoid and trapezius muscles". POUCH (4). First pouch Atresia and diverticuli of the eustachian tube, (recurrent bouts of otitis media). Bifid tongue, perforated tympanic membrane and branchiogenic nasopharyngeal cysts. Second pouch A thyroglossal duct cyst, lingual thyroid. Third pouch. Fourth pouch DiGeorge syndrome hypocalcemia and tetany as well as impaired cellular immunity, accessory parathyroid glands and thymic cysts. CLEFT(4). Branchial cleft First branchial cleft- external auditory canal stenosis or atresia as well as preauricular skin tags and pits may result. Second branchial cleft- Cyst with cervical sinuses. Third branchial cleft - thymic cyst. Fourth branchial cleft- cysts closely associated with the thyroid gland.

Conclusions
1. Understanding the development and anatomy of the pharyngeal apparatus is very important to dissect the correct differential and the diagnosis in many of the head and neck masses and facial malformations in children. 2. This exhibit is an insight into imaging of development and various developmental anomalies associated with pharyngeal apparatus.
### Imaging of Palate Masses

J Bykowski, M McDonald

*1 UC San Diego Health System, La Jolla, CA, 2 UC San Diego, San Diego, CA*

<table>
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<tr>
<th>ARCHES (5)</th>
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<td>First arch “mandibular arch”</td>
<td>“First Arch Syndrome abnormalities involve the eyes, ears, palate, and mandible. Two main syndromes associated are Treacher Collins and Pierre Robin.”</td>
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<td>Second arch “hyoid arch”</td>
<td>Malformed auricle (microtia) and ossicles (stapes, malleus, and incus). Hyoid muscular asymmetry of the face.</td>
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<td>Third arch</td>
<td>Hyoid malformations and carotid artery aneurysms.</td>
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<td>Fourth arch</td>
<td>Laryngeal stenosis, laryngoptosis, chondromalacia, double aortic arch, and persistent branchial arches.</td>
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<td>Sixth arch</td>
<td>Anomalies of sternocleidomastoid and trapezius muscles</td>
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<td>POUCH (4)</td>
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<td>First pouch</td>
<td>Atresia and diverticuli of the eustachian tube, (recurrent bouts of otitis media, perforated tympanic membrane and branchiogenic nasopharyngeal cysts.</td>
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<td>Second pouch</td>
<td>A thyroglossal duct cyst, lingual thyroid.</td>
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<td>Third pouch</td>
<td>DiGeorge Syndrome hypocalcemia and tetany as well as impaired cellular immunity.</td>
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<td>Branchial cleft</td>
<td>First branchial cleft- external auditory canal stenosis or atresia as well as pre-auricular pits may result. Second branchial cleft- Cyst with cervical sinuses. Third branchial cleft - thymic cyst. Fourth branchial cleft - cysts closely associated with the thyroid gland.</td>
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Purpose
To review the imaging presentation of primary masses of the palate and key regional anatomy in the context of primary diagnosis as well as post-treatment surveillance.

Materials and Methods
A 10-year review of the imaging database of a regional medical center with head/neck cancer center identified cases of primary masses of the hard and soft palate with pathologic correlation.

Results
Key cases will be used to define anatomy, regional vascular supply, drainage and innervation, as well as indications and implications for surgical resection. • Benign masses: hemangioma, lymphangioma, necrotizing metaplasia, papilloma, pleomorphic adenoma, abscess. • Salivary gland malignancy: adenoid cystic carcinoma, acinic cell carcinoma, mucoepidermoid carcinoma, postoperative recurrence and perineural spread. • Squamous cell carcinoma. • Lymphoma. • Melanoma. This exhibit also will review NCCN guidelines for the above listed malignancies.

Figure 1: Mucoepidermoid carcinoma was identified on FNA in this 27-year-old man with a palpable right soft palate mass. Contrast-enhanced CT demonstrated a homogenously enhancing mass at the junction of the right hard and soft palate on sagittal view (A), extending towards but not crossing midline on coronal projection (B). Margin assessment on axial views (C) can be difficult depending on gantry angulation and slice profile, given the location of these masses. Bone windows (D) are critical for surgical planning, here demonstrating the erosion of the right maxilla.

Conclusions
Primary masses of the palate often are diagnosed by FNA, however imaging plays an important role for local margin assessment and determination of regional nodal or perineural spread of malignant tumors. Understanding primary treatment algorithms and common surgical procedures assists in the evaluation of suspected recurrence.
eEdE-151

Imaging Spectrum of Pigmented Villonodular Synovitis Involving the Head and Neck Region

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¹Winthrop University Hospital, Mineola, NY, ²Stony Brook University Medical Center, Mineola, NY, ³St Johns University, westbury, NY, ⁴Stony Brook University Medical Center, Stony Brook, NY
Purpose
Pigmented villonodular synovitis (PVNS) is a relatively synovial neoplastic disorder of unknown etiology most commonly seen involving the larger joints in the lower extremities (knees, ankle, and hips). We aim to present the imaging spectrum of PVNS involving head and neck region.

Materials and Methods
1. Brief review of head and neck anatomy of areas involved in PVNS. 2. Review clinicopathologic spectrum of acute, chronic and acute on chronic PVNS. 3. Discuss spectrum of imaging (CT and MRI) findings in PVNS. 4. Review mimics with emphasis on key findings differentiating these entities. 5. Brief discussion of treatment, prognosis and follow up in PVNS.

Results
1- Emphasize key CT and MRI findings, e.g. Erosion of mandibular condyle, glenoid fossa with or without associated lobulated lytic lesion. 2- Emphasize key MRI findings, e.g. T1 and T2 Hypo-to-isointense mass with peripheral rim of low signal with herterogenous area of mild enhancement. 3- Review differential diagnosis including Giant cell tumor, Chondrosarcoma, Calcium pyrophosphate dihydrate deposition disease, and Synovial chondromatosis.

Conclusions
Pigmented villonodular synovitis is a rare cause of aggressive mixed lytic-sclerotic lesion with or without an associated mass which can cause cranial neuropathies and ipsilateral brain parenchymal abnormalities secondary to mass effect. Combination of CT and MRI can help narrow the differential diagnosis and guide biopsy. Familiarity with common and uncommon complications of PVNS mass biopsies is critical in patient management and follow up.
Axial bone CT demonstrates widening of the right TMJ joint space and multiple rounded erosions of the adjacent skull base involving the internal aspect of the zygomatic arch and greater wing of the sphenoid.

(Filename: TCT_eEdE-151_PVNScasepresentation.jpg)

eEdE-107

Impaired vision: how to optimize imaging and diagnosis hypotheses

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¹Fondation A de Rothschild, PARIS, France, ²Fondation Rothschild, Paris, Paris
Purpose
Visual loss has many causes, which may be disclosed by either ophthalmological examination, or often complementary imaging. Selection of the appropriate imaging (focused on the anterior or posterior visual pathways), depending on the clinical presentation and knowledge of the different aspects of the pathologies are mandatory to reach the correct diagnosis. We propose a practical clinical and imaging guide which aims to improve self-confidence and radiologic know-how of inexpert radiologists. This work is based on a daily experience in an ophthalmological reference center.

Materials and Methods
During several years, we selected imaging files of patients presenting with various visual loss (brutal, progressive, uni or bilateral, with unilateral or bilateral visual field alteration) and correlated imaging finding with clinical presentation. Patients underwent mainly MRI (Philips ingenia 3T Philips). We separated optic nerve lesions, optic chiasm lesions and posterior visual pathways lesions including optic tracts. MR imaging protocol depended on the clinical data. Anterior optic pathway study was performed in a patient eyes shut, with at least thin (2-3mm) coronal T2 and T1 Gd FATSAT focused on the optic nerves and optic chiasm, brain 3D FLAIR and 3DT1 Gd. Complementary sequences (thin axial T2 and T1 Gd FATSAT, diffusion, SWI) were added if necessary. Brain study for posterior visual path lesion depended on the clinical presentation and the patient history.

Results
Sudden visual loss: trauma complication (section, traction, lesion with bone fragment), ischemia either transient (transient ischemic attack) or irreversible: imaging focused on the vessels of the neck in emergency (stenosis). Other ophthalmological causes: acute glaucoma. Progressive visual loss with pain: 1- Optic neuritis. Main optic nerve abnormalities: increased volume, hyper signal on T2 WI, contrast enhancement if acute. According to the location of the abnormalities and associated brain lesions: multiple sclerosis, acute demyelinating encephalomyelitis, DEVIC disease or other causes of neuritis. 2- Tumor, more seldom, glioma (mainly children with NF1). 3- Compression: often associated with optic atrophy at fundus examination, mainly due to meningioma. 4- Glaucoma: Visual field abnormalities. Bi temporal hemianopia: optic chiasm lesion mainly compression (pituitary macroadenoma), glioma (less typical). Homonymous hemianopia. Occipital, parietal, temporal or optic tracts lesion. Imaging depending on the clinical presentation (acute: vascular event, progressive: tumoral, infectious or inflammatory diseases).

Conclusions
Seeing and looking is precious. Knowledge of the clinical presentation of visual pathways disturbances, of the difference between anterior and posterior lesion, of the protocols needed depending on the clinical data, and of the different aspects of the pathology is mandatory to help the diagnosis, orientate the therapeutic approach and preserve at best our patients vision.

Intracranial and Intraorbital Complications of Sinusitis and Atypical Sinus Infections: What the Radiologist Needs to Know.

Z Chaudhry, A Salem, S Osei-Bonsu, V Velayudhan, D Reede, R Holliday, L Gentry, W Smoker
Purpose
1. Review relevant sinus anatomy that facilitates the spread of disease to the orbit and intracranial compartments. 2. Learn the imaging features and clinical findings of intracranial and orbital complications of typical and atypical sinus infections. 3. Demonstrate how to use an image-based algorithm to facilitate the detection of the complications of sinusitis.

Materials and Methods
Material is presented in a quiz format to emphasize key points. Relevant anatomy of the paranasal sinuses, orbits and adjacent structures in the face and intracranial compartments is discussed. After a review of the relevant anatomy, cases (including clinical history) are presented to demonstrate common complications associated with infections in various sinuses. This is followed by a discussion of pathology in the different anatomical regions with an emphasis on the anatomical areas to scrutinize for clues of important and atypical pathology and complications associated with specific sinus infections. Pathophysiologies of orbital and intracranial complications are discussed including the Chandler classification of orbital complications of sinusitis. An image-based algorithm is provided to facilitate detection of the complications of typical and atypical sinus infections.

Results
Meningitis and other intracranial complications are more common with frontal sinus disease due to their proximity to the brain, loose dural attachment in this region and drainage via valveless diploic veins. Complications associated with specific sinuses are presented as follows: ethmoid and, less commonly, maxillary (pre and postseptal cellulitis, orbital and subperiosteal abscess and sagittal sinus thrombosis), sphenoid (cavernous sinus thrombosis and epidural abscess) and frontal (preseptal and orbital cellulitis, Pott puffy tumor, meningitis, epidural abscess, subdural empyema and cerebral abscess). Cases of invasive fungal sinusitis are shown to stress the importance of assessing the soft tissues adjacent to the sinuses. Imaging findings of angioinvasive fungal disease (i.e., mucormycosis) and associated complications, such large vessel arteritis and infarcts also are discussed.

Conclusions
This exhibit illustrates the imaging features of a spectrum of complications associated with sinusitis and reviews imaging findings of atypical infections. Complications from sinusitis are uncommon, but can be life threatening. Major complications include extension into the orbit and intracranial compartments that may require emergent operative intervention by ophthalmology, otolaryngology and/or neurosurgery. Immunocompromised patients with acute sinusitis also are susceptible to infections from unusual pathogens, such as invasive fungal sinusitis, which is a surgical emergency. Therefore, it is important to accurately and promptly identify atypical infections and complications of sinusitis. Knowledge of pertinent anatomy, typical patterns of disease spread, complications associated with infections in specific sinuses and key imaging findings improves diagnostic accuracy, which expedites appropriate treatment and improves patient outcomes.
Knowing what, when and how to interpret: Guide to imaging of salivary gland pathology.

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\textsuperscript{1}University of Iowa hospitals and clinics, Coralville, IA, \textsuperscript{2}University of Iowa Hospitals and Clinics, Coralville, IA, \textsuperscript{3}University of Iowa hospitals and clinics, Iowa city, IA, \textsuperscript{4}University of Iowa Hospitals & Clinics, Iowa city, IA

Purpose
Salivary gland pathology is very varied, ranging from inflammatory etiologies to neoplastic and obstructive entities. It is imperative the radiologist be familiar with the options available including the advances and approaches currently in imaging and on the otolaryngology front.

Materials and Methods
A brief overview of the normal anatomy of salivary glands is presented. Various modalities then are discussed with advantages and disadvantages. These are illustrated with examples from our database. A short quiz is presented at the end; aimed at consolidating the knowledge in the presentation.

Results
Due to the variety of salivary gland pathology; deciding the best imaging test for a particular pathology can be challenging. The radiologist plays a central role in moving towards a decision and then is ultimately tasked with interpreting the exam. This exhibit should help the radiologist in making such decisions. The modalities discussed include Conventional Sialography, MRI, CT, ultrasound and PET CT. The figures show examples of sialolithiasis, parotid spill and a parotid oncocytoma. The advantages and disadvantages include radiation dose involved, pathology best
seen, cost, and accessibility. Technical advice also is given on getting the maximum out of each modality.

Conclusions
Salivary gland pathology is commonly encountered by radiologists and clinicians and the choice of the right modality is crucial for minimizing morbidity and mortality. The presentation aims at preparing the radiologist on the what, when and how of salivary gland imaging interpretation.
Laryngeal trauma – complicated acute imaging and chronic sequelae

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\textsuperscript{1}UC San Diego Health System, La Jolla, CA, \textsuperscript{2}UC San Diego, San Diego, CA

Purpose
To review the acute imaging findings of laryngeal trauma with cases to illustrate a systematic approach of supraglottic, glottic, subglottic trauma patterns, with normal and chronic post-trauma imaging for comparison.

Materials and Methods
A 10-year review of the imaging database of a level I Trauma center inclusive of adult blunt and penetrating neck trauma identified cases of acute laryngeal trauma, acute extra-laryngeal neck trauma, and patients with chronic sequelae of laryngeal trauma.

Results
This exhibit will review the normal laryngeal anatomy and indicators for surgical versus conservative management of laryngeal trauma. Key cases include the following: -Supraglottic: acute fractures of hyoid and thyroid cartilages, healed chronic hyoid and thyroid fracture deformities, postsurgical fixation of thyroid cartilage fracture, discussion regarding endoscopic 'blind spot' of epiglottis displacement due to thyroepiglottic ligament injury. -Glottic: vertical thyroid cartilage fracture, acute vocal cord paralysis, discussion of arytenoid separation in setting of trauma versus intubation. -Subglottic: Acute cricoid fracture and chronic fracture deformities, acute laryngotracheal separation and chronic sequelae. -Extra-laryngeal: Penetrating and blunt soft tissue trauma, acute ICA dissection concomitant with laryngeal injury, acute pyriform sinus and esophageal rupture, thyroid gland injury, evaluation of suspected recurrent laryngeal nerve injury. Figure 1: Axial CT imaging for acute blunt neck trauma demonstrates a fracture of the cricoid (A) with airway narrowing, and diffuse loss of the normal planes of the subglottic airway (B) associated with laryngotracheal separation. Axial CT with contrast performed 10 years later shows the chronic healed fracture deformity (C) and restoration of the laryngeal anatomy post
surgical fixation (D). Additional planes and volume rendering will be provided with case illustrations.

Conclusions
Acute laryngeal trauma can be difficult to evaluate given concomitant need for intubation or additional life-threatening injuries, however given the improved outcomes with early repair, it is important to identifying these injuries on cervical spine and CT angiographic exams. Understanding of endoscopic 'blind spots' and factors which influence surgical management facilitate communication in the acute setting. Additionally, recognition of traumatic sequelae is important for appropriate evaluation of laryngeal function in the chronic setting.
Magnetic Resonance Imaging: Relevance to Space Medicine

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¹University of Texas Health Science Center-Houston, Houston, TX, ²The University of Texas Medical Branch, Galveston, TX, ³USRA, Houston, TX

Purpose
To describe how quantitative and qualitative magnetic resonance imaging techniques are being utilized to better understand the etiology of visual impairment in astronauts recently manifested with progressively longer missions in microgravity.

Materials and Methods
All imaging is performed at 3T using an eight-channel sense-encoding head coil. Phase-contrast flow analysis through the mid cerebral aqueduct is utilized to measure cerebral spinal production rate pre and postflight to assess for any physiologic response to microgravity. High resolution axial 3D T2-weighted fast spin-echo imaging of the orbits currently is the standard acquisition technique in the anatomical imaging assessment. This technique provides detailed anatomy of the orbits necessary to identify subtle morphological changes after exposure to microgravity. The optic nerve sheath diameter is measured to evaluate for abnormal dilatation and the sheath is evaluated for a kink. The optic nerve papilla is evaluated for reversal of the physiologic cup. The posterior globe contour is evaluated for loss of normal convexity. The retrolaminar optic nerve is evaluated for abnormal thickness. Sagittal T2-weighted images of the pituitary gland are evaluated for displacement of the pituitary stalk and concavity of the pituitary dome.

Results
Evaluation of astronauts exposed to microgravity reveals consistent and ongoing evidence of various degrees of posterior globe flattening when compared to preflight data sets indicative of exposure to intracranial hypertension. Evidence of intracranial hypertension is supported further by abnormal dilatation of the optic nerve sheath, optic nerve sheath kink, reversal of the physiologic cup of the optic nerve, optic nerve thickening and posterior displacement of the pituitary stalk with moderate concavity of pituitary dome. Simultaneous evaluation of the cerebral spinal fluid production rate shows additional evidence of modulation related to intracranial hypertension.

Conclusions
Magnetic resonance imaging using both physiologic and anatomical approaches has been instrumental in understanding changes in astronaut vision after exposure to microgravity. The hyperoptic shift in vision experienced by a large percentage of astronauts is in part a direct result of posterior globe flattening physically displacing the focal point of the retina towards the lens. Clinical evidence of optic disc edema in a subset of astronauts is further supported by reversal of the normal physiologic cup of the optic papilla associated with dilatation of the optic nerve sheath, optic nerve sheath kink and thickening of the optic nerve. Changes of pituitary gland morphology and cerebral spinal fluid production rate although subclinical also are supportive of exposure to intracranial hypertension. The combination of high resolution orbital imaging and cerebral spinal fluid production rate also may prove useful in the evaluation of new therapies for
idiopathic intracranial hypertension as both anatomical and physiologic parameters can be measured simultaneously using the same imaging modality.

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eEdE-138

6:30AM - 3:00PM

More than sinusitis & polyps - malignant tumours of the paranasal sinuses: A radiologic-pathologic correlation

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Purpose
1. To review the pathophysiology and mechanisms of spread of the common and uncommon
malignant tumors of the paranasal sinuses. 2. To pictorially demonstrate both the radiologic and pathologic findings of these tumors. 3. To exemplify how the gross anatomical and histologic findings correlate with those seen on CT and MR imaging. 4. To explain the pertinent radiologic positives and negatives in order to guide successful operative planning.

Materials and Methods

Sinus disease is very common, but malignant paranasal sinus tumors are rare adult otolaryngological presentations, comprise only 3% of all head and neck cancers and 1% of all malignancies. Even if imaging is performed early, a radiologist inexperienced with sinonasal anatomy and tumor features may interpret early signs of a malignant tumor as benign. Radiology trainees typically do not see the pathological correlation of these tumors after surgical resection. It is vital that the pathology of these tumors is understood and considered, especially the routes of spread of tumors.

Results

Key 'red flag' imaging features that are suggestive of malignancy include bony destruction, perineural spread, lymphadenopathy and intracranial extension. The spread of tumor can be direct, lymphatic, or perineural. CT and MRI play complementing roles in the evaluation of these tumors.

Conclusions

Radiologic identification of paranasal sinus tumors can play a vital role in the early diagnosis, management and treatment of patients.

Morphological Change on Skull Base by Achondroplasia

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Purpose

To learn process of how the skull base generates and to know detailed and substantial morphologic changes on the skull base that occurred in achondroplasia with embryology.

Materials and Methods

Achondroplasia is the most common skeletal dysplasia. It is caused by FGFR3 gene and MAPK signaling changes. Hypoplasia of the skull base can cause neurological complications in achondroplasia. Previous studies have shown that the small foramen magnum is implicated in sudden death and temporal bone rotation is related partially to hearing loss. Although there have been many papers studying specific locations, only a few reviews of imaging findings have been reported so far. Here, therefore, we make the comprehensive review of morphological changes on the skull base by achondroplasia, including embryology.

Results

The characteristics of the skull base in achondroplasia follow: 1. Small posterior cranial fossa, including small foramen magnum having a tail, short clivus and narrowing of the jugular foramen. 2. Early closure of sphenoid-occipital and ocipital bone synchondroses. 3. Foreshortening of the carotid canals. 4. Shortened cribriform plate length. 5. Prominent basal
emissary foramina. 6. Acute cranial base angle. 7. Poor development of the mastoid air cells. 8. Increasing anterior sphenoidal length. 9. Towering petrous ridges. 10. Rotation of the temporal bone structures. These findings can be explained well by disturbance of endochondral ossification and accelerated fusion of ossification centers.

Conclusions
Understanding vital morphologic changes on the skull base with embryology helps you to know various neurological complications in achondroplasia.
MR Imaging Review of the Skull Base Foramina and Their Lesions

B Sur

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Purpose
Complex and intricate anatomy of the skull base foramina can make identification of disorders affecting them challenging. These foramina can be involved with various diseases including central nervous system and peripheral nervous system malignancies as well as benign masses. Radiologic evaluation of the skull base foramina plays a critical role in diagnosis and treatment planning. In this exhibit, we will review the anatomy of the skull base foramina with illustrations and corresponding CT and MR images. Then, common disorders affecting the foramina are highlighted with exemplary images. Knowledge of the anatomy and recognition of these imaging features will allow radiologists to provide complete imaging assessment and suggest appropriate differential diagnostic considerations.

Materials and Methods
We will review the anatomy of the skull base foramina with illustrations and corresponding CT and MR images. Then, various benign and malignant masses involving the foramina will be demonstrated with exemplary MR images to highlight their characteristic imaging findings.

Results
Distinct cranial nerves and vessels reside in the skull base foramina and they can be involved with malignant and benign disorders. These cases include meningioma, esthesioneuroblastoma, optic nerve glioma, schwannoma, squamous cell carcinoma, chordoma, epidermoid, glomus tumor, metastases, Bell's palsy, and aneurysm.

Conclusions
Understanding of the anatomy of the skull base foramina, knowledge of the characteristic and differential imaging findings of disorders affecting them, and reviewing pertinent clinical history will allow radiologists to formulate accurate diagnoses and present appropriate differential diagnostic considerations.

Navigating the Temporal Bone and IAC to Reveal Hearing Loss Pathology: A Diagnostic Algorithm.

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Purpose
To review complex temporal bone anatomy with a systematic approach and algorithmic checklist to identify causes of hearing loss.

Materials and Methods
We propose a systematic search pattern of the temporal bone on CT and internal auditory canal
on MRI with an algorithmic checklist focused on anatomical/structural abnormalities, patient age, pathology location, imaging characteristics, and clinical pearls to assist in navigation and pathology interpretation.

Results
The temporal bone contains intricate and complex anatomy which can be difficult to navigate without a systematic approach. We present a search pattern for navigating the temporal bone on CT and the internal auditory canal on MRI to elicit findings. Additionally, we present a diagnostic algorithm to help identify causes of conductive, sensorineural and mixed hearing loss. Selected examples will be presented following this algorithm to include congenital, infectious, inflammatory, autoimmune, traumatic, and neoplastic pathology.

Conclusions
A systematic approach and diagnostic checklist can assist in the anatomical navigation and pathological identification of conductive and sensorineural hearing loss causes.
Example Case: 11 month old M with left sensorineural loss due to Comm malformation. Normal right side shown for comparison.

A: CT Rt axial

B: CT Lft axial

C: CT Rt coronal

D: CT Lft coronal

Normal Cochlea

Normal Superior Semicircular canal, Vestibule, and Basal turn of cochlea

Confluence of the semicircular canals cavity

Widened IAC

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Example Case: 19 year old M with sudden onset left sensorineural loss, severe facial paralysis due to a large, Complex cholesterol granuloma involving CNs.

Figure: A – Large expansile T1 hyperintense lesion (yellow arrows) at the left jugular foramen and IAC. The lesion was also found to involve the 7th and 8th nerves complex leading to sensorineural deafness. B – This lesion exhibits T2 hypointense signal (arrows). On post contrast imaging, there was no central enhancement but significant periphery enhancement. The patient required trans-mastoid drainage with resolution of symptoms.

Neoplasm of the Nasal Cavity: A Pictorial Review.

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Purpose
This electronic educational exhibit will define the anatomy of the nasal cavity and provide an image rich review of both common and rare nasal cavity tumors.

Materials and Methods
The exhibit will begin with a review of normal nasal cavity anatomy including a definition of margins and delineation of pertinent contents. The exhibit then will transition to a pictorial review of both common and rare nasal cavity tumors with an emphasis on differentiating radiographic features. A wide variety of nasal cavity tumors are described, including, squamous cell carcinoma, sinonasal undifferentiated carcinoma, melanoma, lymphoma, plasmacytoma, chondrosarcoma, neuroendocrine tumor (attached graphic), juvenile angiofibroma, hemangioma, solitary fibrous tumor, esthesioneuroblastoma and inverted papilloma. Non-neoplastic mimics such as hemophiliac pseudotumor, polyposis, allergic fungal sinusitis with sinonasal polyposis, fractured turbinate, encephalocele, and nasal glioma also are reviewed.

Results
A wide variety of tumors may arise from the nasal cavity, commonly with overlapping clinical presentations. The correct diagnosis may not be readily determinable on visual inspection alone. Therefore, imaging plays a vital role in the management of these patients, and it is essential that the radiologist knows relevant anatomy and key differentiating imaging features that allow an appropriate differential diagnosis.

Conclusions
The nasal cavity often is an overlooked subject in head and neck imaging. This educational exhibit provides an in-depth review of nasal cavity masses with an emphasis on differentiating radiographic features.
Purpose
1) To have an understanding about the common and uncommon but potentially life threatening conditions of the head and neck. 2) To discuss the CT and MRI findings of these emergency conditions and the relevance in patient management.

Materials and Methods
Retrospective analysis of the cases retrieved from PACS database (from 2005-2015) was done.

Results
The findings included, but were not limited to the following: 1) Neck infections that may compromise the airway and their extensions like retropharyngeal abscess, Ludwig angina and necrotizing fasciitis. 2) Orbital pathologies like pseudo tumor and carotid cavernous fistula which acutely compromise vision. 3) Acute inflammatory conditions like angioedema and calcific longus colli tendinitis. 4) Sinusitis and their complication including intracranial. 5) Vascular conditions like Lemierre syndrome. 6) Spinal infections like discitis and septic facetar arthritis.

Conclusions
Knowledge of the imaging findings of common and common conditions of the head and neck is essential for prompt diagnosis and optimal treatment.
Inflammatory changes centered within the left submandibular space in a patient with

Ludwig's angina
Orbital Lymphoproliferative Disorders: the Great Mimicker.

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Purpose
Present the varying imaging appearances of orbital lymphoproliferative disease from the common to the uncommon and discuss the patterns of orbital involvement that it may assume. Reinforce several CT/MRI findings that may provide specificity in the proper inclusion of lymphoproliferative disease of the orbit in the radiologists' differential diagnosis.

Materials and Methods
Lymphoproliferative disease of the orbit is important due to its relative frequency (5-10% of orbital masses, 55% of malignant orbital tumors) and because of its occasional difficult clinical, radiological and pathological diagnosis owing to the wide potential range of imaging and pathologic features it can present. We present a pictorial review of CT and MRI findings with common and uncommon patterns of presentation of this pathology, and reinforce imaging points that may be helpful in diagnosing this lesion.

Results
The most common pattern of presentation of orbital lymphoproliferative disease is a smooth, well circumscribed mass that enhances uniformly situated in the anterior extracanal region. Orbital lymphoma may present in a wide range of uncommon patterns, such as a trans-spatial mass, a diffuse and ill-defined lesion, or as a lacrimal lesion. It can affect any compartment of the orbit: Globe, conjunctiva, nerve/sheath, extraocular muscles, orbital fat and lacrimal glands. It therefore can be the mimicker of many different orbital entities.

Conclusions
Orbital lymphoproliferative disease can be found in various patterns and be located everywhere in the orbit. It frequently is contained in the differential diagnosis of orbital disease. Some imaging findings can be quite helpful in the diagnosis.
Purpose
1. To review the differential diagnosis of facial swelling in children. 2. To explain how CT and MR are used to distinguish causes of facial swelling in children. 3. To provide a pictorial review of common and rare causes of pediatric facial swelling.

Materials and Methods
Pictorial review of common and rare causes of pediatric facial swelling, utilizing CT and MR imaging. Discuss certain imaging features which help to distinguish causes of facial swelling in children and narrow the differential diagnosis. Categories will be divided into the following categories: Infectious, Inflammatory, Vascular, Neoplastic and Traumatic etiologies.

Results

Conclusions
Pediatric facial swelling can be attributed to a number of different etiologies creating a vast and sometimes overwhelming list of differentials. The use of present imaging modalities, specifically; MRI and CT provide information regarding extent of disease, tissue characteristics: (solid versus cystic), enhancement patterns, and nodal involvement. This information along with good clinical history can help narrow the differential diagnosis for the clinician, leading to more targeted and effective treatment.

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**PET-CT and MRI Unusual Findings of Perineural Tumor Spread in Head and Neck Cancer and Review of the Literature.**

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Purpose
To show the usefulness of MRI and PET CT for the detection of perineural tumor spread (PNTS) during the staging or follow up of head and neck cancers with common and unusual case presentations.

Materials and Methods
Selected cases of head and neck cancer from our imaging library were chosen to demonstrate
classic and unusual MRI and PET CT findings of PNTS, with discussion based on literature review.

Results
Perineural tumor spread was identified as abnormal signal, thickness, and enhancement of the nerve on MRI, as well as focal/linear hypermetabolic activity along the nerve on PET CT. Trigeminal and facial nerve involvement are a common, well known presentation. However, skip lesions away from the primary site are potential presentations. We present C2 and C3 nerve roots skip lesions of PNTS, most likely via the great auricular nerve, and skip lesions to the brachial plexus. Secondary findings such as denervation atrophy also may help localize PNTS. In one of our cases, leptomeningeal dissemination was identified as extended involvement of cervical nerve root PNTS.

Conclusions
Perineural tumor spread is a mechanism of neoplastic dissemination through perineural stroma which significantly changes clinical management. Although well described in the literature, the detection of PNTS is difficult for unexperienced eyes. Knowledge of the primary and secondary findings, as well as common and potential unusual presentations on MRI and PET CT, may help to improve patient care and clinical management.

**Pictorial Review of Orbital Tumors and Tumor-like Lesions**

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Purpose
Orbital masses may comprise a spectrum of benign and malignant entities, some of which are rare. The purpose of this exhibit is to review the normal orbital anatomy, vascular supply, and imaging features of orbital masses as seen on multidetector computed tomography (MDCT) and magnetic resonance imaging (MRI) studies.

Materials and Methods
A retrospective review of pediatric and adult orbital masses imaged at a tertiary referral center over a 5-year period (2009-2014) was performed with radiological and pathological correlation. Images of each entity will be presented with any distinguishing imaging features, diagnostic pearls, pitfalls, treatment and prognosis discussed.

Results
A spectrum of benign and malignant orbital masses was found in our adult and pediatric population. The differential diagnosis of orbital masses often was broad and complicated given the similar imaging characteristics of several orbital entities. Consideration of the patient's age and exact location of the mass in the orbit was essential. Examples of the cases includes: cavernous hemangiomas, ophthalmic nerve (CN V1) schwannomas, optic nerve gliomas, optic nerve sheath schwannomas, lacrimal gland neoplasms, tumor-like lesions (orbital varices, inflammatory orbital pseudotumors), etc.

Conclusions
It is crucial for the radiologists to be familiar with the imaging features of pediatric and adult orbital masses which have distinct outcome and treatment planning.
Radiological Approach to Pediatric Neck Masses

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Purpose
In the pediatric population, more than 50% of neck masses correspond to vascular and nonvascular congenital malformations. Many of these masses have an initial presentation with associated inflammatory changes secondary to infection or bleeding making it more difficult to make an accurate diagnosis; however, approximately 10% of these neck masses are malignant. The anatomical location of these masses and their relation to the adjacent cervical structures can narrow the differential diagnosis and guide further surgical management. The initial approach to diagnosis these masses is ultrasound and complementary MRI frequently is performed. The use of DWI and 4D MRA provides additional valid information for the assessment of these masses. The aim of this educational poster is to narrow the differential diagnosis in neck masses according to their anatomical position and imaging characteristics.

Materials and Methods
This pictorial essay will show pediatric neck masses with probed pathology diagnosis. The poster will describe the initial radiological approach and high yield imaging characteristics that can help to give an accurate diagnosis based on imaging and surgical approach.

Results

Conclusions
Knowledge of the imaging characteristics and location of the most frequent pediatric neck masses will allow an accurate management, treatment and surgical approach of these lesions, especially in the cases where the lesions are complicated by bleeding or infection at their presentation.

Radiological Assessment of Typical and Atypical Orbital Infections: A Space-based Approach.

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Purpose
- Illustrate the imaging features of typical and atypical orbital infections utilizing a space-based approach. - Elucidate critical imaging findings of orbital infections which affect clinical management. - Discuss noninfectious disease entities which may mimic the imaging appearance of orbital infection.

Materials and Methods
- Review of pertinent anatomy of the orbit using computed tomography (CT) and magnetic resonance imaging (MRI). - Exhibit the spectrum of imaging findings of orbital infections using CT and MRI. - Illustrate important imaging findings which are crucial to patient care. - Demonstrate orbital pathologies which share similar imaging findings with infection.
Results
- Infections may involve the preseptal, intraorbital, and ocular soft tissues, requiring differing clinical management. - Imaging is crucial in the distinction between preseptal and orbital cellulitis, which are infections of the orbital soft tissue superficial and deep to the orbital septum, respectively. - Invasive fungal sinusitis is a potentially lethal infection with specific imaging features which often secondarily involves the orbit. - Infection may primarily affect the globe and tunicae, resulting in endophthalmitis. - Orbital inflammatory conditions and neoplasms may demonstrate overlapping imaging findings with infectious processes.

Conclusions
Orbital imaging evaluation is a routine first step in suspected orbital infection. CT and MRI can reliably detect pathology, identify the spaces involved, and assess for potential complications which may alter clinical management. Stratification of infections by the affected space is helpful in the differential diagnosis, prediction of potential complications, and directing appropriate clinical care.
Radiological Imaging Approaches and Findings Following Treatment for Orbital Regional Tumors

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Purpose
A wide variety of benign and malignant neoplasms can affect the orbit, either primarily or secondarily, such as via extension of a tumor from a neighboring structure or as a metastasis. Likewise, there are many types of orbital oncological therapeutic modalities available, including surgery, chemotherapy, and radiation. The various types of orbital oncology treatments and their corresponding expected and complicated imaging features are reviewed in this exhibit.

Materials and Methods
CT and MRI generally are suitable modalities for post-treatment surveillance of the orbit. Positron emission tomography (PET) using [18F]-2-deoxy-d-glucose (18FDG) serves a role as a staging tool in ophthalmic oncology, particularly for detecting distant metastatic lesions that conventional imaging studies may otherwise miss. Besides the initial work up of orbital tumors 18FDG-PET can be useful for the assessment of treatment response. The interpretation of post-treatment imaging can be particularly challenging due to the altered anatomy and tissue properties caused by many forms of treatment. Furthermore, many oncological treatments can cause complications that warrant investigation via diagnostic imaging. Some of these complications have particularly characteristic and interesting imaging findings. In order to optimally approach an imaging study of the orbit after treatment, it is important to know what the original tumor was like, the type and timing of the therapy that was administered, and the clinical status of the patient at the time of the scan.

Results
The imaging findings of the following topic will be depicted and discussed: * Orbital biopsy and associated complications. * Enucleation and exenteration procedures, implants and prostheses, and associated complications. * Optic nerve resection. * Radiation therapy and associated complications.

Conclusions
Diagnostic imaging not only plays an important role in the assessment of patients with orbital neoplasms in the post-treatment period.
Purpose
The use of flaps is an integral part of reconstructive techniques in head and neck surgery. This presentation aims to review the basic principles behind reconstructive flaps and characterize their imaging appearance.

Materials and Methods
The indications, anatomical, and technical considerations in flap reconstruction are presented. Clinical cases illustrating when and how reconstructive flaps aid in the surgical treatment of various head and neck conditions are provided. The imaging features of flaps are characterized.

Results
Flaps commonly are used in head and neck surgery for restitution of function and cosmesis. It is important to be familiar with the imaging appearance of flaps in order not to mistake them for pathology. For example, an enhancing flap particularly in close proximity to the previous site of resected tumor, may be misinterpreted as disease recurrence. Conversely, the benign nature of the flap may be overlooked in the presence of recurrent disease nearby. Thus, imaging of reconstructive flaps can be challenging. Serial imaging aids in elucidating the true status (i.e., pathologic versus benign) of the flap in question.

Conclusions
The basic principles behind flap reconstructions are provided. Familiarity with the postoperative imaging appearance of flaps may avert misinterpretations and potential mishaps.
Retromolar Trigone Cancers: The overlooked ability of 16 section MDCT in evaluating bone erosion and assessing resectability.

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Purpose
To use axial sections and multiplanar reformations (coronal, oblique and sagittal) and puffed cheek technique with 16 slice MDCT, 1. To demonstrate the normal anatomy of the retromolar trigone (RMT) and 2. To depict the ability of MDCT to accurately evaluate soft tissue extent and bone erosion in RMT cancers.

Materials and Methods
The ability of contrast-enhanced MDCT to image the RMT region is described scantily in the literature. With the puffed cheek technique and multiplanar reformations including the less
described oblique reformation, this curved region can be imaged adequately to accurately evaluate mandibular and maxillary erosion as well as the posterior soft tissue extent.

Results
The retromolar trigone is an area familiar to the oral surgeon, but often not amenable for clinical examination due to posterior location, dentition and trismus accompanying cancers of this region. MR imaging has been advocated as the optimal modality for evaluating the RMT with reported high accuracy for T staging. However the important factors that affect treatment of RMT cancers are a) posterior soft tissue spread, b) presence and extent of mandibular erosion apart from c) nodal status. MDCT with its capability of generating high-resolution reformatations ad hoc in any plane and its speed of scanning has an advantage over MRI. The oblique sagittal reformation best demonstrates the alveolar crest as well as inferior alveolar canal in the curved RMT region in entirety while the coronal reformation helps measure the depth of erosion. MDCT also can adequately depict the posterior soft tissue extent, its superior limit with respect to the mandibular notch as well as extension into pterygopalatine fossa, factors that decide resectability.

Conclusions
This exhibit aims to familiarize the radiologist with the often overlooked extended capabilities of MDCT to depict the RMT region, accurately stage cancers of this region and decide resectability of these cancers.

eEdE-122

Review of the Pterygomandibular Raphe

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Purpose
1. To review the relevant anatomy of the pterygomandibular raphe. 2. To describe route of spread of oral cavity cancer via the pterygomandibular raphe. 3. To use case examples to illustrate oral cavity cancer involving the pterygomandibular raphe. 4. To discuss implications for treatment of oral cancer involving the pterygomandibular raphe.

Materials and Methods
A literature review on oral cavity cancer involving the pterygomandibular raphe was performed. Current understanding of anatomy and clinical relevance with regard to treatment will be presented. CT, MR, and PET images demonstrating the relevant anatomy as well as examples of typical imaging findings seen in oral cavity cancer involving the pterygomandibular raphe were collected at University of Florida Health in Jacksonville, Florida. Patient identifying information was removed so the images may be presented for educational purposes.

Results
The pterygomandibular raphe is an underappreciated conduit for spread of oral cavity cancers. This structure often is overlooked by radiologists but is an important landmark for appropriate staging and treatment. Relevant anatomy will be reviewed including anatomy of the mandibular retromolar trigone, adjacent musculature, and connections with the buccal fat and osseous skull base. Cross-sectional and illustrative images will be reviewed demonstrating normal anatomy.
and salient imaging findings regarding oral cavity spread of cancer via the pterygomandibular raphe.

Conclusions
The pterygomandibular raphe is an important route of spread for head and neck cancers. We review the anatomy of the pterygomandibular raphe and show case examples of its involvement in head and neck cancer. Because the pterygomandibular raphe is not detected clinically, knowledge of the relevant anatomy and imaging findings is critical to facilitate correct clinical management.

Role of Imaging in Pre-Operative Planning in Modern Endoscopic Skull Base Surgery

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Purpose
To outline modern endoscopic approaches in skull base surgery, discuss their indications and limitations, and define the role of imaging in pre-operative planning.

Materials and Methods
The presentation begins with a simple methodology for classifying endoscopic approaches of the midline skull base and defines their anatomical limits. Then, imaging features of select cases of lesions involving the skull base are discussed, highlighting important surgical landmarks and key findings that routinely may not be included in the report but represent critical information the surgeon needs to know for pre-operative planning.

Results
Different endoscopic approaches may be undertaken depending on the nature of the target lesion, its location, and the nasal corridor. These include transcribriform/transplanum approaches for access to the anterior skull base, transtuberculum/transsellar approaches for access to the sella and parasellar regions, transterygoidal approach to access the petrous apex and infratemporal fossa, transclival approach for access to the clivus and transodontoid approach to access the craniocervical junction. Depending on the endoscopic approach, the surgeon should be aware of neurovascular landmarks and potential critical variant anatomy. For lesions in the sella/parasellar regions, a transsphenoidal corridor may be navigated, in which case it is important for the neuroradiologist to convey the morphology of the sphenoid sinus, including the size and presence of septations, the sellar size, the intercarotid distance, the presence or absence of carotid or optic nerve dehiscence, the relationship of the pituitary gland to the tumor, the stalk, optic apparatus, anterior cerebral arteries and the cavernous sinus. The vidian canal is another critical landmark for the second genu of the internal carotid artery as is the Eustacian tube for the paraclival portion or transclival and transodontoid approaches.

Conclusions
Modern endoscopic techniques allow greater access to a wide variety of skull base lesions than conventional neurosurgery. The importance of collaboration between the neurosurgeon and the neuroradiologist must be stressed since pre-operative imaging can provide invaluable information, including key anatomical landmarks and critical variants, which may facilitate surgery and lead to improved clinical outcomes.
Sellar and Suprasellar Mimics: A Case Review Series

A Sneider¹, R Bhatia², N Nagornaya³, C Sidani⁴
Purpose

Mimics of typical sellar and suprasellar lesions are relatively rare and can present a diagnostic dilemma with vital therapeutic implications. The authors report a pictorial review of various common and uncommon mimics of sellar and suprasellar lesions. Also included are more common cases which may have imaging characteristics that are atypical and mimic other lesions.

Materials and Methods

Retrospective case review of patients presenting to the Department of Radiology at Jackson Memorial Hospital and the University of Miami MRI Center, which demonstrated atypical lesions of the sellar and suprasellar spaces, as well as more common lesions found at these locations with atypical imaging characteristics.

Results

We present multiple cases in which uncommon sellar or suprasellar lesions have the appearance of other more often encountered masses of this location. Included are cases such as bilateral cavernous internal carotid artery aneurysms which protrude into the suprasellar space, as well as an optic nerve cavernoma, lymphocytic hypophysitis and Rosai-Dorfman disease. Additionally, a fatal case of an enhancing hypothalamic mass which was pathologically proven to represent paraneoplastic syndrome. We also present atypical imaging characteristics of more common lesions, such as lymphoma, metastasis and arteriovenous malformation.

Conclusions

Many less commonly encountered pathologies of the sellar and suprasellar spaces may mimic those lesions which present more commonly in practice. In contrast, typical lesions of the sellar and suprasellar spaces may have atypical imaging characteristics, altering our differentials. Here, we review a set of cases which challenge both our knowledge of sellar and suprasellar lesions, as well as our eyes.
Sigmoid Sinus Wall Anomalies and Idiopathic Intracranial Hypertension Resulting in Pulsatile Tinnitus: Spectrum of Imaging Findings

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Purpose
Pulsatile tinnitus is a common disorder that can be caused by a variety of pathologies. Although anomalies of the jugular bulb as a cause of tinnitus are well known to neuroradiologists, the spectrum of sigmoid sinus wall anomalies that can result in pulsatile tinnitus is now increasingly recognized. The purpose of this exhibit is to illustrate the appearance of these anomalies on high resolution CT and also to discuss the relationship between these anomalies and idiopathic intracranial hypertension, an association that still is not completely understood. Findings after surgical reconstruction of the sinus wall also are described.

Materials and Methods
A retrospective review of high resolution CT studies for pulsatile tinnitus was performed. An initial cohort was compiled of all cases where the imaging findings suggested a venous cause of the tinnitus. The final group was selected based on relevant imaging features and surgical confirmation of a sigmoid sinus wall anomaly.

Results
Sigmoid wall anomalies include attenuation of the sinus plate, frank dehiscence resulting in exposure of the sinus to the air in the mastoid air cells (the "air on vein" sign), diverticula and segmental sigmoid sinus ectasia. A high prevalence of imaging findings associated with intracranial hypertension including "empty" sellae, distended optic nerve sheaths and venous sinus stenosis were observed. Postoperative complications are rare, but may include sinus thrombosis and operative site hemorrhage.

Conclusions
The neuroradiologist plays a key role in the evaluation of pulsatile tinnitus. Careful scrutiny of the sigmoid sinus wall may reveal a spectrum of abnormalities that may result in pulsatile tinnitus. If detected, imaging signs that may support a diagnosis of idiopathic intracranial hypertension must be sought.
Spectral Evaluation of Head and Neck Lesions Using Dual Energy CT

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Purpose
There is increasing evidence to support the advantages of using dual energy CT (DECT) for evaluating head and neck lesions. The purpose of this exhibit is to provide a practical review of the approaches to, and of the current applications of, DECT for head and neck imaging.

Materials and Methods
This exhibit will provide an overview of (1) general approaches to lesion analysis using a single source DECT scanner with rapid kVp switching, and (2) of its specific applications in the evaluation of head and neck lesions. A review of the principles of gemstone spectral imaging (GSI; GE Healthcare, Milwaukee, WI), of virtual monochromatic images (VMIs), and of analytic tools such as spectral Hounsfield unit attenuation curves, effective Z, and iodine overlay maps, will be undertaken. Subsequently, specific applications of DECT for evaluation of head and neck lesions, such as head and neck squamous cell carcinoma (HNSCC), will be discussed.

Results
Dual energy CT with GSI enables reconstruction of VMIs at various energy levels, which can be used to accentuate different tissue characteristics. Iodine overlay maps can be generated, which reflect and can be used to quantify the iodine content of enhancing lesions such as HNSCC. Additional analysis, including calculation of the effective Z of tissues, analysis of ROIs, and comparison of spectral curves, also can be performed. Low keV VMIs can be used to increase the conspicuity of enhancing lesions such as tumor, whereas high keV VMIs can be used to improve visualization of areas obscured by artifact. High keV VMIs and iodine overlay maps may improve evaluation of thyroid cartilage invasion.

Conclusions
Dual energy CT is a useful tool for evaluating head and neck pathology. Virtual monochromatic image reconstructions at different energy levels, iodine overlay maps, and spectral curve analysis can be used to improve lesion visualization and characterization, including evaluation of thyroid cartilage invasion.

Hypopharyngeal Squamous Cell Carcinoma

(Filename: TCT_eEdE-102_Slide1.jpg)

eEdE-131

6:30AM - 3:00PM

Spectrum of Maxillary and Mandibular Cystic and Sclerotic lesions
Purpose
To classify various maxillary and mandibular lesions. To illustrate the imaging characteristics of maxillary and mandibular lesions. To discuss the complications of these lesions. To discuss the role of radiologists in the diagnosis of these lesions.

Materials and Methods
Combined analysis of retrospective and prospective study in patients with mandibular and maxillary cystic lesions on 64-slice multidetector computed tomography (MDCT) was done. The mandibular and maxillary lesions were classified into various categories of odontogenic and nonodontogenic, infective and noninfective, benign and malignant lesions. Various imaging characteristics of different lesions were described.

Results
The maxillary and mandibular cystic and sclerotic lesions are classified as odontogenic and nonodontogenic lesions. Odontogenic tumors develop during or after the formation of teeth. Odontogenic lesions are classified further as lesions with mineralization and without mineralization. Odontogenic tumors without mineralization appear as well corticated cystic lesions like ameloblastomas, odontogenic keratocysts and dentigerous cysts. Odontogenic lesions with mineralization show complex dental tissue within. Examples of these include complex odontomas and odontogenic myomas. Nonodontogenic tumors have no association with dental development however can mimic odontogenic tumors. Nonodontogenic lesions include benign fibro-osseous lesions, focal or periapical cemento-osseous dysplasia, florid osseous dysplasia, traumatic bone cyst, lingual salivary gland inclusion defect, central giant cell granuloma, brown tumor of hyperparathyroidism and mucoepidermoid carcinoma. Knowledge of varying imaging characteristics of these lesions is necessary to establish a differential diagnosis, although microscopic tissue evaluation generally is necessary for the definitive diagnosis.

Conclusions
The detailed knowledge of varying imaging characteristics of the maxillary and mandibular cystic and sclerotic lesions help the radiologists in the diagnosis of these lesions. Early diagnosis of these lesions may prevent the complications as these lesions can be locally aggressive, infective or may be malignant.
Surface Anatomy of the Brainstem: Correlation of 2D Radiologic Landmarks, 3D Image Reconstructions, and Gross Anatomic Appearance

J Ormsby¹, T Morris², A Blitz³, A Choudhri⁴
Purpose
To show the imaging correlate of surface anatomy features of the brainstem, with surgical and gross-anatomy, with additional focus on anatomical landmarks with the underlying nuclei and white matter tracts, as well as that of the origins of cranial nerves in order to provide guidance to neurosurgeons planning surgical procedures in this region.

Materials and Methods
2D and 3D reconstruction MR images were obtained of surface anatomy of the brainstem along with surgical and gross-anatomy images then used to come up with a review for the neuroradiologist in order to better help with neurosurgical planning in this area.

Results
Correlated images are provided of the medullary pyramids, olives, pontomedullary sulcus, anterior median fissure, vagal trigone, hypoglossal trigone, and facial colliculus. Additional images include the location of the nuclei, fascicular and cisternal segments of the lower cranial nerves, and their relationship to these surface landmarks.

Conclusions
With a better appreciation for the surface anatomy of the brainstem on MR imaging the neuroradiologist can play a crucial role in helping the neurosurgeon plan for surgery in this area.

(Filename: TCT_eEdE-105_Brainstemanatomy.jpg)

6:30AM - 3:00PM

T bone: the Rare and the Well-done

C Nguyen¹, K Learned², A Tuan², L Loevner³
Purpose
To review common and rare temporal bone pathologies in an interactive and image-rich presentation.

Materials and Methods
A variety of neoplastic and non-neoplastic processes can present in the temporal bone. We will review the pathophysiology, clinical presentation, CT and MR imaging characteristics, and treatment of these processes in an unknown case-based format based on anatomical location in temporal bone. We will highlight overlapping imaging features and distinguishing characteristics that differentiate these entities as well as imaging tips and pitfalls.

Results
Clinical symptoms range from asymptomatic to hearing loss, vertigo, pulsatile tinnitus and facial nerve palsy, resulting from the involvement of the specific anatomical structures and the disease process. Temporal bone pathologic processes are based on compartmental anatomical locations: external auditory canal (malignant otitis externa, keratosis obturans, cholesteatoma, carcinoma), middle ear and mastoid (otomastoiditis and complications, granulation, cholesteatoma, and paraganglioma), inner ear (labyrinthitis, otosclerosis, Paget's disease, fibrous dysplasia, and endolymphatic sac tumor), petrous apex (mucocele, cholesterol granuloma, cholesteatoma, cephalocele, internal carotid artery aneurysm), and facial nerve (schwannoma and hemangioma). Bony destruction associated with the effusion and/or soft tissue indicates the complication of otomastoiditis, cholesteatoma and aggressive neoplasm. Clinical erythema and edema of acute otomastoiditis manifest on imaging as substantial degree of soft tissue inflammation. Methodological search for the presence of a subperiosteal abscess and intracranial, skull base extension of the infection and vascular compromise is vital to patient's management. The lack of infectious inflammation clinically and on imaging generally indicates the neoplastic nature of the soft tissue mass. Bony preservation or remodeling helps one recognize the benign or slowly growing processes such as keratosis obturans and schwannoma. Additional imaging pearls tailored to each patient's clinical presentation oftentimes provides the accurate diagnosis. The integrity of facial nerve and petrous internal carotid artery is critical in all disease processes and one must carefully access these structures. While CT is the workhorse in temporal bone evaluation, MR is valuable in differentiating cholesteatoma from granulation and cholesterol granuloma as well as superior in evaluating intracranial disease.

Conclusions
This review will help viewers better understand common and rare temporal bone pathologies, recognize aggressive disease and provide clinically relevant imaging assessment to better serve patient.

eEdE-150

T-bone: The Aftermath! Postoperative Imaging of the Temporal Bone

A Tuan, K Learned, C Nguyen, L Loevner

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Purpose
Postoperative imaging of the temporal bone can be a diagnostic challenge due to alteration of the normal anatomy by unfamiliar surgical procedures. This exhibit will illustrate the normal appearance of commonly encountered temporal bone surgeries. We will offer step-wise analysis and highlights specific to each surgical procedure to help the viewer easily navigate through complex postoperative imaging of the adult temporal bone.

Materials and Methods
Temporal bone surgeries in adults are performed to treat neoplastic and non-neoplastic disease. Representative examples of common temporal bone surgical procedures will be shown in a case-based format. Anatomy will be emphasized to differentiate between the various surgical procedures and to focus on pertinent changes.

Results
Common drainage procedures include tympanostomy tube placement for middle ear effusion and infracochlear tube drainage for a petrous apex cholesterol cyst. Procedures for hearing loss include bone-anchored hearing aid (BAHA), myringoplasty, tympanoplasty, ossicular reconstruction (incus interposition, ossicular prosthesis), and cochlear implantation. Cholesteatoma resection routinely requires transcanal atticotomy, canal-wall-up or canal-wall-down mastoidectomy, or radical mastoidectomy. Tegmen tympani reconstruction for repair of CSF leak and cephalocele utilizes a variety of grafts. Vestibular schwannoma resection involves a translabyrinthine or retrosigmoid approach. Other neoplastic processes may require a combination of mastoidectomy, translabyrinthine resection, and lateral temporal bone resection with reconstruction.

Conclusions
This review will help viewers understand the most common temporal bone surgical procedures and confidently identify their expected postoperative appearances.

eEdE-95
6:30AM - 3:00PM

T4a versus T4b of Head Neck Cancers: Current Concepts Beyond Resectibility Issues

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¹University of Texas Health Science Center at San Antonio, San Antonio, TX, ²University of Texas Health Science Center at San Antonio, SAN ANTONIO, TX

Purpose
This pictorial presentation focuses on key imaging findings that separate T4a and T4b head neck cancers by using computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography/computed tomography (PET/CT) and endoscopic findings. Treatment differences, beyond resectibility issues, are discussed accordingly.

Materials and Methods
Locally advanced head neck cancers are classified as T4a and T4b lesions according to invasion into deep soft tissues or bony structures. The latest edition (7th) of American Joint Committee of Cancer (AJCC) staging defines T4a and T4b tumors as moderately advanced and very advanced local diseases respectively, instead of resectable and unresectable diseases per the previous edition (6th). The differences between the two tumor stages are greatly important because they dictate treatment options and patient prognosis. Clinically, radiographically and pathologically
proven cases of T4a and T4b tumors were selected from the tumor registry in a tertiary care facility and classified into each head and neck site/subsite.

Results
Total of seven sites of head neck cancers include oral cavity, oropharynx, nasopharynx, hypopharynx, larynx, paranasal sinus, and thyroid. Examples include oropharyngeal cancers involving skull base is considered a T4b lesion, necessitating chemoradiation as a primary treatment instead of curative surgery. On the other hand, a T4a oropharyngeal cancer involving the mandible prompts the surgeon to perform mandibulectomy with reconstruction as the aim for cure. With advance in surgical techniques, experiences of surgeons and patients' conditions, some T4b oval cavities invading medial pterygoid muscles are operable instead of being considered unresectable per previous AJCC criteria.

Conclusions
It is crucial for neuroradiologists to be able to discriminate T4a and T4b head neck cancers, which dictate treatment planning and prognosis.
Temporal Bone Trauma: What the Radiologist Needs to Know.

L Eisenmenger¹, R Wiggins, III²

¹University of Utah, North Salt Lake, UT, ²UUHSC, Salt Lake City, UT
Purpose
The purpose of this exhibit is to highlight critical points for a radiologist to understand about temporal bone anatomy in reference to trauma in order to accurately and concisely describe temporal bone trauma key points, and to convey this information to the clinicians.

Materials and Methods
Through a case-based approach this exhibit will highlight critical temporal bone anatomy in trauma cases, including normal anatomical structures that can be confused with traumatic injuries. Important anatomical variations also will be discussed with examples. The lexicon for describing fractures including terms such as longitudinal (Figure 1, A) transverse (Figure 1, B) or fractures and optic capsule involving (Figure 1, C involving the vestibule and image D involving the cochlea) or sparing will be clearly presented. Case-based examples of when radiologists should recommend additional imaging such as CTA in the case of carotid canal involvement will be covered as well as what other specific structures should be identified and cleared including involvement of the facial nerve and ossicles. CT imaging protocols that are best for evaluating temporal bone fractures also will be discussed as well as what injuries can be seen best on which reformat.

Results
Accurate diagnosis of complex temporal bone trauma can greatly affect patient care through guiding the need for additional imaging, treatment decisions, and predicting outcomes.

Conclusions
Temporal bone fractures can be extremely complex cases with involvement of many structures, but an ordered approach to temporal bones fractures can help the radiologist provide the most relevant information to the clinicians as well as reduce the chance of missing important findings. This exhibit will explain what a radiologist needs to know in the setting of difficult temporal bone trauma cases.

(Filename: TCT_eEdE-145_figure11.jpg)
The Imaging of Orbital Apex Syndrome

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Purpose
Orbital apex syndrome refers to visual disturbance from cranial nerve palsies affecting cranial nerves 2, 3, 4, 6, and at times branches of 5. The etiology is diverse ranging from carotid cavernous fistulas to trauma to neoplasms. When describing the affected anatomical location, syndromes such as superior orbital fissure syndrome or cavernous sinus syndrome may be used to localize the disease process. This exhibit will familiarize the reader with the various etiologies that may present as orbital apex syndrome and its variants.

Materials and Methods
1. Better understand orbital nerve, cavernous sinus, and orbital anatomy. 2. Review the spectrum of diseases that may lead to orbital apex syndrome.

Results
A. Review the anatomy of cranial nerves 2, 3, 4, 5, and 6. B. The causes of orbital apex syndrome has been categorized into the following conditions: 1. Inflammatory. 2. Infectious. 3. Neoplastic. 4. Vascular. 5. Iatrogenic/traumatic. 6. Other.

Conclusions
After viewing this exhibit the viewer will be able to identify and classify the various etiologies of orbital apex syndrome.
The nuts and bolts of head and neck tumor evaluation

C McKnight\textsuperscript{1}, A Corey\textsuperscript{2}, K Malloy\textsuperscript{1}, A Srinivasan\textsuperscript{3}

\textsuperscript{1}University of Michigan, Ann Arbor, MI, \textsuperscript{2}Emory University School of Medicine, Atlanta, GA, \textsuperscript{3}University of Michigan Health System, Ann Arbor, MI
Purpose
The goal of this exhibit is to review the key imaging features that are crucial to convey to the clinician and impacts management when evaluating a patient with head and neck tumor.

Materials and Methods
The exhibit is divided into the following segments:
- Evaluation of lymph nodes: - Nodal stations, accepted range of normal size, morphological abnormalities. - The nodes without a station: facial and retropharyngeal.
- Determination of T3 and T4 staging in the common head and neck cancers: - Sinonasal cavity, - Nasopharynx, - Oropharynx, - Larynx.
- Locations of the 'unknown primary'.
- Evaluation of perineural spread. Invasion of osseous structures - e.g., temporal bone, maxilla/mandible.
- Invasion of prevertebral space.
- Encasement of carotid artery.
- The nonsquamous cell carcinomas: Melanoma, lymphoma, chondorsarcomas and salivary gland carcinomas.

Results
Accurate staging of head and neck cancers helps select appropriate management of management of T1 and T2 stage cancers typically are treated with single modality therapy such as radiation whereas T3 and T4 cancers may necessitate a multimodality approach involving surgery, chemotherapy and radiation. This makes it pertinent for imagers to be aware of the key findings on CT or MRI that upstages tumors. Also, there are blind spots faced by many radiologist such as enlarged retropharyngeal or facial nodes that may not be detected readily but whose presence can change the appropriate field for radiation therapy. Therefore, we have designed this exhibit to be a quick overview of the essentials of head and neck tumor evaluation.

Conclusions
To be on the same page as the referring otolaryngologist, the radiologist needs to be aware of the crucial imaging features that upstages a head and neck cancer and impacts management. This exhibit is designed to focus on the most pertinent issues that will be repeated during tumor board discussions and impact patient management.
This eye does not look right. An Imaging Overview of Common Oculoplastic and Orbital Surgeries.

F Nasseri¹, S Nabavizadeh², L Loevner³, A Vossough², S Mohan²

¹University of Pennsylvania, Philadelphia, PA, ²University of Pennsylvania, Philadelphia, PA, ³University of Pennsylvania Medical Center, Philadelphia, PA
Purpose
• To present a comprehensive and systematic review of the imaging spectrum of the oculoplastic and orbital surgeries including various types of orbital implants and prostheses. • To review imaging features of potential surgical complications and discuss plausible pitfalls.

Materials and Methods
A variety of surgeries currently are performed for various orbital disorders including traumatic, congenital, senile/degenerative, neoplastic, infectious, and inflammatory pathologies. We will present a comprehensive pictorial review of postoperative orbit including: 1) Orbital surgeries: Orbital wall reconstruction, augmentation and decompression, 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) Lens surgery and implants. 6) Eyelid surgery and eyelid weights. 7) Eyelid surgery such as blepharoplasty and eyelid weights. 8) Retinopexy and scleral buckles.

Results
The development of new surgical techniques, as well as advances in the prostheses offer a wide range of novel alternatives for orbital and oculoplastic surgeries. Imaging plays a critical role in the postoperative setting, enabling early diagnosis of complications as well as long term follow-up evaluation.

Conclusions
Imaging evaluation of the postsurgical orbit remains challenging even for an expert neuroradiologist. This exhibit provides a simplified framework for understanding the complex postoperative appearances, supported by abundant case-based examples.

eEdE-152

6:30AM - 3:00PM

TI-RADS (Thyroid Imaging Reporting and Data System): Are We There Yet?

S Kushchayev¹, A Salei¹, O Teytelboym¹
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Purpose
Thyroid nodule evaluation is a common clinical and imaging challenge. Guidelines from Society of Radiologists in Ultrasound (SRU) in 2005 and American Thyroid Association (ATA) in 2006, revised in 2009, have offered evaluation and management guidance, but left many uncertainties in deciding which nodules to biopsy. Horvath, taking BI-RADS as a model, developed the first TI-RADS concept in 2009. Subsequent proposals, particularly by Kwak, have offered improved ability for thyroid nodule risk stratification. This exhibit provides a comprehensive image-based review of current TI-RADS proposals and comparison with SRU and ATA guidelines.

Materials and Methods
Systematic literature review from the Pubmed database.

Results
Review SRU and ATA management guidelines for patients with thyroid nodules and the Bethesda System for reporting thyroid cytopathology. Illustrate and review currently proposed TIRADS systems, their advantages and limitations. Horvath (2009) standardized 10 ultrasound (US) patterns and correlated the malignancy. Russ (2011) presented a flowchart to define the
score based on US features. Park (2009) used complex multiple logistic regression analysis. This system was improved by Kwak (2011) who used the number of suspicious US features (solid component, hypoechogeticity, marked hypoechogeticity, microlobulated or irregular margins, microcalcifications, and taller-than-wide shape) to stratify malignancy risk. Later the authors assigned different risk score to each suspicious US feature (Kwak, 2013). Describe how incorporation of proposed TI-RADS-based categories and risk assessment tools can improve patient care and communication with endocrinologists and surgeons.

Conclusions

Proposed TI-RADS systems by Kwak and Russ easily can be applied for thyroid nodule risk stratification, and may be superior to SRU an ATA recommendations in guiding the biopsy decision. Introducing TI-RADS can standardize and simplify the reports, allowing effective communication between the radiologists, pathologists, and clinicians. TI-RADS may result in improving quality of care and cost-effectiveness, avoiding unnecessary biopsies.
Towards the development of an automated assessment of the recurrent laryngeal nerve and non-recurrent laryngeal nerve based upon the branching patterns of the aortic arch.

N Chasen¹, M Chasen², J Hunter³

¹Mayo Clinic Health System, Waycross, GA, ²University of Texas MD Anderson Cancer Center, Houston, TX, ³Texas Children's Hospital, Houston, TX
Purpose
Assessing the branching pattern of the aortic arch currently requires reconstruction of the images and specialized knowledge of the embryological origins of the great vessels and the companion anomalies of the recurrent laryngeal nerve. The purpose of this communication is to test the feasibility of axial imaging to predict the various aortic branching patterns and by inference the accompanying variations in the recurrent laryngeal nerve.

Materials and Methods
Axial CT images of the cervicothoracic continuum were selected corresponding to the various aortic arch anomalies. Examples of variations in the branching pattern were traced manually onto a deformable anatomical template by one author.

Results
The schematics below show the arch branching patterns in axial projection. Note that the unique patterns are created by varying the embryonic regression within the aortic arch. Once the patterns are established, computerized interpretation becomes a possibility. The anatomical variants of the aortic arch branches can be superimposed onto axial templates, which can be deformed to match the patient images. Legend. A. In utero, the superior surface of the double arch begins as a ring, which surrounds the trachea and esophagus (white asterisk). The ring is anchored anteriorly by the ascending aorta (1) and posterior by the descending aorta (2). When this configuration persists, it is called a double aortic arch. Usually, the portion of the ring that connects the right subclavian artery (solid black circle) with the descending aorta (2) regresses, and the remainder of the right arch is renamed the right brachiocephalic artery (solid black triangle). B. Less commonly, the portion of the ring between the right common carotid (solid black rectangle) and right subclavian (solid black circle) regresses. The right common carotid artery becomes the first branch and the right subclavian artery becomes the last branch resulting in a left aortic arch with an aberrant right subclavian artery. C. Rarely, the portion of the ring between the left common carotid (open black rectangle) and left subclavian (open black circle) regresses. The left common carotid becomes the first branch, and the left subclavian becomes the last branch, which results in a right aortic arch with aberrant left subclavian artery. D. The least common variant involves regression of the portion of the ring between the left subclavian artery (open black circle) and the descending aorta (2.) The remainder of the left arch is renamed the left brachiocephalic artery (black X) that becomes the first branch off of the right arch. This results in a left aortic arch with mirror branching.

Conclusions
The atlas format was well suited to the presentation of information relative to reporting important arch anatomy and associated anomalies.
eEdE-92

Typical and variable findings of cervical lymph nodes helping for benign and malignant differentiation

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Purpose
Sonography is useful in the evaluation of cervical lymph nodes. The purpose of this exhibit is to document the common sonographic appearances of cervical lymphadenopathy according to the causes.
Materials and Methods
We retrospectively reviewed ultrasonography including color/or power Doppler ultrasound in evaluation of cervical lymph nodes pathologically proven cases.

Results
On gray-scale sonography, normal and reactive nodes tend to be hypoechoic and oval and to have an echogenic hilum. Color Doppler sonogram shows hilar vascularity with/without radially branching toward periphery of lymph node. Reactive lymph nodes may show variable findings with hypertrophic cortex and hilar vascularity but much increases. On spectral Doppler sonography, normal and reactive nodes usually show low vascular resistance. Tuberculous lymphadenitis shows hypoechoogenicity with focal nodal cystic necrotic or echogenic granulation foci with displaced hilar vascularity. Kikuchi disease shows increased nodal echogenicity with dirty perinodal fat planes, and markedly increased hilar vascularities. Metastatic nodes usually are hypoechoic, round, and without echogenic hilum, coagulation necrosis or intranodal cystic necrosis, eccentric cortical hypertrophy, extracapsular spread. Intranodal cystic necrosis is common in metastasis from head and neck squamous cell carcinomas. Metastatic nodes from papillary carcinoma of the thyroid may be hyperechogenicity with punctate calcifications. Intranodal reticulation is characteristic finding of lymphomatous lymph node. Metastatic and lymphomatous nodes usually show peripheral or mixed vascularity and malignant lymph nodes tend to have high RI and PI values.

Conclusions
Sonographic features differentiating pathologic lymph nodes between the diseases include round or ovoid shape, absent or present hilum, intranodal necrosis, reticulation, calcification, matting, soft-tissue edema on gray scale US, and hilar or peripheral or mixed vascularity on Color Doppler US.

Windows to the acoustic world: a review of pathologies involving the oval, round and ‘third’ windows.

R Shah¹, A Srinivasan¹
¹University of Michigan, Ann Arbor, MI

Purpose
•To review physiology of hearing and the importance of the oval and round windows in this process. •To discuss pathologies involving the oval and round windows and treatment options. •To describe the 'third window' phenomenon and present illustrated examples of different causative etiologies.

Materials and Methods
In the first part of the exhibit, we will provide a brief summary of the physiology of sound transmission through the middle and inner ear with emphasis on the role of the oval and round windows. In the next part of the exhibit, we will discuss individual pathologies involving the oval and round windows that include otosclerosis, oval and/or round window atresia or stenosis, annular ligament of stapes calcification, and fistulas. In the final part of the exhibit, we will elaborate on the pathophysiology of the third window phenomenon and present etiologies such
as dehiscence of the superior and posterior semicircular canals, vestibular aqueduct dehiscence and cavitary otosclerosis.

Results
While there can be a variety of reasons for hearing loss and imbalance/vertigo, some of the pertinent ones are those involving the oval and round windows or where a 'third' window has been created pathologically. Therefore, the radiologist evaluating temporal bone scans on a regular basis needs to be aware of the potential pathologies involving the oval and round windows and the potential sites of the third window. For example, one of the most common indications for dedicated temporal bone imaging is vertigo and to evaluate for presence of superior semicircular canal dehiscence. This creates a "third window" in the inner ear that has been described to cause vestibular symptoms. In this exhibit, we will present and review the physiology of the 'third' window and provide additional less commonly known pathologies that cause the 'third' window phenomenon including posterior semicircular canal dehiscence and vestibular aqueduct dehiscence. We also will review the literature to discuss how well these structural abnormalities correlate with audiograms and clinical features.

Conclusions
A clear understanding of the potential pathologies involving the oval and round windows, and of the 'third' window phenomenon can help the radiologist focus their evaluation of their temporal bone imaging on pertinent regions that they might otherwise overlook. This will help establish a better relationship with the referring clinician and eventually impact patient care.

(Filename: TCT_eEdE-146_image1.jpg)

Monday
6:30AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exp Hall A (Level 1)-3
Arachnoid Granulations, Venous Sinuses and Headache, are they related?

D Quiñones Tapia¹, J Viaño Lopez¹
¹Hospital del Rosario, Madrid, Spain

Purpose
Cystic arachnoid granulations often are detected inside dural venous sinuses. These may partially obstruct venous outflow. We have detected several cases of venous thrombosis associated with a prominent venous arachnoid granulation in the affected sinus. Dehydration and altered blood coagulation may be predisposing factor for thrombosis in these veins with restricted outflow. In other cases giant arachnoid granulations may erode adjacent bone and occupy the dural sinus nearly completely, probably collateral venous outflows are present. We hypothesize that these granulations may obstruct venous outflow, and in situations of exercise, or certain head postures may increase the venous obstruction and become symptomatic as headache.

Materials and Methods
A retrospective review of arachnoid granulations reported on brain MRI is performed. Over 120 cases were reviewed, and we selected a dozen of the most prominent. Twenty-seven cases had venous MRA. Invasive DSA was not performed.

Results
We found three cases of dural sinus thrombosis, associated with an intramural arachnoid granulation in the dural sinus, obstructing over 50%. A giant posterior sagittal sinus arachnoid granulation 2 cm in maximum diameter practically occludes the sinus, the patient has chronic headache. In seven patients with headaches related to exercise or sexual intercourse arachnoid granulations occluding over 50% of the dominant transverse sinus were noted. Physiopathology of increased venous pressure is reviewed.

Conclusions
Venous sinuses containing prominent arachnoid granulations may restrict venous outflow, and relate to some headaches. MR imaging and MRA may demonstrate these anomalies, but invasive DSA and venous pressure measurements are necessary to document venous pressure gradients if treatment is considered (stent placement).
Life-Threatening Lytic lesion of the Mandible: A Lesson Learned

N Supakul¹, J Tejada²
¹Ramathibodi Hospital, Mahidol University, Bangkok, Thailand, ²Indiana University School of Medicine, Indianapolis, IN

Purpose
1. To review the characteristic imaging findings of mandibular vascular malformations to avoid unnecessary biopsy of the mandibular lesion. 2. To demonstrate interventional treatment options
for vascular lesions in the mandible in life-threatening conditions and also in the pre-operative setting.

Materials and Methods
We performed a retrospective review using our computerized radiology information systems from 2008 to 2014 in two medical centers. We identified patients who presented with bleeding from a mandibular mass. All imaging modalities including panoramic views of the mandible, computed tomography (CT), magnetic resonance imaging (MRI) and conventional angiogram were reviewed.

Results
Nine patients (8 males, 1 female and age range from 7 - 34 year) were included. All patients presented with life-threatening bleeding after either mandibular biopsy or tooth extraction. Imaging checklists and key imaging findings of the mandibular lesions will be highlighted as a tool for interpretation. Conventional catheter angiography and treatment techniques will be demonstrated.

Conclusions
Vascular malformations of the mandible are extremely rare conditions but potentially life-threatening conditions from intractable hemorrhage after tooth extraction or biopsy. It occurs predominantly during childhood with a variety of symptoms including gingival bleeding, bruit, dental loosening, swelling of the soft tissues of the face, changes in skin and mucosal color or sometime neurosensory deficits. Cross-sectional imaging especially CT and MRI with contrast are useful imaging modalities and help to clarify the extent of the lesion, the degree of bone erosion and involvement of major vessels. Radiologist should be able to recognize the imaging patterns to avoid unnecessary biopsy and suggest prompt treatment in case of life-threatening hemorrhage or the need for pre-operative treatment.
Magnetic Resonance Guided Laser-Induced Thermal Ablation Therapy: a Visual Review of Key Concepts

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¹University of South Florida College of Medicine, Tampa, FL, ²Radiology Associates of Tampa, Tampa, FL

Purpose
The use of lasers for thermal ablation of brain lesions recently has become a viable option, in large part due to the development of real-time, intra-operative thermal magnetic resonance imaging (MRI). As MR-guided laser thermal ablation becomes more widely practiced, the radiologist should become familiar with several key concepts of this therapy.

Materials and Methods
The goals of this exhibit are to first review procedure indications and necessary pre-operative imaging. We then will discuss the procedure itself, focusing on the real-time MR imaging used intra-operatively, and conclude with postoperative imaging findings and potential complications. These teaching points will be illustrated with images obtained using the Visualase Thermal Therapy System (Visualase Inc., Houston, TX) at a large tertiary care facility.

Results
MR-guided laser thermal therapy involves an MRI compatible diode laser and cooling laser applicator system to induce coagulation necrosis in brain tissue (1, 2). The procedure currently is used for ablation of epileptogenic foci and metastatic or primary brain tumors (1-4). Pre-operative imaging includes postgadolinium MRI with volumetric sequences to plan the laser trajectory. After the laser is placed into the brain, a 3-dimensional, T1-weighted sequence is acquired to check its position and choose the imaging plane used during ablation. Once ablation begins, a fast gradient echo sequence is continuously performed to generate dynamic, color-coded thermal maps using shifts in proton resonance frequency, which show a linear relationship to temperature change due to temperature dependent alterations in the hydrogen bonds of water molecules (1-2). The length of time each image voxel remains at a particular temperature then is used to create a map of tissue destruction using an Arrhenius model (1-2). Immediately after ablation, a T1-weighted postgadolinium helps confirm an adequate ablation zone (1-4). Follow-up images show an initial increase in ablation zone size for an average of 1-2 weeks, followed by a gradual decrease in both size and enhancement (2, 4-5). Potential complications include hemorrhage, worsening neurologic deficits due to edema, or damage to adjacent structures (1-4).

Conclusions
Initial studies of MR-guided laser thermal ablation have generated promising results, and the therapy is likely to become more commonly practiced. Being familiar with the surgical technique, specialized intra-operative MR sequences, and expected postoperative imaging appearance will enable the radiologist to play a more active role in the application of this therapy and have a greater impact on patient care.
Vertebral Artery Dissecting Aneurysms - clinical presentation, imaging findings, and treatment options

Figure 1. Imaging due to medical condition, showing images of the system; top right: right medi, top right: showing right medi. Bottom right: showing h. gadolinium zone of interest; right medi showing post op and hypo: representing necrosis and edema.
Purpose
A review of the clinical presentation, imaging findings, anatomical considerations and treatment options of intradural vertebral artery dissection.

Materials and Methods
A prospectively maintained neuroendovascular database and the senior authors personal teaching files were reviewed to obtain cases for this presentation.

Results
Intradural vertebral dissection can present clinically with ischemia or hemorrhage. A review of the underlying pathology and natural history will be exhibited. The relevant anatomy, in particular the vascular supply to the posterolateral medulla and spinal cord will be emphasized. The treatment options for hemorrhagic presentation will be discussed including deconstructive and reconstructive (stent-related) forms of endovascular treatment and the rationale for these. For those cases that present with ischemia the management involves prevention of further infarction, with endovascular treatment being reserved only for those cases showing progressive aneurysmal change. A selection of cases will be shown which illustrate the challenging diagnostic and endovascular therapeutic issues related to this disease entity.

Conclusions
With the help of this exhibit we hope to improve the understanding of the imaging findings and anatomical considerations with regards to vertebral artery dissecting aneurysms and to highlight the available treatment options.
Monday
6:30AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exp Hall A (Level 1)-4

Electronic Educational Exhibit (eEdE) - Pediatrics
eEdE-189

6:30AM - 3:00PM

A Dirty Dozen: Extraordinary Cases of Pediatric CNS/Head & Neck Tumors that Didn’t Read the Textbooks

T Sato¹, G Bathla¹, L Lai¹, T Moritani¹, P Kirby¹, Y Sato¹
Purpose
We will review a dozen cases of pediatric tumors that presented with unusual imaging features or in uncommon locations contrary to the standard textbook description. By comparing these unique cases with the typical presentation of the tumors, we will identify key common shared imaging and pathophysiological features which may help radiologists arrive at a correct diagnosis.

Materials and Methods
We will present 12 unique cases including: esthesioneuroblastoma in the nasopharynx, craniopharyngioma in the sphenoid sinus, chordoma without bony attachment floating in the subarachnoid space, and a intra-axial schwannoma. These initially will be presented in a quiz format so the reader may have an opportunity to check their diagnostic acumen. This will be followed by individual discussion of each entity along with their classic presentations. Shared and atypical imaging features will be discussed so that the reader gets a better understanding of these entities and is aware of the atypical presentations.

Results
Atypical presentations of pediatric central nervous system (CNS)/head & neck tumors can be difficult to recognize and thus diagnose accurately. Over the years, we have come across quite a few rare presentations of what is otherwise a well described entity. Retrospective analysis of these cases often reveals subtle clues which could have assisted in diagnosis pre-operatively. By comparing and contrasting typical and atypical presentations of these tumors, we can identify the features that assist in making the correct diagnosis.

Conclusions
Not every tumor follows the textbooks or walks along the beaten path, so we hope to help readers think outside the box and extend the scope of differential diagnosis. By becoming more familiar with atypical features of these tumors and the unique ways in which these cases can present, we hope readers will be able to correctly diagnose these extraordinary cases when they present in the future.

eEdE-188
6:30AM - 3:00PM

A Pictorial Review of Typical and Atypical/ Bizarre Imaging Findings, as well as Post-Treatment Changes in Pilocytic Astrocytomas in Children.

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Purpose
To present the most common imaging findings in pilocytic astrocytomas in children, to discuss atypical/ bizarre imaging aspects of these brain tumors, as well as to present interesting imaging findings related to treatment.

Materials and Methods
We retrospectively reviewed the clinical charts and neuroimaging studies in 108 children diagnosed with pilocytic astrocytomas in the last 19 years. MR imaging was performed on a 1.5T GE Signa Horizon and 1.5T General Electric (GE) Excite. Available sequences included sagittal
T1 and T1 3D SPGR, axial T1, T2, FLAIR, GRE and DWI, as well as coronal T2. Diffusion tensor imaging (DTI), magnetic resonance spectroscopy (MRS), dynamic susceptibility contrast imaging (DSC) and dynamic contrast-enhanced (DCE) studies were obtained in some patients, and gadolinium chelates were administered in all. A neuroradiologist with 19 years experience (BL) evaluated all the images. The diagnosis was confirmed by pathology after surgical resection of the brain tumor.

Results
The most common neuroimaging features in pilocytic astrocytomas were: 1- Predilection for the posterior fossa; 2- Predilection for the cerebellar hemisphere instead of the cerebellar vermis; 3- Presentation as round well circumscribed lesions instead of infiltrative; 4- Presence of cysts along with solid components; 5- High signal intensity on the T2 in the solid portion; 6- Absence of restricted diffusion in the solid portion; 7- Enhancement in the solid portion; 8- Displacement of adjacent white matter tracts on the DTI. Imaging findings that could be considered atypical or bizarre were: 1- Presentation as a transmantle lesion; 2- Presence of blood products; 3- Restricted diffusion; 4- Very high choline peak along with presence of lipids and lactate in the MRS; 5- High blood volumes in the DSC studies; 6- CSF spread. Interesting imaging findings during/after chemotherapy/radiation therapy were: 1- Development of enhancement in a previously nonenhancing tumor; 2- Transient enlargement of the lesion related to pseudoprogression; 3- Development of cavernous angioma.

Conclusions
Pilocytic astrocytomas are a very common brain tumor in children. Once these are grade I tumors with very good prognosis after surgical resection, precise diagnosis is essential. The radiologist should be familiar not only with the most common neuroimaging aspects of these lesions but also with atypical/bizarre imaging findings, as well as possible changes after treatment.

Acute Necrotizing Encephalopathy: Neuroimaging Diagnosis and Differentials

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Purpose
Acute necrotizing encephalopathy (ANE) is a rare childhood disorder characterized by rapid neurological deterioration following an acute febrile illness and ultimately resulting in coma. Although there are no specific diagnostic markers, neuroimaging plays an important role aiding in diagnosis, in which the finding of bilateral symmetric thalamic lesions in the appropriate clinical context is considered characteristic (1); however, the ultimate diagnosis may hinge upon pathological data. This presentation will review the neuroimaging features of ANE by combining both our own experience and cases reported in the literature, thereby to evaluate the current diagnostic criteria, and to provide an imaging differential diagnosis.

Materials and Methods
Pediatric cases with bilateral thalamic abnormalities collected in our institution were analyzed for imaging features and correlated with final clinical diagnosis. In addition, a review of the English literature was performed to retrieve reported ANE cases with both neuroimaging and pathology findings.
Results
Literature review revealed 14 cases of ANE from 11 papers with both neuroimaging and neuropathologic findings. Imaging evidence of symmetric thalamic lesions classically is associated with ANE (13/14). Additional lesions involving the periventricular white matter, putamen, caudate, upper brainstem tegmentum, and cerebellum also are common. The histological feature of hemorrhagic necrosis has been described consistently within lesions (12/14). Atypical imaging features entailing lack of thalamic lesions were reported in one case. Two cases with classic imaging features were not confirmed on pathology. Differential diagnosis from a neuroimaging standpoint includes hypoxic-ischemic encephalopathy, acute demyelinating encephalomyelitis, acute hemorrhagic leukoencephalitis, hemolytic uremic syndrome, bilateral thalamic arterial infarcts, bilateral venous infarcts, infantile bilateral striatal necrosis, and Leigh encephalopathy.

Conclusions
A combination of clinical and radiological features is suggestive but not sufficient for the diagnosis of ANE. Neuropathology ultimately may be necessary for definitive diagnosis. Acute necrotizing encephalopathy as well as a number of differential diagnoses should be considered in a child with acute presentation of bilateral thalamic abnormality.

eEdE-172

Cerebellar cysts in children: a pattern-recognition approach

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Purpose
Neuroimaging plays a key role in the diagnostic work up of congenital posterior fossa abnormalities. Cerebellar cysts are rather uncommon findings in pediatric neuroimaging and may be seen in selected disorders of both malformative and disruptive etiology. Here we summarize our experience with cerebellar cysts and review the available literature.

Materials and Methods
We qualitatively analyzed the neuroimaging studies of children with known cerebellar cysts. We focused on the size, shape, and location (cortical-subcortical, within the white matter, focal or widespread) of cerebellar cysts as well as additional neuroimaging findings within the posterior fossa (morphology of cerebellum and brain stem) and supratentorial brain (e.g., migration anomalies, white matter signal abnormalities, hydrocephalus, white matter cysts). We excluded cystic cerebellar tumors (such as low grade gliomas and hemangioblastomas), parasitic cysts (such as echinococcus cysticus and alveolaris, and neurocysticercosis), or post-traumatic and postsurgical cysts.

Results
We classified the diseases with cerebellar cysts into broad categories based upon the underlying pathomechanism: normal cystic structures (cystic perivascular spaces in mucopolysaccharidoses), isolated cysts (e.g., neuroglial cysts), destructive cysts in some types of pontocerebellar hypoplasia, malformative cysts (e.g., congenital muscular dystrophies, Aicardi
syndrome, GPR56 mutation, LAMA1 mutation), cysts associated with cerebellar dysplasia [e.g., Cohen syndrome, disruptive (cysts confined to a unilateral, dysplastic hemisphere of reduced volume), unknown], and a group including various diseases such as leukoencephalopathy with calcifications and cysts and early-onset multiple carboxylase deficiency.

Conclusions
We provide a classification of diseases associated with cerebellar cysts. This classification allows a neuroimaging-based pattern recognition approach and takes the clinical information into account. The provided classification may be useful in deciding targeted diagnostic work up.

eEdE-165

Cerebellar Infections in Children. Clinical and Imaging Vignettes

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Purpose
To describe the clinical presentation and diagnostic algorithm for infections of the posterior fossa in children. To illustrate the imaging findings of frequent and infrequent infectious diseases that affect preferentially the posterior fossa structures.

Materials and Methods
Using a case-based format we review the clinical presentation, diagnostic work up and imaging findings of multiple infectious processes that present predominantly in the posterior fossa in children.

Results
A variety of infectious diseases may present with isolated or predominant involvement of the posterior fossa in children. Frequent symptoms include fever, headaches, vomiting, ataxia, dysmetria, vertigo, and seizures. The initial work up includes CBC and cultures, CSF analysis, and imaging studies such as CT and MRI. The imaging findings include focal leptomeningeal enhancement without parenchymal lesions, areas of cytotoxic edema in the cerebellar hemispheres, focal parenchymal lesions in the brainstem or cerebellum, and focal areas of cerebellar parenchymal enhancement. We present cases with documented posterior fossa infections caused by Shigella sonnei, Plasmodium falciparum (cerebellar malaria), poststreptococcal infection, and viral encephalitis. In a few additional cases the workup suggested either a viral or a parasitic infection (eosinophilic meningitis), however a specific agent could not be isolated. Some of the patients develop acute hydrocephalus as a result of fourth ventricular obstruction and need temporary or permanent ventricular shunting. The treatment protocol, imaging follow up and complications are included in the discussion.

Conclusions
A number of infectious agents have predilection for posterior fossa infection in children, and manifest with a variety of clinical and imaging presentations. Empirical treatment frequently needs to be instituted while the confirmation of the etiology is pursued. Hydrocephalus is a frequent complication of cerebellar infections and may lead to transient or permanent cerebrospinal fluid (CSF) shunting.
Deconvoluting convulsions: An MRI-based review of pediatric epilepsy

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Purpose
Approximately 25% of children with epilepsy have a form that is resistant to medication therapy (1). Advances in MRI technology have led to considerable improvement in detection of culprit abnormalities in as much as 80% of cases (2). The information that the radiologist provides is vital for both diagnosis, as well as surgical planning in cases where it is applicable (3). In this exhibit, we review the characteristic imaging findings as well as relevant clinical information associated with these conditions.

Materials and Methods
Several MRI sequences are described based on our institution's routine seizure protocol. The key MR imaging findings as well as associated clinical features are presented using illustrative cases. Some of the diseases to be covered include: • Migrational abnormalities including focal cortical dysplasia, polymicrogyria, heterotopic gray matter, and hemimegaencephaly. • Mesial temporal sclerosis. • Intracranial mass lesions including ganglioglioma, xanthoastrocytoma, hypothalamic hamartoma. • Syndromic conditions including tuberous sclerosis and Sturge-Weber syndrome.

Results
A subset of pediatric epilepsy derives from culprit lesions that are discernible on MRI, especially among those that are refractory to anti-epileptic medications. Familiarity with the key associated imaging findings will augment the radiologist's ability to provide a diagnosis, facilitating appropriate clinical management.

Conclusions
Many cases of medication refractory epilepsy have underlying abnormalities that can be identified with MR imaging. Our goal is to provide a case-based overview of several common epilepsy-associated diseases, describing key imaging and clinical features to help the radiologist arrive at the correct diagnosis.
Figure 1: Sagittal T1W image demonstrates a hypothalamic hamartoma. T1W+ image demonstrate leptomeningeal enhancement in a case of Weber Syndrome(b). Axial T1W (c) and FLAIR (d) images demonstrate cortical dysplasia in the left parietal lobe.
Diffusion Tensor Imaging and Fiber Tractography of Pediatric Posterior Fossa Malformations

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Purpose
Diffusion tensor imaging (DTI) is an advanced magnetic resonance technique (MRI) that provides information about the three-dimensional degree of water diffusion in individual voxels of MRI images providing essential information about the course of white matter tracts. Fiber tractography (FT) combines this information between neighboring voxels allowing the graphical three-dimensional reconstruction of white matter pathways. Diffusion tensor imaging and FT have been shown to provide important information that may help to better characterize and categorize posterior fossa malformations. These malformations may look similar on conventional MRI, but may show different neuronal fiber courses which may reflect different pathomechanisms

Materials and Methods
We reviewed our experience as well as the available literature on DTI and FT of posterior fossa malformations.

Results
After a short introduction about the principles of DTI and FT, we will show DTI and FT findings in well defined posterior fossa malformations including Dandy-Walker malformation, Joubert syndrome, rhombencephalosynapsis, pontine tegmental cap dysplasia, horizontal gaze palsy and progressive scoliosis, pontocerebellar hypoplasia, and Chiari 2 malformation. We will discuss how DTI and FT findings added important information to better delineate these diseases and understand their pathogenesis. In addition, we will discuss some cases that have been solved only by DTI and FT.

Conclusions
Diffusion tensor imaging and FT provide noninvasively detailed qualitative and quantitative information about white matter microstructural integrity and organization in children with posterior fossa malformations. This information may go undetected or remains underestimated on conventional MRI sequences and may suggest the possible pathomechanism of posterior fossa malformation. Diffusion tensor imaging should be part of the standard neuroimaging protocol of children with suspected posterior fossa malformation.
Purpose
Diffusion tensor imaging (DTI) is an advanced magnetic resonance technique (MRI) that provides information about the three-dimensional degree of water diffusion in individual voxels of MRI images providing clues about the microstructure of the brain tissue and the course of white matter tracts. Fiber tractography (FT) combines this information between neighboring voxels allowing the graphical three-dimensional reconstruction of white matter pathways. Nowadays, several analytic approaches are available for DTI and FT data and allow a qualitative and quantitative analysis.

Materials and Methods
We will discuss the principles of each analytic approach emphasizing their pros and cons. We will illustrate the application of these approaches with example from our pediatric neuroimaging research activity.

Results
After a short introduction about the principles of DTI and FT and available tools for artifacts correction, we will discuss the following analytic approaches: qualitative analysis, regions of interest-based analysis, atlas-based analysis, voxel-based analysis, tract-based spatial statistics, and structural connectome.

Conclusions
Diffusion tensor imaging and FT are ideal neuroimaging tool to study the pediatric brain and can be applied to several pediatric neurology diseases. Several qualitative and quantitative approached are available to analyze pediatric DTI and FT data. Each approach has advantages and disadvantages. The choice of the most suitable method for a research study depends on the research question and hypothesis.

eEdE-170
Evolution of fetal dural sinus malformations

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Purpose
Dural sinus malformations (DSM) are congenital vascular malformations characterized by enlargement of dural sinuses that may be associated with arteriovenous shunts. The purpose of this educational exhibit is to describe the evolution of dural venous malformations seen on fetal MRI.

Materials and Methods
Retrospective review of fetal MRI and postnatal imaging of four patients with congenital dural sinus malformation.

Results
Initial 2nd trimester ultrasound revealed posterior fossa lesions, hence fetal MRI were recommended. All four patients underwent fetal MRI in the late 2nd trimester. In all patients a large posterior fossa hypointense lesion was identified in the region of the torcular Herophili,
which was displacing the supratentorial structures anteriorly and the cerebellum and brain stem anteriorly and inferiorly. The location of the lesion was typical for fetal dural sinus malformation. Follow-up postnatal imaging showed spontaneous decrease in size and eventual near complete resolution in two patients. The other two patients had persistent malformations and required extensive percutaneous and endovascular treatments, but continue to do well. Conclusions Early prenatal diagnosis of rare fetal dural sinus malformation can help optimize therapy and management of patients postnatally with improved positive outcome.
Purpose
Fetal head & neck (H&N) anomalies represent complex diagnostic and management challenges, often requiring serial imaging and a multidisciplinary team approach. In this exhibit, we will discuss the complementary roles of ultrasound (US) and MRI in prenatal diagnosis of H&N malformations, with postnatal imaging and clinical correlation.

Materials and Methods
With approval from our institutional review board, we reviewed over 200 H&N anomalies diagnosed on fetal MRI between 1997-2014 at a single institution. All examinations were performed using a 1.5T magnet with triplanar T2 SSFSE, DWI (b = 600), T1 FMPSPGR, and T2* EPI sequences at gestational ages ranging from 19-37 weeks. We present the fetal MRI imaging findings of a wide spectrum of congenital H&N malformations and anomalies with correlative prenatal US and postnatal imaging (US, CT, MRI, angiography). Additional critical management information will be provided including clinical course and obstetric/surgical interventions, as well as postpartum and/or postmortem pathologic correlation.

Results

Conclusions
Fetal MRI and US are complementary imaging techniques for the diagnosis of H&N anomalies. Advantages of US include low cost, real-time surveillance, and minimal maternal discomfort; while major limitations are the small acoustic window and low image contrast. Key indications for fetal MRI include detailed evaluation of craniofacial malformations, particularly posterior fossa and deep structures; characterization of lesion composition, lesion location, and extent; and improved evaluation of complications such as airway obstruction, vascular involvement, and fetal hydrops. The added information from fetal MRI can have important implications for patient counseling and management decisions, including various intrapartum (fetal surgery, EXIT procedure, induction, termination) and postpartum (neonatal surgery, sclerotherapy) interventions.
Focal Cortical Dysplasia Deconstructed

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Purpose
Focal cortical dysplasias (FCD) are difficult lesions to identify radiographically. Our purpose is to build a primer of radiological findings with multiple examples of all the pertinent imaging findings that can aid in their correct identification.

Materials and Methods
The information will be presented in an interactive teaching module with both instructive and testing sessions. Retrospective pediatric epilepsy surgical cases in patients with medically refractory seizures from 2004-2014 with biopsy proven focal cortical dysplasia and accompanying brain MRI with or without PET/SPECT brain were reviewed. Focal cortical dysplasias (FCD) on anatomical MR sequences were identified and correlated with PET/SPECT brain images when available. Multiple examples of both type I and type II FCD are presented with examples of each of the pertinent associated radiological findings (e.g., blurring of the gray/white matter junction, white matter changes, focal enlargement of the subarachnoid spaces).

Results
Multiple subtle radiological findings can be seen with focal cortical dysplasias (FCD). Among them are: focal enlargement of the subarachnoid spaces seem to point at the dysplastic lesion, increased cortical thickness, blurring of the gray-white matter junction, blurring subcortical white matter digitations, white matter and gray matter signal abnormalities, abnormal gyral/sulcal patterns such as polymicrogyria, focal and/or lobar hypoplasia/atrophy, etc. Some of these findings can be subtle and easily overlooked. We will demonstrate cases identifying all of these findings. When available, PET/SPECT scan correlation will be provided.

Conclusions
Focal cortical dysplasias (FCD) can be difficult lesions to identify radiographically. Excellent understanding of all the radiological manifestations of FCD will aid the radiologist to arrive at the correct diagnosis.
Where is the abnormality?
DIAGNOSIS:
BRAIN, LEFT "SUPERIOR FRONTAL GYRUS," CRANIOTOMY
- CORTICAL NEURONS WITH MILD ARCHITECTURAL DISARRAY AND MILD DYSMORPH
- INCREASED NUMBERS OF WHITE MATTER NEURONS
- FOCAL LEPTOMENINGEAL CHRONIC INFLAMMATION, CONSISTENT WITH GRID PLAC
(SEE COMMENT)
• Cortical thickness

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How to Facilitate Differentiation of Various Bumps and Lumps in the Pediatric Head and Neck by MRI and Dynamic Contrast Enhanced MRA

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Purpose
Demonstrate differentiating imaging characteristics of common head neck bumps and lumps in children with emphasis to age specific anatomy/location of the masses and MR imaging features.

Materials and Methods
Head and neck masses diagnosed from fetal life to young adulthood will be presented including
but not limited to dermoid, teratoma, branchial cleft and pouch cysts, thymic lesions, neoplastic masses (rhabdomyosarcoma, lymphoma) and infectious diseases using MRI and MRA (when necessary). Vascular anomalies of the head and neck will be discussed with special emphasis on the 2014 International Society for the Study of Vascular Anomalies (ISSVA) classification utilizing dynamic contrast-enhanced time-resolved MRA (TWIST).

Results
Radiation-free high resolution imaging is critical to diagnosis and assessment of head and neck masses in children. Anatomical location, MRI signal characteristics and contrast enhancement pattern are essential for correct diagnosis.

Conclusions
Pediatric head and neck masses require special attention, since the differential diagnosis are quite different compared to the adult counterparts. Radiation-free high resolution MR imaging provides detailed anatomical information, and excellent tissue characterization leading to accurate diagnosis.

eEdE-173

Imaging of the macrocephalic pediatric patient.

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Purpose
To present an educational review of common and uncommon etiologies underlying macrocephaly in the pediatric population.

Materials and Methods
We will present various etiologies that lead to the clinical presentation of macrocephaly. Related MRI and/or CT images obtained at our institution for the most relevant common and uncommon etiologies of macrocephaly will be included. A succinct description of the imaging findings for each entity, as well as therapeutic and prognostic information, where relevant, will accompany these images.

Results
Head circumference is measured routinely in successive well and sick child visits, as a way to monitor growth and development while also assessing for possible pathologic central nervous system processes. There are over 70 different causes of macrocephaly in children. The most common cause of macrocephaly tends to be inaccurate measurement, leading to erroneous overestimation. There also are a number of common benign causes of macrocephaly often identified on physical examination or imaging. These include scalp hematomas and caput succedaneum in the newborn period, and benign enlargement of the subarachnoid space in early childhood. More worrisome findings that are not infrequently encountered include extra-axial hematomas, hydrocephalus and various brain tumors. Developmental malformations, including aqueductal stenosis, Chiari and Dandy Walker malformations and vein of Galen malformation/aneurysm also are relatively frequent. Less common causes of macrocephaly include neurocutaneous disorders, such as neurofibromatosis and tuberous sclerosis. Metabolic defects also may result in an enlarging head circumference - examples include glutaryl-coenzyme A dehydrogenase deficiency in type I glutaric aciduria, mutations in the gene
encoding the enzyme aspartoacylase in Canavan's disease and fibrillary astrocytes with eosinophilic deposits in Alexander's disease. Macrocephaly also may be part of a syndrome. For example, Soto's syndrome is secondary to midline defects, an enlarged skull and normal brain size. Simpson-Golabi-Behmel syndrome includes enlarged skull with oro-palatal anomalies and Weaver syndrome is associated with accelerated skeletal maturation and limb anomalies with macrocephaly.

Conclusions
A large or increasing head circumference is a common clinical indication for referral to neuroimaging in the pediatric population at different ages. While the underlying etiology may be as trivial as an overestimation of the actual head circumference, other more serious and potentially life-threatening conditions such as hydrocephalus, nonaccidental trauma and brain tumors, among others, are encountered frequently and need to be diagnosed promptly and treated. Less frequently encountered conditions also will benefit from prompt diagnosis by helping guide appropriate management. It is important for radiologists who provide care for the general community, not only neuroradiologists and pediatric radiologists, to be aware of common and uncommon etiologies underlying macrocephaly in order to provide the most appropriate care for such patients.
Imaging of the Pediatric Hypothalamic-Pituitary Axis: How Embryology Sheds Light on Pathology

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Purpose
The purpose is to review congenital and acquired disorders of the pediatric hypothalamic-pituitary axis and sellar region, with an emphasis on imaging features of normal gland development and how the disruption of coordinated embryological events leads to congenital pathology.

Materials and Methods
The methodology consists of creating an interactive, educational PowerPoint presentation which includes representative cases collected at our institution, reviews the current literature and highlights what attendees should learn after viewing the presentation with multiple choice questions.

Results
We illustrate the normal MRI imaging appearance of the developing pituitary gland in the newborn, children and the young adult, including examples of the normal premenstrual gland, normal pubertal gland and normal postpartum gland. We address dilemmas that arise in imaging the developing pituitary gland and offer management considerations. For example, at the time a child presents with diabetes insipidus, a pituitary stalk lesion such as a germ cell tumor may not be visible yet by imaging, and in such patients repeat imaging should be obtained in 3 to 6 months and, if still negative, a second repeat examination should be obtained. We also discuss the sessile and pedunculated forms of hypothalamic hamartoma, and their association with seizures and precocious puberty. We discuss the differential diagnosis of absence of the T1 hyperintensity of the posterior pituitary; the importance of not mistaking the normal superiorly convex appearance of the pubertal female gland for pathology; and the different locations of craniopharyngioma along the path of Rathke pouch through the craniopharyngeal canal. In emphasizing the point of disruption of normal pituitary gland development and/or function, we discuss the following congenital and acquired pathology of the hypothalamic-pituitary axis through image-rich case material collected at our institution: Ectopic neurohypophysis, septo-optic dysplasia, persistent craniopharyngeal canal, trans-sphenoidal cephalocele, duplicated pituitary gland, pituitary stalk lesions, Rathke cleft cyst, craniopharyngioma, and hypothalamic hamartoma.

Conclusions
We review the pathogenesis and imaging features of pediatric hypothalamic-pituitary axis disorders. The normal neonatal, pubertal and young adult pituitary gland have their own distinct appearances that should not be confused with congenital pathology. Knowledge of normal embryology of the pituitary gland, particularly the development of adenohypophysis from the Rathke pouch and of the neurohypophysis from the diencephalon, is central to the understanding of congenital pathology. Interpretation of imaging features of acquired disorders also is enhanced by grasping basic concepts of hypothalamic-pituitary axis embryology and function.
Imaging Spectrum of Cortical Dysplasia and Associated Abnormalities in Children with Intractable Epilepsy

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Purpose
MR imaging is an important part of the presurgical evaluation of children with intractable epilepsy and can be challenging to interpret. Cortical dysplasia (CD) is the most common pathology identified after resection, with a recently updated classification system (ILAE 2010) (1). Identification of epileptogenic lesions on MRI is of critical importance in patient selection for surgery and surgical guidance as patients with MRI detectable lesions and complete resection have better postsurgical outcomes (2). To improve radiologist awareness, we describe the imaging spectrum of CD in a large cohort of children who have undergone surgical resection for intractable epilepsy with histopathologic correlation. Emphasis will be placed on typical MR imaging features, role of additional noninvasive imaging and electrophysiologic techniques.
(PET, SISCOM, MEG, EEG), the ILAE 2010 classification scheme, and commonly missed findings.

Materials and Methods
The pathology database at a large tertiary care academic children's hospital was reviewed for the term "cortical dysplasia" in surgical patients for intractable epilepsy from 2007 – 2014. Presurgical MRI examinations were re-evaluated. PET, SPM analysis of PET, SISCOM, and MEG studies were reviewed when available. Detailed evaluation of MRI findings of CD and hippocampal sclerosis (HS) was performed in each region. Pathology was reviewed and classified according to ILAE 2011 guidelines.

Results
A total of 174 resection regions in 78 patients were evaluated and serves as the study population for the educational exhibit. All had a dedicated presurgical seizure MRI protocol, 69 (88%) at 3T. By patient, there were 24 with type I, 25 type IIa, nine type IIb, eight type IIIa (anterior temporal lobe type I and HS), six type IIId (type I CD associated with an encephaloclastic process), and six with dual pathology (type II or type IIIId with HS). Lesional MRI findings were identified in 63 resection locations (16% of type I, 38% of type IIa, 86% of type IIb, 44% of type IIIa, and 80% of type IIIId dysplasias) in 44 patients (56.4%). In mesial temporal resections with HS/hippocampal dysplasia (16), MRI was abnormal in nine (56%). Multiple case examples will be provided demonstrating the imaging, clinical, surgical, electrophysiologic, and pathologic findings in each dysplasia type.

Conclusions
Interpretation of MR imaging in children with intractable epilepsy undergoing presurgical evaluation is challenging but important to help direct surgery. As a group, MRI may be abnormal in just over a half of patients, usually those with Type II CD (especially type IIb), and type I dysplasia associated with HS (IIIa) or encephaloclastic lesions (IIId). Evaluation of associated temporal lobe signal changes (type IIIa CD) is important. Understanding patterns of overlooked findings is essential to improve diagnostic accuracy.

eEdE-167

6:30AM - 3:00PM

Inflammatory Autoimmune Diseases of the Pediatric Central Nervous System

S Kanekar
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Purpose
1. To discuss the pathophysiology and pathology of the inflammatory autoimmune diseases of the pediatric central nervous system. 2. To discuss with illustrations the imaging findings of inflammatory autoimmune diseases of the pediatric central nervous system.

Materials and Methods
Inflammatory demyelinating disorders of the brain are quite frequent in pediatric patients. A typical clinical presentation is either acute or subacute and is clinically challenging to distinguish from other causes of neurological deficit. Early recognition and treatment is must as most these conditions are completely reversible. We retrospectively studied MRI, and CT of 281 pediatric patients from PACS system who had final diagnosis of inflammatory demyelinating disease of
central nervous system (CNS). All the imaging findings were correlated with the clinical findings, laboratory results and cerebrospinal fluid (CSF) analysis.

Results

Patients were classified into two major groups: Nonvasculitic inflammatory brain diseases (NVIBD) and vasculitic inflammatory brain diseases (VIBD). NVIBD were further classified into acute disseminated encephalomyelitis (ADEM), acute necrotizing encephalopathy, acute hemorrhagic leukoencephalitis, clinically isolated syndrome (CIS), pediatric multiple sclerosis (MS), atypical forms of MS, neuromyelitis optica (NMO), anti-NMDAR encephalitis, Rasmussen's encephalitis, febrile infection-related epilepsy syndrome (FIRES) and acute transverse myelitis (TM). VIBD were categorized into primary CNS vasculitis (cPACNS) and secondary CNS vasculitis: infection and post infectious, systemic rheumatic disease (SLE, systemic vasculitis, scleroderma, dermatomyositis), systemic inflammatory disease (Kawasaki disease, inflammatory bowel disease, celiac disease), exposures (radiation).

Conclusions

This exhibit gives an algorithmic approach to the inflammatory autoimmune diseases of central nervous system in pediatric patients.

**eEdE-191**

6:30AM - 3:00PM

**Intraoperative Imaging: Techniques and Applications in Pediatric Neurosurgery**

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Purpose

Imaging is critical for identifying and characterizing surgically treatable lesions and understanding their relationship to eloquent regions. Imaging is being used increasingly to help guide neurosurgical procedures intra-operatively. Radiologists can play an important role in assisting neurosurgeons in pre-operative planning, as well as intra-operatively, to define safe corridors for surgical access, estimate completeness of resection, and to provide real-time intra-operative guidance. Modern neuronavigation systems have a wide range of tools that can assist the radiologist and surgical team in outlining appropriate operative plans. The purpose of this exhibit is to review the modalities and techniques for image-guided neurosurgery and intra-operative imaging and to share our collaborative approach using these tools to care for children with neurosurgically treated disorders.

Materials and Methods

Case material from a large tertiary care children's hospital from 2007-2014 will be used to provide an illustrative review of pre-operative and intra-operative imaging techniques. Modalities routinely utilized at our institution include: intra-operative ultrasound, fMRI, DTI-based tractography, pre-operative and intra-operative angiography, intra-operative MRI, integrated MEG, PET, SISCOM and subdural grid segmentation, CT angiography, and CT imaging. Image fusion and integration is performed using BrainLab iPlan 3.0, implemented on a networked server allowing easy image transfer, fusion, and object creation for operative use.

Results

Image guidance for neurosurgical procedures has been valuable in many clinical settings at our institution. Scenarios to be reviewed include: Imaging protocols and techniques for anatomical...
planning and neuronavigation; pre-operative fMRI and DTI tractography with operative integration; combined modality fusion in pediatric epilepsy; intra-operative ultrasound for CCJ surgery, tumor resection (brain and spinal cord) and ventricular and spinal shunt procedures; intra-operative MRI for tumor and lesion resection assessment, functional neurosurgery, and depth electrode placement; 3D angiogram integration for aneurysms and vascular malformations, and intra-operative angiography for documentation of removal/exclusion of various vascular pathologies. Potential pitfalls and technical issues related to these indications and modalities will be reviewed.

Conclusions
Operative integration of multimodality imaging is critical in managing many neurosurgical conditions in children. Techniques and pitfalls of imaging used for surgical planning and intra-operative use are reviewed and can be applied in adult and pediatric populations. A collaborative approach, using the varied skill sets of radiologists, neurosurgeons, and neurologists involved in the care of children with neurosurgical problems is optimal.

eEdE-166
6:30AM - 3:00PM
Linear Scleroderma "en Coup de Sabre" and Parry-Romberg Syndrome: Two related variants of Localized Scleroderma with CNS findings

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Purpose
Linear scleroderma en coup de sabre (LScs) and Parry-Romberg syndrome (PRS) are variant manifestations of localized scleroderma in which face and scalp involvement is a dominant feature. The two entities share similar histopathologic features of fibrosis involving the skin, adipose tissues and occasionally cartilage and bone. LScs typically presents as unilateral reddish discoloration of the forehead and/or scalp regions, eventually evolving into cicatricial hairless plaques and band-like hyperpigmented fibrotic plaques resembling "the stroke of a sword" (i.e., coup de sabre). PRS is a progressive fibrotic disorder resulting in unilateral atrophy of the face and scalp. Rarely patients with LScs and PRS manifest with central nervous system findings, which is well reported in the neurology and rheumatology literature. A thorough description of the neuroimaging findings, however, is lacking with no published radiology literature present to our knowledge.

Materials and Methods
We reviewed MR and CT brain images in localized scleroderma patients with LScs/PRS and CNS findings. We also reviewed the electronic medical record of these patients to identify presenting symptoms, pertinent lab findings and treatment regimens.

Results
The results of our database search for patients with LScs/PRS and CNS manifestations revealed six patients (4 female, 2 male). The neuro-imaging findings were primarily T2 hyperintense, often juxtacortical, white matter lesions. These lesions were strikingly unilateral to the facial abnormalities (5 of 6). Microhemorrhages (3 of 6), cysts (2 of 6) and calcification (1 of 6) also were seen. Mainstay of treatment was immunotherapy, such as steroids and methotrexate.
Conclusions
The causal relationship between LScs/PRS and CNS involvement warrants further investigation. Understanding the neuro-imaging in these clinical entities will improve the diagnostic accuracy of the neuroradiologist, helping avoid mimics such as demyelination or cortical dysplasias. Furthermore, increased awareness of the link between LScs/PRS and CNS lesions will prompt earlier neuro-imaging and subsequent treatment.

eEdE-184
6:30AM - 3:00PM

Masqueraders of neonatal hypoxic-ischemic encephalopathy

T Bosemani, M Lemmon, F Northington, M Johnston, T Huisman, A Poretti

Purpose
Neonatal encephalopathy (NE) is a neurological syndrome manifesting from birth and characterized by depression of level of consciousness, respiratory depression, abnormalities of tone, power and reflexes, disturbances of cranial nerve function, and often seizures. Hypoxic-ischemic encephalopathy (HIE) is the most common cause of NE. However, the clinical presentation of HIE may be mimicked by other neonatal neurological and systemic conditions. The management and prognostic implications of HIE is vastly different from its mimickers and hence an accurate diagnosis is required.

Materials and Methods
We reviewed our pediatric MRI database searching for neonatal and hypoxic-ischemic encephalopathy.

Results
Our review will begin with a brief description of the clinical history, clinical presentation, and laboratory and neuroimaging findings of HIE. Then we will discuss following neonatal conditions or diseases that may mimic HIE: sepsis, epilepsy syndromes, ischemic stroke, intracranial hemorrhage, parturitional brain injury, metabolic disorders, neonatal hypoglycemia, cyanotic congenital heart disease, neuromuscular disorders, and maternal drug use. We will present a few cases to highlight the key clinical and neuroimaging findings of these masqueraders.

Conclusions
The literature on HIE is elaborate in terms of etiology, clinical presentation, laboratory investigations, imaging, management and outcomes. The description of mimickers is relatively sparse. Neuroimaging plays an important role in solving this diagnostic conundrum. Appropriate management of HIE mimickers may treat or cure the underlying condition and prevent severe neurological sequelae. It is therefore crucial for the multidisciplinary team that includes neonatologists, neurologists, neuroradiologists, neuropsychologists, neurophysiologists and neurodevelopmental teams to recognize the HIE masqueraders in order to establish the best standard of care.

eEdE-160
Meningioangiomatosis: A Broader Imaging Spectrum than you Think!

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Purpose
Meningioangiomatosis (MA) is a rare condition caused by meningeal vascular proliferation of unknown etiology. The imaging appearance can be quite variable. We present 10 cases of MA highlighting a spectrum of appearances, ranging from classic cases to those mimicking or co-existing with other lesions.

Materials and Methods
A query for "meningioangiomatosis" was performed on all radiology reports over a period of 10 years at Primary Children's Medical Center and the University of Utah Hospital, yielding nine cases where MA was the provisional diagnosis. All were treated conservatively; none went to surgery. Ten years of pathology records at the University of Utah yielded no path-proven cases. One case was contributed from a personal teaching file.

Results
Meningioangiomatosis is a rare condition and one that is rarely resected, with most of the literature consisting of case reports and series. The most common reported findings are gyriform calcification, gyriform enhancement, and subcortical edema/gliosis. A 2011 meta-analysis reported calcification in 90% and enhancement in 80% (1). Another paper studying path-proven cases reported subcortical involvement in 7/8 (88%) cases (2), while the meta-analysis reported subcortical involvement in 46% (1). Meningioangiomatosis can co-exist with other lesions. Meningioma is the most common (3). Cysts, both subcortical and in the subarachnoid space, have been reported (2, 4). Other associated lesions include oligodendroglioma, vascular malformations, and cortical dysplasia (3). We present 10 cases illustrating the spectrum described above and discuss differential considerations for each. Four typical cases are included first. Next, five cases demonstrating associated lesions including meningioma, subcortical cysts (Figure a), subarachnoid cysts (Figure b), and cortical dysplasia (Figure c) are presented. Another case demonstrates ill-defined gyriform calcifications that initially were called subarachnoid hemorrhage by CT (Figure d).

Conclusions
Meningioangiomatosis should be considered whenever there is gyriform calcification and enhancement. However, it is important to be aware of potentially confounding variant imaging appearances.
MR evaluation of antenatal fetoscopic myelomeningocele repair – what does the pediatric neurosurgeon want to know?

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Purpose
To present a systematic approach for the antenatal and postnatal imaging evaluation of patients with Chiari malformation type II following intra-utero repair of myelomeningocele (MMC).

Materials and Methods
In this study, we demonstrated morphometric changes occurring in the posterior fossa identified on MR follow up of fetuses and newborns submitted to antenatal fetoscopic repair of MMC, with emphasis on potentially reversible abnormalities.

Results
Myelomeningocele (MMC) is characterized by a defect in caudal neurulation and appears at birth with a constellation of neuro-anatomical abnormalities, including Chiari malformation type II defined by a small posterior fossa, herniation of the cerebellar vermis below the foramen magnum, an elongated brainstem, and a compressed fourth ventricle. Antenatal repair of MMC results in qualitative decreases in hindbrain herniation with reduced need for shunt placement and improvements in neurologic function compared with postnatal standard repair. Fetoscopy now is performed in selected patients and presents an additional therapeutic alternative for expectant mothers carrying a fetus with MMC.

Conclusions
There are some reversible changes in abnormalities associated with Chiari malformation type II that should be assessed during MR follow up of antenatal myelomeningocele repair and informed to the pediatric neurosurgeon.
Neurological Manifestations of the Phakomatoses: An Interactive Case-Based Approach

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Purpose
The purpose of this exhibit is to overview the spectrum of neurological manifestations of the phakomatoses in an interactive case-based format and review the relevant imaging findings.

Materials and Methods
This educational exhibit will detail the various phakomatoses in an interactive case-based format with focus on the clinical presentation, imaging findings, and treatment and prognostic implications. The diseases interrogated in this exhibit include neurofibromatosis type 1 and 2, tuberous sclerosis, Sturge-Weber syndrome, von Hippel-Lindau disease, ataxia telangiectasia, incontinentia pigmenti, hypomelanosis of Ito, Proteus syndrome, neurocutaneous melanosis, and Gorlin-Goltz syndrome.

Results
The phakomatoses are a diverse group of disorders bound together by involvement of structures arising from the embryonic ectoderm such as the nervous system, skin, retina, etc. Many present with nonspecific symptoms, and correlation of the constellation of imaging findings can help guide the appropriate diagnosis and subsequent patient management.

Conclusions
This educational exhibit reviews the neurological manifestations of phakomatoses and clinical implications. The use of a case-based format is designed to enhance knowledge retention and
help define findings that distinguish this diverse set of diseases from other pathologies. After reviewing this exhibit, the viewer should develop a confident and practical method to approaching this subset of diseases.

**Patterns of Abnormal Perfusion in the Pediatric Brain Evaluated with Arterial Spin Labeling**

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**Purpose**

Recent literature has illuminated increasing diagnostic uses of the arterial spin labeling (ASL) technique. ASL obtains accurate and reliable cerebral blood flow (CBF) measurements noninvasively and can be performed multiple times during the same exam, unlike other perfusion techniques. A wide variety of entities, including normal variants, pathological conditions, and technical errors can demonstrate abnormal CBF values. This Educational Exhibit has three main purposes: 1. To classify the main abnormal ASL perfusion patterns in the pediatric brain. 2. To discuss the significance of abnormal ASL values, understand their significance and learn to correlate them in the clinical context. 3. To discuss the utility of this technique in the pediatric clinical setting.

**Materials and Methods**

For the purpose of this study, brain perfusion abnormalities were divided into two main categories: patterns with increased perfusion and patterns with decreased perfusion. Subsequently, these main categories were divided into two main subcategories: focal or diffuse distribution of the perfusion abnormalities. A third main category was added, including the cases which showed a mixed pattern of perfusion abnormality. A review of our RIS database was performed looking for cases which might better illustrate the above-mentioned different categories and subcategories of perfusion abnormalities.

**Results**

We gathered a group of representative/illustrative cases with different abnormal perfusion patterns from our RIS. We subsequently classified them in the following manner: I. Entities with increased perfusion on ASL: I.a. Diffuse, I.a.1 Profound anoxic injury/cardiac arrest. I.a.2. Sickle cell anemia, I.a.3. Meningoencephalitis. I.b. Focal, I.b.1. Luxury perfusion post infarct, I.b.2. Hypoxic ischemic encephalopathy of the newborn, I.b.3. Encephalitis I.b.4. Seizure (ictal phase). II. Entities with decreased perfusion on ASL: II.a. Focal, II.a.1 Low grade neuroepithelial tumor, II.a.2. PRES, II.a.3. Seizure (interictal phase), II.a.4. Artifactual: tilted position of the head, II.a.5. Subdural hematoma. II.b. Diffuse: II.b.1. moyamoya disease, II.b.2. Menkes syndrome, II.b.3. Craniosynostosis. III Entities with a mixed pattern of increased and decreased perfusion on ASL: III.a Concomitant sickle cell and moyamoya, III.b. Dyke Davidoff Masson syndrome with contralateral hyperperfusion. Our Electronic Exhibit will explain the different perfusion patterns that can be seen in the clinical setting, show cases from our database of the above-mentioned entities and add a brief description of each diagnosis.
Conclusions
Arterial spin labelling (ASL) is a robust, noninvasive MR technique that can be used to characterize and measure cerebral brain perfusion. In recent years, ASL perfusion has become increasingly available in routine clinical practice; radiologists should be comfortable with ASL interpretation. This exhibit depicts various processes that may alter the appearance of ASL images in characteristic patterns and enhance diagnostic yield.
A. Increased diffuse: sickle cell anemia

B. Increased focal: seizure (ictal phase)

C. Decreased diffuse: craniosynostosis

D. Decreased focal: PRES

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eEdE-204

Pediatric Neuro CT in the ER-pearls and pitfalls for the radiologist

6:30AM - 3:00PM
Purpose
Evaluation of pediatric CTs in the ER is challenging. Besides normal variants, there are certain entities unique to children making interpretation of these studies even harder. The purpose of this exhibit is to highlight pearls and pitfalls which might be useful to radiologists when evaluating such cases.

Materials and Methods
Cases of pediatric neuro CTs in the ER which were interpreted incorrectly initially by the radiology resident were evaluated and are discussed and presented in the form of an educational exhibit.

Results
Cases in this exhibit are divided into traumatic and nontraumatic categories. In the traumatic category - cases of fractures and their mimics such as normal/accessory sutures and Wormian bones are shown. Critical when evaluating fractures, particularly in nonaccidental trauma, is the utility of 3D imaging are discussed. The controversial entity 'Benign extra axial subarachnoid spaces of infancy', more commonly known as BESS and its relationship to nonaccidental trauma is addressed. Nontraumatic etiologies might also mimic trauma such as cavernomas, venous sinus (cortical vein) thrombosis and cases of normally increased dense sinuses, in neonates as well as in cases of renal failure (due to nonexcretion of contrast) may be interpreted inaccurately as venous sinus thrombosis (pseudo delta sign). Key observations when evaluating nontraumatic parenchymal abnormalities such as edema due to HIE or ADEM or hemorrhage due to vascular anomalies or tumor are presented. Besides skull fractures, particular attention to the skull vault when evaluating conditions such as arachnoid cysts (particularly those with underlying hemorrhages) and/or arachnoid granulations is highlighted.

Conclusions
Evaluation of pediatric neuro CTs in the ER requires not only knowledge of normal variants but also recognizing certain pathologies and conditions which are common in children.

eEdE-201
6:30AM - 3:00PM

Pediatric Extradural Spinal Masses: Spectrum of Common and Uncommon Pathology Affecting the Young Spine

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Purpose
This electronic educational exhibit presents: 1) A basic organization of pediatric extradural masses based on clinical and radiological findings; 2) Imaging spectrum of common and uncommon pediatric extradural masses.

Materials and Methods
While the central nervous system (CNS) is second only to the hematopoetic system as a site for
pediatric tumor formation, pediatric spinal tumors comprise less than 10% of all CNS pediatric
tumors. Spinal tumors are divided into three categories based on location: intradural masses
(either intramedullary or extramedullary), or extradural masses. Most articles focus on an
approach to intradural masses. This exhibit presents a radiological organization and imaging
spectrum of common and uncommon pediatric extradural masses.

Results
Evaluation begins with a pertinent clinical history and physical findings. Clinical history may
lead to a specific diagnosis for etiologies including epidural hematoma or epidural
phlegmon/abscess, metastatic disease in the setting of a known malignancy, or extramedullary
hematopoiesis (in a condition such thalassemia). In the setting of a nonspecific clinical history, a
basic radiological organization of an extradural mass includes whether the mass is of primarily
bone origin, primarily soft tissue origin, or if the mass significantly involves both soft tissue and
bone. A pediatric spinal mass involving primarily the bone includes an aneurysmal bone cyst,
osteoid osteoma and osteoblastoma, osteosarcoma, Langerhans cell histiocyteisis, and chordoma.
A pediatric spinal mass that is of primarily soft tissue origin includes an infantile hemangioma,
venous malformation, neuroblastoma or ganglioneuroblastoma, and nerve sheath tumors. A mass
which may demonstrate significant soft tissue and bone involvement includes leukemia and
lymphoma, and Ewing's sarcoma.

Conclusions
Within each group, imaging clues to a more specific diagnosis will be detailed in this
presentation. Depending on whether a specific diagnosis or a differential diagnosis can be
obtained, through imaging in conjunction with the clinical history, a biopsy or PET CT may be
helpful for further evaluation. In consultation with the spinal surgeons and other neurological
specialists, radiologists can be an integral component of the team providing added value to
patient care.

eEdE-200
6:30AM - 3:00PM

Pediatric Spinal Nerve Root Enhancement: Clinical and Differential Considerations

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Medicine, Baltimore, MD, ³The Johns Hopkins University School of Medicine, Baltimore, MD

Purpose
On neuroimaging, spinal nerve root enhancement indicates lack of integrity of the blood-nerve
barrier. In pediatric neuroimaging, it is a nonspecific finding that may be seen in several different
diseases including neoplastic and inflammatory processes. The correct diagnosis is paramount in
terms of management and prognosis. Neuroimaging provides helpful diagnostic information that
may guide further diagnostic work up in correlation with clinical and laboratory findings.

Materials and Methods
We reviewed our pediatric MRI database searching for children with spinal nerve root
enhancement.

Results
We will present and review a range of conditions with spinal nerve root enhancement including
Guillain-Barre, meningitis, metastatic disease, chronic inflammatory demyelinating
polyneuropathy, hereditary neuropathies, and various inflammatory and infectious conditions such as neuroborreliosis. We classified the diseases based on their pathogenesis and created a comprehensive differential diagnostic list.

Conclusions
Familiarity with the various pathologic entities associated with spinal nerve root enhancement in children is important for a concise differential diagnosis in the appropriate clinical setting.

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eEdE-190

**Perfusion imaging in neonatal and pediatric brain.**

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Purpose
The purpose of this educational exhibit is to evaluate the clinical utility of perfusion imaging in neonatal and pediatric brain.

Materials and Methods
Retrospective review of MRI brain imaging in neonatal and pediatric brain imaging in the last year (2013-14) was performed and clinical utility of ASL imaging was evaluated in various subgroups. Perfusion imaging using both GE (1.5 and 3T) and Siemens (a new sequence on 3T Skyra) 3D pseudo-continuous ASL sequences were reviewed.

Results

Conclusions
Noninvasive evaluation of cerebral perfusion offers unique additional information in the imaging of pediatric brain. It may help differentiate high grade and low grade tumors, reflect seizure-related perfusion changes which may help find a region of dysplasia, guide treatment in stroke and evaluate small vessel disease. Other future applications may include evaluation of silent
ischemia in sickle cell patients, monitor changes in intracranial pressure in hydrocephalus and possibly offer additional insights in nonaccidental trauma.

**eEdE-195**

**Phakomatosis Syndromes: An Educational Review and What Every Radiologist Should Know.**

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**Purpose**

The phakomatoses are multisystem disorders involving the neurocutaneous tissues and other tissues throughout the body. These disorders frequently demonstrate a large number of radiographic findings that all radiologists should know, especially in neuroradiologic imaging. Understanding the spectrum of the radiographic findings for these diseases is important for these patients, and in many cases may be diagnostic, effect prognosis, or effect treatment. Our purpose is to review the collective radiographic findings of common individual phakomatoses, focusing on neurofibromatosis I and II, tuberous sclerosis, Sturge-Weber, and ataxia telangiectasia.

**Materials and Methods**

A retrospective review of neuroradiology cases at the University of Texas Health Science Center at San Antonio was performed to identify patient cases with a diagnosis of phakomatosis. Characteristic findings of neurocutaneous and systemic manifestations of the specific diseases were identified on imaging and organized into a review of neuroradiologic and other findings in the phakomatosis diseases. As well, we reviewed literature for imaging of these diseases.

**Results**

Intracranial findings on both CT and MRI are prevalent in phakomatosis disease, although for intracranial findings MRI is more sensitive and specific for diagnosing lesions. Additionally, there are often extracranial findings. The following diseases are shown and discussed including background and common imaging findings: Neurofibromatosis type I: - optic pathway gliomas, - dysplastic white matter lesions, - neurofibromas/plexiform neurofibromas, - vascular dysplasia: stenosis, moyamoya, aneurysm. Neurofibromatosis type II: - bilateral vestibular schwannomas, - schwannomas of cranial nerves and spinal nerve roots, - meningiomas, - ependymomas. Tuberous Sclerosis: - Multiple partially calcified subependymal nodules, - subcortical tubers, - radial migration of white matter lines, - subependymal giant cell astrocytoma, - white matter cyst-like lesions. Sturge Weber: - Pial angiomatosis and leptomeningeal enhancement, - parenchymal volume loss and atrophy, - ipsilateral choroid plexus enlargement, - cortical calcifications. Ataxia telangiectasia: - ocular telangiectasia, - cerebellar ataxia. Basal cell nevus syndrome: - lesions of mandible and maxilla resembling odontogenic keratocysts, - extensive calcification of falx cerebri, - frontal and parietal bossing, - medulloblastoma. PHACES syndrome: - posterior fossa malformations, often unilateral cerebellar hypoplasia, - cortical dysplasia, - vascular abnormalities, - eye abnormalities. Neurocutaneous melanosis: - giant or multiple benign and/or malignant lesions of the central nervous system, - leptomeningeal melanosis and melanoma.
Conclusions
The phakomatoses are a collection of neurocutaneous disorders which frequently involve multiple organ systems and tissues. In radiology, it is important to understand the spectrum of findings in these diseases as it may pertain to the patient's diagnosis, prognosis, symptoms, and/or treatment.

**eEdE-180**
6:30AM - 3:00PM

**Pictorial review of non-traumatic head and neck emergency imaging in children.**

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**Purpose**
Most children evaluated in the emergency department are treated without the need for imaging. When imaging is indicated, it may be for evaluation of trauma or nontraumatic reasons. The purpose of this study is to review the varied pathologies encountered in children who undergo head and neck imaging for nontraumatic reasons, referred via the emergency department. Some of the most common signs and symptoms that these children present with include evidence of infection, airway compromise, rapidly increasing neck masses, and rapid onset of proptosis.

**Materials and Methods**
Retrospective review of imaging and clinical data to find representative examples of common and uncommon pathologies encountered while imaging the nontraumatic pediatric head and neck.

**Results**
We will focus on the imaging of both common and uncommon nontraumatic conditions affecting children in the acute emergency room setting. Each disease will be displayed as a separate entity and a multimodality imaging approach will be presented. We will attempt to simplify common radiological problems by seeking out pitfalls for each diagnosis and depicting methods to avoid these errors. Additionally, we will have a brief discussion of the differential diagnosis for each entity. Lastly, the clinical presentation will be emphasized and we will discuss the selection of appropriate imaging modalities with specific references from the "ACR Appropriateness Criteria". A whole host of pathologic conditions will be covered, that may contribute to symptoms requiring urgent/emergent imaging. 1. Inflammatory/Infection: a. Complications of Mastoiditis, i. Epidural Abscess; ii. Venous Sinus Thrombosis; iii. Osteomyelitis. b. Complications of Sinusitis, i. Orbital infection; ii. Frontal osteomyelitis; iii. Intracranial abscess. c. Deep neck infection and complications. d. Airway Compromise, i. Epiglottitis; ii. Croup; ii. Exudative Tracheitis; iv. Subglottic hemangioma. 2. Neoplasm and neoplasm like disorders: a. Hemangiomas. b. Rhabdomyosarcoma. c. Neuroblastoma. d. Juvenile angiofibroma. e. Langerhan cell histiocytosis. 3. Congenital abnormalities: a. Infected congenital cysts, sinuses or fistulae. b. Vascular malformations.

**Conclusions**
Imaging the pediatric head and neck, for emergency indications can be a challenge. This presentation will review the imaging characteristics and differential diagnosis of common and uncommon pathologies leading to imaging the pediatrics. Learning objective To review the varied
pathologies encountered in imaging the head and neck in children referred from the emergency department, with emphasis on imaging findings, imaging workup and differential diagnosis.

**eEEdE-185**

6:30AM - 3:00PM

**Post-mortem MRI as an Adjunct to Autopsy in Pediatric Brain Tumors: Report from the Pediatric Brain Tumor Repository.**

J Leach¹, B Jones¹, L Miles¹, J Young¹, M Fouladi¹, L Chow¹, C Dumoulin¹, T Hummel¹, M Dewire¹

¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH

**Purpose**
The Pediatric Brain Tumor Repository (PBTR) is a prospective study evaluating autopsy obtained tissue from children with brain tumors in order to facilitate future clinical and translational research. The project is supported by a multidisciplinary team of oncologists, radiologists, pathologists, and basic researchers. One component of the project is post-mortem MR imaging of the removed brain, performed to increase understanding of preterminal progression of tumor, and to provide guidance for autopsy sampling and detailed imaging-pathology correlation. This exhibit will present our technique and initial imaging findings of the PBTR.

**Materials and Methods**
Fourteen subjects enrolled in the PBTR who had post-mortem MRI are included in this exhibit. All subjects underwent a limited brain autopsy immediately post-mortem with removal of the brain and leptomeninges. Selected portions of tumor and uninvolved brain tissue were removed fresh for biologic assays. All specimens were imaged on a 1.5T small bore MR system (¹) employing high resolution volumetric T2, T1, SWI, and DTI sequences. Volumetric data sets were reconstructed into standard anatomical orientations to duplicate standard in vivo slice orientation and plane of brain cutting. At subsequent brain cutting for permanent histologic analysis, both pre-mortem and post-mortem imaging was used to guide tissue sampling, identifying areas suspicious for spread of tumor or other pathology. The locations for sampling were marked on brain slices and photographed prior to submission for histopathology. Additional images were reconstructed from volumetric sequences acquired on the pre- and post-mortem MR exams to match pathologic cut planes. Results of sampling and imaging findings in each area were tabulated.

**Results**
Five females and nine males, ages 2 – 26 years (mean:12 years) had post-mortem MRI. Diagnoses included nine DIPG, three anaplastic astrocytomas, one PNET, and one ATRT. One specimen was imaged immediately after autopsy, prior to fixation; all other specimens were imaged after fixation, with an average length of time of tissue fixation of 12 days (range: 4-49 days). The average length of time between the last pre-mortem MR and the post-mortem exam was 85 days (range 28-455 days). In seven subjects (50%) findings on post-mortem MRI demonstrated areas of potential progression that were not visible on the last pre-mortem MRI, leading to targeted sampling of specific regions at brain cutting. Examples of the detailed correlation between imaging and pathology provided by this process will be presented.
Conclusions
Post-mortem MR imaging can be helpful in directing tissue sampling and determining patterns of tumor spread and post-treatment effects at autopsy in children with pediatric brain tumors. MR imaging features of fixed tissue differ substantially from in vivo imaging, and familiarity with these differences can increase utility of this technique. Understanding pathologic findings underlying imaging abnormalities can inform clinical practice, and potentially help direct therapy in the future.

Radiologic Pathologic Correlations of Pilocytic and Pilomyxoid Astrocytomas with Emphasis on Diffusion-Weighted Imaging

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Purpose
Pilocytic and pilomyxoid astrocytomas, classified as grade I and II astrocytic tumors by the World Health Organization, are the most common type of glioma in children and young adults. This exhibit aims to provide a comprehensive overview of pilocytic and pilomyxoid astrocytomas from imaging findings with emphasis on diffusion-weighted imaging (DWI) and the differential diagnosis to treatment.

Materials and Methods
We will review imaging findings of pilocytic and pilomyxoid astrocytomas on CT, MRI, MR spectroscopy with emphasis on DWI with the apparent diffusion coefficient (ADC) map, and correlate with the histopathology. We will examine patterns of extension and discuss issues regarding treatment, recurrence and prognosis.

Results
Pilocytic and pilomyxoid astrocytomas are typically well circumscribed, homogeneously contrast-enhancing mass, frequently with cystic components on MRI. Macro and microcyst formation are common. Enhancement patterns can be variable, irregular or heterogeneous with or without internal hemorrhage or calcifications. However, general imaging features of pilocytic and pilomyxoid astrocytomas are relatively nonspecific. The MRI appearance can be similar to that of high grade gliomas in some cases. ADC values of pilocytic and pilomyxoid astrocytomas are generally higher than those in other gliomas, reflecting the proportion of the cellularity, microcystic component or more water content in the extracellular matrix such as myxoid matrix in these tumors. If the tumor is located close to the cistern or ventricle, the risk of leptomeningeal dissemination is increased. Partial resection is associated with a risk of recurrence and dissemination. The pre-operative diagnosis influences the decision on the extent of resection and because of the high risk of leptomeningeal dissemination associated with these tumors, careful and correct diagnosis by MRI is important.

Conclusions
Variable findings of pilocytic and pilomyxoid astrocytoma on MRI and other imaging modalities are demonstrated, and correlated with the histopathology. Diffusion-weighted imaging with the ADC map is especially useful for the differential diagnoses. The correct pre-operative diagnosis is important for the decision on the extent of resection.
Review of Pediatric Head and Neck Emergencies

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Purpose
We aim to detail the spectrum of nontraumatic imaging diagnoses seen in an emergency room setting and review critical findings that radiologists must convey to clinicians which can directly influence patient treatment and outcomes.

Materials and Methods
We describe the imaging spectrum of pediatric head and neck emergencies while focusing on clinical presentations, specific imaging findings and complications. An emphasis is placed on critical imaging findings that can directly impact patient care.

Results
Head and neck emergencies are less common in the pediatric age group, often with nonspecific signs and symptoms. Imaging plays an important role in the timely diagnosis of these potentially life threatening conditions which is crucial to appropriate triage and treatment of pediatric patients in the emergency room. Pathology examined in this educational exhibit includes infectious, inflammatory, neoplastic and congenital disease processes which can present in this setting.

Conclusions
This exhibit reviews pediatric head and neck emergencies from both the radiologist's and referring clinician's perspective. The goal of the educational exhibit is to emphasize critical imaging findings of these emergencies that directly impact patient management. After reviewing this exhibit, the viewer should develop a confident and practical approach for these lesions.

eEdE-175
6:30AM - 3:00PM

Rhombencephalosynapsis: Review of Cerebellar Embryology, Key Imaging Findings and Associated Anomalies.

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Purpose
Rhombencephalosynapsis is a rare congenital malformation characterized by fusion of the cerebellar hemispheres and absence of the cerebellar vermis. The exhibit will allow radiologists to: 1. Identify classic features of rhombencephalosynapsis. 2. Recognize associated abnormalities such as aqueductal stenosis and septo-optic dysplasia. 3. Be familiar with associated syndromes like Gomez Lopez Hernandez syndrome and VACTERL. 4. Improve communication with pediatric neurologist.

Materials and Methods
We will briefly discuss the embryologic basis of rhombencephalosynapsis and normal anatomy of cerebellum. Illustrative cases of rhombencephalosynapsis ranging from a newborn to adult patient illustrating key imaging findings and associated anomalies will be shown. The cases will include isolated rhombencephalosynapsis and those with associated anomalies such as aqueductal stenosis and septo-optic dysplasia. Diffusion tensor imaging illustrating cerebellar fusion and anomalous cerebellar white matter will be shown.

Results
Rhombencephalosynapsis is a rare condition. Approximately 150 cases have been reported in the
literature to date. Imaging studies typically show dorsal fusion of the cerebellar hemispheres and hypogenesis/agenesis of the vermis resulting in a single-lobed, hypoplastic cerebellum. Other characteristic anomalies are fusion of the middle cerebellar peduncles, dentate nuclei, inferior colliculi and absence of septum pellucidum. Hydrocephalus is the most frequently associated supratentorial condition and may be related to aqueductal stenosis. Prosencephalic or midline facial anomalies are common. Clinical presentation is variable and seems to be related to the severity of supratentorial anomalies. Patients usually have short lifespan, but may occasionally survive to adulthood.

Conclusions
Rhombencephalosynapsis, although a rare congenital disorder, can be encountered in pediatric as well as occasionally in adult patients. It is prone to be under-reported due to radiologists' relative lack of awareness of this condition. Familiarity with classic imaging findings, associated supratentorial anomalies and related syndromes will allow correct identification and reporting of this rare condition.
Spinal Dysraphisms- Congenital Spine and Spinal Cord Abnormalities
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Purpose
Spinal dysraphisms consist of a very wide range of pathologies and imaging appearances, some of which can be particularly challenging for radiologists and clinicians who primarily deal with adult patients. To simplify these potentially confusing congenital anomalies, spinal dysraphisms generally can be divided into two major categories - open and closed types. This electronic educational presentation will provide an overview of the imaging appearance of both open and closed type spinal dysraphisms. Multiple imaging examples of each type will be provided to reinforce the spectrum of congenital abnormality that can be diagnosed, particularly on MRI. Also, multiple image examples of spinal dysraphisms on fetal MRI also will be provided, which has become an increasing indispensable imaging modality to make early diagnosis of congenital anomalies in utero.

Materials and Methods
Imaging studies from patients with congenital abnormalities of the spine and spinal cord are identified from a large tertiary referral center by retrospective case review. Of these, a wide range of cases is selected that represent the appearance of a majority of spinal dysraphisms, including multiple examples of fetal MRIs. From these cases, a PowerPoint presentation is generated focusing on the imaging appearance of each type of congenital abnormality and providing an organized approach to various open, closed and segmentation anomalies.

Results
After viewing this presentation, the viewer will have greater familiarity with the appearance of spinal dysraphisms and be better equipped to diagnose these congenital abnormalities based on the organized approach provided.

Conclusions
Congenital spinal cord and spinal abnormalities can be a complex topic for many radiologists. By reviewing this exhibit, the viewer will become more familiar with the appearance of spine dysraphisms, leading to a more organized approach to this spectrum of abnormalities.

eEdE-204a
6:30AM - 3:00PM

State of the art multi-modal MR assessment of Vein of Galen Malformations

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Purpose
Vein of Galen malformations are an uncommon but serious congenital malformation of the cerebral vasculature with high associated morbidity and mortality. At present catheter directed angiography is used to determine the presence and assess the severity of any arteriovenous shunting. This technique carries with it a small but not insignificant risk of both minor and major complication. Combined MRI and MRA techniques have the potential to change the way these children are followed, reducing the necessity of catheter angiograms. We present an efficient and thorough, multimodal method for garnering the critical information necessary for treatment
planning and surveillance imaging. The approximately 30-minute protocol significantly reduces the MR component of cumulative anesthesia times in this vulnerable population.

Materials and Methods
All children presenting for initial assessment or follow up of Vein of Galen malformations undergo a multimodal MR protocol with general anesthesia. The imaging regimen includes volumetric RF spoiled gradient echo (FSPGR), T2 FSE (CUBE), postcontrast SPGR, axial susceptibility-weighted imaging (SWAN), DWI and axial postcontrast 2D FLAIR sequences. Specific MRA elements include contrast-enhanced time-resolved MRA (TRICKS) and postcontrast time of flight MRA. Table time is 35 minutes.

Results
Key to the assessment of Vein of Galen malformations is accurate anatomical information regarding brain volume, ventricular size, evidence of infarction, hemorrhage and/or dystrophic calcification. Volumetric acquisitions allow reconstruction in any plane with exquisite anatomical detail. When interpreted in toto postcontrast SPGR, T2 CUBE and postcontrast TOF MRA sequences allow holo-lesional assessment of the Vein of Galen lesion and differentiation between components that are patent, or occluded with introduced embolic material for therapy or thrombus. Time-resolved postcontrast MRA allows noninvasive assessment of vascular kinetics, which can help to accurately and noninvasively quantify the degree of arteriovenous shunting and presence of venous hypertension.

Conclusions
Reliable demonstration of Vein of Galen anatomy and flow kinetics is possible using state of the art MR imaging techniques requiring only 35 minutes of table time. This may obviate the need for invasive and risky catheter angiograms on children in certain situations.

eEdE-176
6:30AM - 3:00PM

The Crooked Truth of Segmental Spinal Dysgenesis: Multimodality Demonstration of Natural Disease Progression.

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Purpose
Segmental spinal dysgenesis (SSD) is a rare congenital abnormality with dysmorphic vertebrae in the thoracic or lumbar spine that presents at birth. Early recognition of this entity is critical as early operative treatment may prevent progressive motor loss and instability.

Materials and Methods
The clinical presentation, imaging findings, and associated congenital conditions will be discussed. A unique case of untreated segmental spinal dysgenesis will demonstrate the clinical and morphologic progression over a 14-year time span using multiple modalities (x-ray, CT, and MR).

Results
Segmental spinal dysgenesis is a rare congenital abnormality with dysmorphic vertebrae in the thoracic or lumbar spine. Initial presentation is at birth with a focal kyphosis in the lower thoracic or lumbar spine. Radiographs are the initial modality and sufficient for diagnosis. MR imaging must be performed to provide additional information regarding the spinal cord. There is
strong associations with other congenital malformations. Spinal cord abnormalities are common and consist of closed spinal dysraphisms and tethered cord. Bilateral talipes equinovarus deformity is present in all cases. Neurogenic bladder almost always is present and may present as recurrent urinary tract infections. Renal abnormalities and heterotaxia also have been described in the literature. A unique case of untreated segmental spinal dysgenesis demonstrates the natural progression. The patient had multiple medical problems associated to prematurity including chronic lung disease and necrotizing enterocolitis which did not make him a surgical candidate. Follow-up imaging with multiple modalities over 14 years demonstrates the morphologic progression. At birth, the patient was moving all extremities. By age 1, he had lower extremity paresis. Imaging findings demonstrate dysmorphic L2-L4 vertebrae with focal kyphosis which increased from 32 degrees at 5 months to 50 degrees at 12 years. The focal spinal stenosis also increased in severity and length of involvement. This demonstrates the progressive nature of the kyphosis and spinal canal dysmorphology. As commonly seen, neurogenic bladder and bilateral equinovarus feet also were present. Surgical management can address associated instability and congenital spinal cord stenosis. Early reconstructive surgery in infancy may prevent progressive motor loss.

Conclusions
Understanding the clinical presentation and imaging findings of segmental spinal dysgenesis is critical for early diagnosis. Early surgical intervention is recommended to prevent progression to lower extremity paresis and spinal instability. Other congenital abnormalities such as neurogenic bladder and bilateral equinovarus feet are strongly associated with segmental spinal dysgenesis.
The view from the mastoid fontanel of the neonatal brain

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Purpose
To display normal anatomy seen from the mastoid fontanelle, to show artifacts and pathologies of the posterior fossa that is more clearly evaluated by mastoid fontanel imaging, to emphasize the clinical conditions that adding this approach would help diagnosis.

Materials and Methods
Results
Posterior fossa visualization through the anterior fontanel is complicated by the echogenic tentorium and vermis, and visualization is achieved best by obtaining images through mastoid fontanels. Study of the neonatal brain with the addition of mastoid fontanel imaging affords greater accuracy in detecting neonatal intracranial pathologies.

Conclusions
The normal anatomy and pathologies observed through the mastoid fontanel should be known for early and accurate diagnosis.

(eEdE-186)

Timing of Immediate Post-Operative Follow-up MR Imaging After Resection of Paediatric Brain Tumours

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Purpose
Primary brain tumors are the second most common neoplasm in the pediatric population, with gross-total resection (GTR) being the most effective method of intervention. Multiple studies
have demonstrated the crucial role that residual tumors play as the main prognostic factor in progression-free survival (PFS). A standardized post-resection surveillance imaging protocol (yet to be achieved) is crucial for determining the most appropriate intervention plan, be it further immediate resection (best performed rapidly prior to healing) and/or adjuvant therapy, as well as for setting the optimal course of future surveillance.

Materials and Methods

A pictorial essay of different paediatric brain tumor cases, accompanied with a relevant comprehensive review of the literature evaluating the optimal timing of the first postoperative MRI follow up, will be presented in this educational poster.

Results

1. Older studies with early (within 7 days) as opposed to immediate (within 72 hours) MR follow up had no identifiable differences between residual tissue and postoperative changes. 2. Immediate MRI, and especially DWI, follow up within 24-72 hours overcomes the aforementioned limitation by establishing a baseline for postsurgical iatrogenic changes (gliosis and fibrosis), which could persist and present on subsequent imaging as new focal contrast-enhancing lesions, causing confusion with residual tissue. It also eliminates confusion with neovascularization and inflammation, which occur 3-5 days postoperatively. 3. Immediate MR follow up within 48 hours is of particular importance in tumors with a low recurrence rate, wherein GTR is considered the sole therapeutic option. When residual tumor is undetected, no routine surveillance is required, whereas when detected, possible re-intervention or simple surveillance are considered. 4. Resection extent is an even better prognostic factor than grade in certain tumors, calling for careful evaluation with immediate MR follow up. 5. In certain high grade tumors, despite requiring adjuvant therapy in addition to surgical intervention, resection extent remains the most important prognostic factor for PFS, thus requiring immediate MR follow up. In fact, it was shown that <2 hour MR follow up is more appropriate for detecting residual tumor in the resection margin of glioblastoma compared to 48 hour MR follow up. Medulloblastoma, on the other hand, shows no correlation between resection extent and PFS, and therefore might not benefit from immediate follow up.

Conclusions

Resection extent remains the most important prognostic factor for PFS. The literature suggests that immediate MR follow up, within 72 hours postoperatively, improves accurate evaluation of resection extent by accounting for confounding postsurgical factors. The optimal timing of the immediate MR follow up, however, remains controversial as the degree by which PFS is affected by the resection extent is greatly influenced by the tumor type and grade. That said, the literature suggests that for most brain tumors, the earlier the MR follow up, the more accurate and beneficial radiological evaluation becomes.
Purpose
In children, the bony structures and the soft tissues of the spine show a gradual and constant changing development. There are different manifestations at the different age. Each stage has different landmarks. So the imaging of the pediatric spinal trauma has its uniqueness and slightly different approaches than adults, due to the maturity and anatomical differences between the children and adults. In this exhibit, we illustrate the different types of trauma of the pediatric spine and their imaging characteristics. Their differences from the adult type, unique approaches and the pitfalls of the imaging will be discussed.

Materials and Methods
We will review the anatomy of the spine and spinal cord, the radiological evaluation of pediatric spinal trauma, certain injuries unique to children and the pertinent history and physical exam findings. Discussion also includes spinal cord injury without radiographic abnormality (SCIWORA). Epidemiology differences also will be reviewed. The discussion will be divided into cervical, thoracic and lumbar trauma focusing on the anatomical and radiologic differences between adult and pediatrics. We also will review common pitfalls.

Results
Trauma to the spine include fractures, ligamentus injury, disc disruption and cord injury. Vascular insults can be direct or indirect. In this exhibit, examples of each category are illustrated. We also have described various imaging approaches to the trauma of the pediatric spine. Their clinical correlation and certain pitfalls have been discussed. Although rare, spinal injury carries a higher mortality rate in children. Majority of pediatric spinal injuries occur from not wearing a seatbelt during a motor vehicle accident, and most commonly involves the cervical region. Average age is between 14 to 15 years old.

Conclusions
Trauma to the pediatric spine are relatively uncommon, only accounting for approximately 1-2 percent of all pediatric fractures. The reviewer will gain familiarity to interpret studies of different types of traumatic injury of the pediatric spine with a higher level of confidence.
Volume-Rendered Virtual Endoscopy of the Middle Ear in Children

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Purpose
The characterization of middle ear pathology can be challenging, particularly when minor ossicular anomalies or other subtle findings are present. Volume-rendered virtual endoscopy of the middle ear is a powerful tool in this regard and may complement routine axial and coronal images when interpreting temporal bone CT as well as provide a 'road-map' for the otologist.

Materials and Methods
The complementary role of volume-rendered virtual endoscopy of the middle ear will be demonstrated using cases selected from our radiology database. Isolated, syndromic and secondary abnormalities of the ossicles will be considered, but cases also will include middle ear masses (e.g., cholesteatoma, teratoma, benign fibrous tumor), persistent stapedial artery and the displaced ossicular prosthesis.

Results
Volume-rendered virtual endoscopy of the middle ear may help characterize known or identify previously unknown abnormalities of the ossicles. The technique is particularly helpful in demonstrating minor anomalies characterized by deficiency of the long or lenticular process of the incus, malleo-incudal separation or malleal/incudal fixation by a long bony strut. The technique also may be helpful in the presurgical evaluation of middle ear masses, but close correlation with source images is mandatory. Such correlation is helpful in selecting the most appropriate threshold, ramp filter and opacity for the case under consideration. The technique is least helpful when evaluating small or largely opacified tympanic cavities, short/broad types of ossicular fixation or minor anomalies of the stapes superstructure.

Conclusions
Volume-rendered virtual endoscopy of the middle ear is performed easily and complements routine axial and coronal images in the evaluation of middle ear pathology, particularly involving the ossicular chain.

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eEdE-161

What about Us! : Strokes in Infants, Children and Young Adults
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Purpose
1. Heighten awareness that strokes occur in infants, children and young adults. 2. Review the demographics, risk factors and etiologies of stroke in various age groups. 3. Learn the imaging findings on various modalities (CT, CTA, MR, MRA, MR spectroscopy and cranial ultrasound).

Materials and Methods
After a review of the demographics, risk factors and etiologies (in different age groups) of strokes, cases are presented to highlight the imaging findings of acute strokes and there sequelae on various imaging modalities.

Results
Ischemic and hemorrhagic strokes each account for approximately 50% of strokes in children. This is in contrast to adults where vast majority of strokes are due to ischemia. There are age specific differences in the etiology and clinical manifestations. Etiologies of stroke are more diverse in the pediatric population. Examples of common etiologies in the various age groups include: Neonates and infants less than 1 year of age: Hypoxia-ischemia, seizures, hypoglycemia, thromboembolic disease, due to congenital heart disease, thrombocytosis, protein c/s deficiency and Vein of Galen malformation. Children between the ages of 1–14 years: moyamoya, Sickle Cell disease and vasulitis. Young adults of ages 15 -23 years: Arterial dissection, drug abuse, vasulitis, patent foramen ovale. Pathophysiology, treatment and additional diagnostic testing will be stressed.

Conclusions
Approximately 5-10% of all strokes occur in children and young adults and it is one of the top 10 causes of childhood death. Many challenges exist in the evaluation and treatment of these patients, including delay in diagnosis due to failure of family members and healthcare providers to recognize clinical findings, which often are nonspecific in neonates and infants. Also, recent reports suggest an increase in the number of strokes in young adults due to lifestyle issues such as obesity, lack of exercise, diabetes, poor diet, smoking and drug abuse. Imaging plays a major role in the diagnosis and management of these patients. Therefore radiologists should be familiar with the different etiologies of stroke in this patient population and the imaging findings of acute stroke and its sequelae. This will increase diagnostic accuracy, reduce adverse outcomes and enable radiologists to provide referring clinicians with information regarding additional diagnostic testing.
What is & What is Not Abusive Head Trauma in Neuroimaging?

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Purpose
Abusive head trauma (AHT) is an injury to the skull or intracranial contents of a young child (<5 years) due to inflicted blunt impact and/or violent shaking. AHT accounts for 30-64% of all pediatric head injuries and 53-80% of associated fatalities. At presentation, neuroimaging of AHT can represent a diagnostic challenge. As such, detecting AHT and differentiating it from its mimickers is critical to determine management and predictive outcome.

Materials and Methods
Using our institutional experience with AHT as gained from monthly multidisciplinary Combined Child Protection-Radiology rounds, the neuroimaging findings of AHT are summarized and discussed in this educational poster along with their presentation, mimickers and differentiating features.

Results
The most common AHT findings were: 1. Skull fractures: Mimickers of AHT: a) birth-related; b) accidental; c) diastasis. 2. Subdural hematoma (SDH): most common finding. Mimickers: a) birth-related; b) accidental; c) benign infantile enlargement of subarachnoid spaces; d) meningitis; e) postintraventricular shunting; e) metabolic disorders. 3. Subarachnoid hemorrhage (SAH): usually concomitant with SDH. Mimickers: a) meningitis; b) postshunting; c) metabolic disease. 4. Epidural hemorrhage (EDH): rare in AHT (6%). 5. Diffuse intra-axial injuries: life-threatening. Types: a) hypoxic-ischemia injury (HII) and b) diffuse axonal injury. Mimickers: a) cardiac arrest; b) suffocation or drowning. 6. Atrophy: rapid in severe insults. Mimicker: communicating hydrocephalus (e.g., due to SAH), which are indistinguishable with imaging. 7. Spine injuries: mostly asymptomatic and 60% of AHT cases demonstrate spinal SDH.
Mimickers: a) accidental: <1% present with spinal SDH; b) normal variation and metabolic disorders: mimic "vertebral notching"; c) primary spondylolysis of C2: mimics Hangman's fracture but associated with articular facets deficit; d) pseudosubluxation mimics cervical fracture.

Conclusions
Given the weight and repercussions of a diagnosis such as AHT, along with the fact that none of its aforementioned neuroimaging manifestations are very sensitive or specific, interpretation of imaging findings is not clear-cut and should be approached with caution in order to support or negate a working diagnosis of AHT. The constellation of neuroimaging and non-neuroimaging findings always should be interpreted collectively, rather than individually, in the context of the child's clinical and social history as well as the guardians' provided mechanism of injury, with special consideration to possible mimickers and differential diagnoses of the detected imaging findings.

eEdE-164
6:30AM - 3:00PM
What’s the matter with white matter? A review of pediatric white matter diseases.

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Purpose
A host of diseases are known to involve the cerebral white matter in the pediatric population. These may be categorized into demyelinating and dysmyelinating conditions. For the former, there is an inflammatory culprit that destroys the myelin sheath and often times the associated axons and oligodendrocytes (Verhey LH, 2013). In the latter group, pathology derives primarily from an inability to form myelin (Ibrahim M, 2014). Due to differences in prognosis and therapeutic options, distinguishing these diseases from one another is of great clinical importance.

Materials and Methods
The MR appearance of normal pediatric white matter at different age ranges is presented (Guleria S, 2014). Characteristic MRI and CT imaging findings are emphasized along with important demographic as well as clinical details for the following: • Demyelinating diseases, to include pediatric multiple sclerosis, acute demyelinating encephalomyelitis (ADEM), and osmotic demyelination. • Dysmyelinating diseases, to include metachromatic leukodystrophy, adrenoleukodystrophy, and Van der Knaap disease.

Results
Being acquainted with a few critical imaging and clinical features, as well as the appearance of normal white matter in different age groups, can augment the radiologist's ability to contribute to the diagnosis in pediatric white matter diseases. This in turn can positively impact patient management.

Conclusions
Pediatric white matter diseases can be a challenging topic. Familiarity with key imaging and clinical features can help the radiologist arrive at the correct diagnosis.
Figure 1: Axial T2 (a) and T1W+ (b) images in pediatric patient with multiple sclerosis. Axial FLAIR images of a patient with ADEM demonstrate multiple T2 hyperintense lesions, including an enhancing lesion (a) and white matter (c). Axial FLAIR image of a patient with adrenoleukodystrophy (d).
Wise Up on Cracks: Pictorial Review of pediatric Skull Base Fractures, Resultant Complications, and Normal Variant Lucencies of the Pediatric Skull Base

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Purpose
1. Review anatomy of the skull base with special attention to central skull base foramina and their contents. 2. Review normal skull base lucencies in pediatric patients and normal ossification patterns of the anterior, middle, and posterior skull base. 3. Using standard bony algorithm CT images, and 3D surface shaded image reformat, present pictorial review of normal skull base lucencies and skull base fractures in pediatric patients. 4. Use all available imaging to present pictorial demonstration of common and a few uncommon complications from pediatric skull base fractures. 5. Review frequently associated complications associated with specific skull base fracture locations.

Materials and Methods
Retrospectively reviewed imaging performed on pediatric patients presenting with skull base fractures at our institution over a 10-year time frame. Cases selected for presentation have characteristic imaging findings and the whenever possible, also have surgical confirmation. All patient identifying information was removed from the images used.

Results
The imaging features of the following entities discussed: 1. Anatomy of the skull base with review of central skull base foramina and their contents. 2. Normal ossification patterns of the anterior, middle and posterior skull base. 3. Normal lucencies of the pediatric skull base caused by entities such as sutures, fissures, synchondroses, vascular channels, and clefts. 4. Common and uncommon complications from pediatric skull base fractures with review of typical complications associated with the specific fracture location.

Conclusions
Basilar skull fractures can be associated with numerous critical complications. Rapid recognition of these fractures is imperative for optimal management of their complications. However in pediatric patients, normal variant skull base lucencies from sutures, fissures, synchondroses, vascular channels, and clefts often can be confused for fractures. Distinguishing between fractures and these normal lucencies is imperative for all radiologists involved in interpreting imaging for pediatric head trauma. This pictorial review hopes to aid the radiologist in differentiating between basilar skull fractures and normal variant skull base lucencies. It also aims to aid in the rapid recognition of critical complications due to skull base fractures.
Purpose
To review the characteristic imaging findings of inherited metabolic disorders involving the brain categorized primarily by location (white matter, gray matter, and basal ganglia), allowing for pattern recognition for the most common disorders in each group.

Materials and Methods
A review of radiology information systems (2010-2014) from two medical centers was performed for patients with metabolic disorders involving the brain. Medical history and radiological exams, with attention to computed tomography (CT), magnetic resonance imaging (MRI) and magnetic resonance spectroscopy (MRS) of the brain were reviewed.

Results
Ten of the most common metabolic disorders encountered in a pediatric neuroradiology practice detected from CT, MRI and MRS will be demonstrated. Imaging checklists, pattern recognition and key imaging findings in each category of metabolic disease will be highlighted as a tool for interpretation. Anatomical categorization of metabolic brain diseases will be predominantly white matter location (metachromatic leukodystrophy, adrenoleukodystrophy, alexander disease), predominantly gray matter location (Tay-Sachs disease, and Pompe disease), both gray and white matter location (Leigh disease, Krabbe disease, MELAS syndrome) and basal ganglia location (Fahr disease and Wilson disease).

Conclusions
Inherited metabolic disorders affecting the brain are complex, heterogeneous and have varied clinical symptoms. Cross-sectional imaging can be helpful, especially MRI, which can be tailored to narrow the differential diagnosis and guide further evaluation and treatment. Characteristic imaging findings and patterns suggesting metabolic brain disease should prompt further evaluation, particularly when the clinical history is nonspecific.
“Polkadots and moonbeams” Neurocutaneous syndromes made easy

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Purpose
1. To recognize the characteristic imaging for ten of the most commonly encountered neurocutaneous syndromes in a neuroradiology practice by developing a search pattern for each disease. 2. To understand and be able to suggest a proper imaging technique for further evaluation and follow up in these patients.

Materials and Methods
A retrospective search (2010-2014) of a radiology information system was performed from two medical centers for terms of neurocutaneous diseases. These include neurofibromatosis type 1 and 2, tuberous sclerosis, ataxia telangiectasia, Sturge-Weber syndrome, Von Hippel-Lindau syndrome, neurocutaneous melanosis, basal cell nervous syndrome, PHACE syndrome, and Klippel-Trenaunay-Weber syndrome. All available imaging modalities, particularly computed tomography (CT) and magnetic resonance imaging (MRI) were reviewed and findings compatible with a neurocutaneous syndrome.

Results
We will demonstrate imaging findings specific to each of the ten most common neurocutaneous syndromes detected from CT or MRI. Imaging checklists and key imaging findings with pattern recognition suggesting specific neurocutaneous syndromes will be highlighted as a tool for interpretation. Search patterns for further associated lesions specific to each disease on both CT and MRI will be demonstrated.

Conclusions
Neurocutaneous syndromes are a heterogeneous group of disorders that primarily affect the central nervous system with cutaneous manifestations. Cross-sectional imaging, especially MRI, can be tailored to help the diagnosis and guide further evaluation and treatment. Radiologists should be familiar with the characteristic imaging findings of specific neurocutaneous syndromes and develop a search pattern for potential associated lesions once a diagnosis is favored.
A 3D Printing Primer: Basics and Applications for the Neuroradiologist

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Purpose
To discuss the current role of cross-sectional imaging (CT and MRI) in the new era of 3D printing, and specifically to elaborate on the possibilities in designing advanced educational tools in teaching complex neuro-anatomy, particularly pertaining to radiology resident education.

Materials and Methods
The detailed process by which one can take advantage of this emerging technology is discussed. As examples, design of a hybrid cranial nerve/skull base model as well as a pterygopalatine fossa (PPF) model is discussed. An actual patient's CT of the skull base is used to three dimensionally reconstruct the osseous structures and then to enhance the model by either creating the nervous and vascular anatomy in the case of the PPF model or reconstruct the cranial nerves from a steady-state free precession sequence MRI. Materialise Mimics or Osirix is used for performing the initial 3D reconstruction, after perfecting the segmentation on each thin slice of the scan. Autodesk 3D Studio Max then is used to design and/or perfect the neural anatomy. Models then were scaled to a larger size and digitally split in half for better visualization of contents. Subsequently, 3D printing was performed through a commercially available service utilizing rapid prototyping technology on polyamide material with minimum detail of 0.3 mm.

Results
With the dawn of a new generation of three-dimensional (3D) printers, a manufacturing boom has begun, sparking a sense of enthusiasm among inventors. The field of medicine is no exception and vast potentials are being discovered every day utilizing this technology. Furthermore, personalized medicine may improve outcomes by reducing error and incompatibility. Clinical applications of 3D printing include design of custom prosthetic implants, autoclavable orthopedic drill guides, surgical planning models, complicated highly detailed educational models, advanced simulation tools and prototypes of interventional radiology devices, at a relatively low cost.

Conclusions
Radiologists as leaders in cross-sectional imaging must enable the development of innovative applications using 3D printing technologies across medical and surgical subspecialties. Neuroradiologists, due to the detailed and intricate nature of neuro-anatomy, can significantly benefit from this technology in enhancing education of trainees at all levels as well as to provide consulting services to neurosurgeons and otolaryngologists. This exhibit serves as a guide for
those who seek to have a better understanding of the process of custom 3D printing and its pitfalls and potentials.

**eEdE-207**

**Art in Neuroimaging: Seeing more than the Obvious!**

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**Purpose**

For a lot of general radiologists and trainees, neuro-imaging is serious and scary given the complex types of imaging modalities, anatomy and abnormalities and some of the serious consequences if not interpreted accurately. The purpose of this exhibit is to present neuro-imaging in a lighter vein and identify the hidden art and humor on neuro-imaging studies.

**Materials and Methods**

Neuro-imaging studies including plain radiographs, CT and MR will be reviewed. Certain interesting anatomical structures and abnormalities will be identified that have resemblance to a form of art or expression. These will be depicted in a quiz format to give the audience something to think about the image and identify an art or expression related to it. The actual images and the hidden art or expression will be presented together after the quiz, outlining the areas of interest and graphics related to it.

**Results**

There is hidden art on neuro-imaging if we have the time and mind to sit and stare!

**Conclusions**

The present exhibit will present: (a) the hidden art and expression on neuro-imaging studies. (b) provide a different perspective to seeing more than the obvious.

**eEdE-211**

**Communication of Neuroradiology Results Using a Cloud-based Video Reporting System**

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**Purpose**

Neuroradiologists traditionally have played an active role in critical clinical decision-making and education during "radiology rounds." With in-person consultations declining, this project evaluates video reporting as an alternative means for neuroradiologists to interact with primary teams and thus participate more directly in patient care.

**Materials and Methods**

An Institutional Review Board exemption was obtained. Anonymized video reports in MP4 format were created shortly after the completion of select neuroradiology studies using SnagIT screen capture and Centricity PACS software, a standard dictaphone, as well as a dedicated website, www.rayvid.com, created by the authors. Video reports were created from 10 neuro
studies ordered by six attending level internal and emergency medicine physicians and four internal medicine residents. Attending clinicians rated the video reporting system on its quality, helpfulness, and their willingness to use it again on a 5-point scale, with 5 being the most positive response. Residents rated the system's quality, comparison with in-person consultations, and educational value on a 5, 4, and 3 point scale, respectively.

Results
Video reports were accessible to referring clinicians using a mobile device or laptop computer. Average attending responses for video reporting quality, helpfulness, and willingness to use again were: 4.8/5.0, 5.0/5.0, and 5.0/5.0, respectively. In two cases, attendings reported a change of clinical plan as a result of the video report. Average resident responses to the system's quality, comparison with in-person consultation, and educational value were: 4.4/5.0, 3.4/4.0, and 3.0/3.0, respectively.

Conclusions
Radiology video reporting was very helpful to a group of attending clinicians and provided a great educational value to residents, with the experience being similar to in-person consultations.

eEdE-210

6:30AM - 3:00PM

Lessons Learned from the Aviation Industry: The Incorporation of “Near Miss” Reporting into Resident Neuroradiology Education

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Purpose
1. Describe the concept of the "near miss," as first illustrated in the aviation industry, including the proven benefits of analyzing near miss safety data. 2. Explain how our institution translates the near miss approach into a proactive (rather than reactive) neuroradiology focused resident case-based conference. 3. Describe how the capturing of this resident data has become increasingly important in the era of 24/7 attending coverage, in which early mistakes may not be recognized as true learning opportunities.

Materials and Methods
This exhibit describes our identification of "near miss" neuroradiology case data and demonstrates its formal presentation at our biweekly resident-led conferences. Briefly, our radiology reporting system is reviewed weekly by a senior resident (R4) for collection of discrepant near-miss cases with educational value. The reporting software in use by our institution allows quick identification of relevant on-call neuroradiology dictations that required addenda prior to any clinical intervention and thus qualify as a resident "near miss." Examples of clinically relevant ED cases and their unique education content are provided. Several trends for potential blind spots in neuroradiology resident education are identified.

Results
The reportable "near miss" or "close call" was first identified in the commercial aviation industry as a method for identifying safety errors prior to any injury producing event. This approach has since shown to be successful in decreasing fatal aviation accidents, and more recently has been applied to a wide range of high risk fields, including medicine. Incorporating a philosophy of near miss safety reporting has led to new educational techniques in our radiology residency
program, particularly in the high-stakes subspecialty of neuroradiology. (A separate collection of "true miss" data - clinically important discrepancies added after patient discharge - has long been in place at our institution.) As our program has transitioned to 24/7 attending coverage, there has been an unforeseen potential to fail to identify these early mistakes as teaching opportunities. The formal incorporation of near miss cases into neuroradiology curriculum has increased our breadth of teaching cases and helped identify areas of improvement for education.

Conclusions
Our institution's incorporation of near miss cases into the resident neuroradiology education conference series is presented. Continuation of this approach should lead to a number of benefits beyond simply reducing discrepancy rates. Additional benefits include increased resident knowledge, data collection, teaching opportunity, and open discussion of important clinical outcomes.

eEdE-208
6:30AM - 3:00PM

NeuroRadiomics and Personalized Medicine: Imaging Biomarkers and their Implications for Tumor Heterogeneity in Neuroradiology

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Purpose
The purpose of this educational exhibit is to explore the concepts of biomarkers, radiomics, and tumor heterogeneity. Using The Cancer Genome Atlas (TCGA), we will demonstrate how to use radiomics in conjunction with genomics for noninvasive whole body tumor heterogeneity quantification, tumor response prediction, and treatment response assessment.

Materials and Methods

Results
The genomic and molecular signature of tumors manifests great heterogeneity among different patients and often an extraordinary level of heterogeneity within a patient, not only in different metastatic locations but also in the primary site itself. This heterogeneity frequently is reflected
in a nonuniform treatment response; often to a level at which one may ask if we are dealing with the same entity. There is a dire need for reclassification/subcategorization of the tumors, as demonstrated by neoplasms collected of The Cancer Genome Atlas (TCGA) initiative. Consequently, effective next generation biological cancer treatments will require a better understanding of tumor genomic signature to stratify potential responders, reduce numbers needed to treat (NNT), and consequently reduce side effects and cost. The integration of genomics and radiomics provides us with the unique ability to quantify these characteristics in a noninvasive manner. Imaging provides a practical noninvasive approach in the assessment of tumor heterogeneous characteristics in different metastatic locations. If the tumor is widespread, which is the case of many cancers requiring medical treatment, no other methods are feasible. Integration of radiomics and genomics (RadioGenomics) will provide us with the unique opportunity to approach this goal.

Conclusions
Tumors are extremely heterogeneous and the treatment should be personalized. Radiomics is the inevitable part of personalized and precision medicine. Using TCGA, we will explore how to use imaging biomarkers to quantify the tumor heterogeneity, prognosis, and response to treatment.

eEdE-209

Systematic Evaluation of the Head and Neck Remains of Three Ancient Egyptian Mummies Utilizing Dual-Energy MDCT

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Purpose
The head and neck remains of three ancient Egyptian adult mummies preserved using three distinct mummification practices between the periods 1350 BCE and 300 BCE were studied methodically utilizing dual-energy MDCT to demonstrate normal structures remaining following mummification, differences in mummification practices, and evidence of disease.

Materials and Methods
The intact remains of three Egyptian adult mummies dating from approximately 1350 BCE, 900 BCE, and 300 BCE were scanned utilizing MDCT at 140 KeV and 80 KeV. Thin-section multiplanar and three-dimensional CT datasets of the head and neck were reconstructed for each mummy and evaluated according to intact cranial contents, bones, soft tissues of the head and neck, dentition, spine, and spinal cord; signs of disease affecting the head and neck; and postmortem trauma and mummification processes.

Results
Large vessels, major muscle groups, layers of cervical fascia, cranial nerves including V3 and II, wear on the crowns of the teeth, globes and extra-ocular muscles, and portions of the spinal cord were identified in all mummies. None of the mummies had evidence of atherosclerotic disease in the cervical vessels. The mummy dating from 1350 BCE had an intact brain without evidence of attempted excerebration in the craniofacial skeleton, postmortem trauma to the teeth and skull, congenitally absent third molars, a cavernous sinus mass of uncertain origin, and calcification corresponding to cervical nodal chains. The mummy dating from 900 BCE underwent transnasal
excerebration, had severe postmortem spinal trauma, and postmortem orbital and oral augmentation. The mummy dating from 300 BCE underwent transnasal excerebration, had congenital absence of the third molars and extensive periodontal disease, and cervical degenerative disk disease.

Conclusions
Dual-energy MDCT with multiplanar and three-dimensional reconstructions clearly delineates the head and neck structures that remain intact across millennia as well as numerous natural pathologies and postmortem treatments following the practice of mummification.
Updates to and Cross-Reader Reliability Validation of the VASARI Brain Tumor Feature Set for Distributed Scoring of Low-Grade Brain Tumor Cases in Radiogenomic Research

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Purpose
Controlled terminologies for describing imaging are essential for imaging biomarker research. The "VASARI" feature set is a controlled terminology for describing gliomas. The feature set was updated for low-grade gliomas. The purpose of this exhibit is to illustrate the process through which VASARI was updated and validated for cross-reader reliability for low grade glioma cases prior to distributed scoring for radiogenomic research on cases from The Cancer Genome Atlas/The Cancer Imaging Archive (TCGA/TCIA).

Materials and Methods
Neuroradiologists with domain expertise in brain tumors proposed and debated the modification, deletion and new creation of specific VASARI features for clarity and clinical/biological relevance in low grade gliomas. Geographically disparate volunteer readers underwent training on the features before scoring test cases on a cloud-based platform. Analysis of test case scores from six readers revealed areas of inconsistent agreement among readers for several VASARI features. Further visual analysis and subsequent discussion of these discrepant scores revealed likely causes of disagreement and suggested needed changes to feature definitions as well as deletion and addition of certain features. A subsequent update then was tested with an additional reader volunteer after personalized training.

Results
Testing for the updated VASARI feature set revealed areas requiring improvement for inter-reader reliability despite best initial efforts at clarity. Although minor variation in human interpretation is expected, larger discrepancies were indicative of specific human-related or feature-related problems, which were improved through an iterative process.

Conclusions
Updating and using controlled terminologies for describing images for biomarker research is improved by using an iterative process of updating, testing and training to improve inter-reader score reliability and consistency.
Monday
6:30AM - 3:00PM
Sheraton Chicago Hotel & Towers, River Exp Hall A (Level 1)-6

Electronic Educational Exhibit (eEdE) - Spine
eEdE-237
6:30AM - 3:00PM

Acute Spinal Ligament Trauma, Inferring Spinal Stability

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Purpose
Quadriplegia is a dreaded complication of cervical spine injury. Although most patients who develop symptomatic spinal cord compression after trauma are impaired immediately, there is a small subset who survive the initial incident neurologically intact, but suffer spinal instability. In these patients, we seek to protect the spine until fully evaluated, identify the level and nature of the mechanical defect and guide treatment decisions. This exhibit will review the structure, anatomy and function of spinal ligaments, the imaging approach to injuries to these critical elements, the reliability of current imaging, the implications for spinal stability and the management approaches employed as guided by radiological findings.

Materials and Methods
We will review the sensitivity, accuracy and role of plain radiographs, x-ray computed tomography and magnetic resonance imaging. We will discuss the structural implications of imaging findings and management of the injuries. The exhibit will include summaries of original research as well as published guidelines and appropriateness criteria.

Results
Before the advent of computed tomography, the vast majority of unstable spine injuries were detected with plain radiographs and delayed instability was a rare occurrence. CT is clearly more sensitive than plain radiographs, and provides far more detailed anatomical imaging. The precise location, extent and nature of fractures are displayed and the full structural deficits caused by fractures can be described. For these reasons, CT long has been the gold standard for imaging spine trauma. However, CT cannot directly image spinal ligaments, normal or abnormal, and thus provides only inferential evidence of ligamentous injury. The superior soft tissue detail provided by MR produces a similar advance over CT as did CT over plain films. In contrast to unambiguous findings of fractures on CT, MR findings in ligamentous injury frequently are less clear. Often ligaments display findings that appear intermediate between normal and complete disruption. Many of these "edema pattern" injuries appear to preserve mechanical stability of the spine. This has given MR a reputation for high sensitivity and a high false positive rate. Some surgeons treat such injuries conservatively, assuming they are unlikely to represent complete loss of ligamentous tensile strength. The significance of an individual ligament injury also depends the associated fractures or ligament tears and which structures are involved. There are now several alternatives to the classic Denis 3-column concept of spinal injury that appear better founded in theory. Unfortunately, perhaps due to their complexity, they have demonstrated poor interobserver variability. For routine clinical image interpretation, the simplicity and
reproducibility of the Denis approach appears to maintain its value. Combining CT and MR, one can determine the details of posterior ligamentous complex injury. Imaging of osseous and ligamentous injury has now advanced past the known criteria for inferring structural competence.

Conclusions
Review of ligament injury.

eEdE-217

6:30AM - 3:00PM

C1-2 Puncture: A Safe, Efficacious, and Potentially Underutilized Technique

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Purpose
Lateral C1-2 puncture for myelography or cerebrospinal fluid (CSF) collection is performed infrequently today. Many neuroradiologists and trainees receive little practice in the technique, and have the perception that the procedure is dangerous and difficult to perform. In fact, in select populations the C1-2 puncture is more efficacious and possibly safer than the traditional lumbar puncture. This exhibit will review C1-2 puncture technique, indications, complications, and utility.

Materials and Methods
1. Examine the literature, evolving use, and current perceptions of C1-2 puncture. 2. Review the anatomy of the craniocervical junction and relevant variant vascular anatomy. 3. Describe the C1-2 puncture technique, indications, and potential complications. 4. Discuss advantages of the approach for specific patient populations.

Results
Indications for C1-2 puncture include cervical myelography or CSF collection in patients with spinal block or relative contraindications to lumbar puncture. In addition, patients who cannot be moved easily into a prone or lateral decubitus position, such as those who are ventilated, with recent chest or abdominal surgery, or with significant pain in those positions, comprise a population that would benefit from a supine CT-guided C1-2 puncture. C1-2 puncture often is considered a second-line approach, even in cases where lumbar puncture is clearly suboptimal. Infrequent practice and overemphasized risk based on older literature may be to blame. Improvements in fluoroscopic equipment and the ability to use CT for C1-2 puncture allow for better visualization of needle trajectory and target. Expanded consideration of this approach will provide the practice required for proficiency. This combination of factors can diminish patient risk and practitioner concern.

Conclusions
Lateral C1-2 puncture should be the first-line approach in select patient populations. Working knowledge of craniocervical anatomy and vascular variants is vital for safe performance. Review of this procedure and awareness of its utility will allow neuroradiologists and trainees to optimize patient care.

eEdE-229
Purpose
The purpose of this study is to review sample cases from multiple categories of disease which result in meningeal enhancement (ME) in the spine in order to more efficiently recognize and accurately describe this finding.

Materials and Methods
A variety of disease processes may result in enhancement of the spinal meninges, which include the dura, pia, and arachnoid mater. These disease processes encompass infectious, inflammatory, neoplastic, and iatrogenic etiologies. Although the appearance of ME may be similar in certain processes, it is important to accurately identify its presence in order to fully characterize the disease. The goal of this study is to: - Describe the basis for the appearance of ME on postcontrast MR images. - Review the categories of disease which result in ME, including infectious, inflammatory, neoplastic, and iatrogenic etiologies. - Utilize sample cases from each of the above categories of disease in order to accurately identify the presence of ME and distinguish features of specific etiologies.

Results
All images are T1-weighted postcontrast images in the sagittal plane. - Figure 1 depicts the lumbar spine of an 85-year-old woman with a history of AML. Leptomeningeal enhancement (LME) along the cord (arrows) in this patient is consistent with leptomeningeal carcinomatosis. The inset is an axial slice from the level of the arrows which demonstrates circumferential LME.

Conclusions
The spectrum of disease processes which result in meningeal enhancement of the spine is wide. Correctly identifying the presence of this finding is essential for accurate characterization of these diseases. In this study, multiple sample cases exhibiting enhancement of the spinal meninges are provided to help demonstrate the spectrum of imaging appearance of ME and describe characteristics unique to each entity.
Comprehensive Review of Spinal Cord Arteriovenous Lesions (SCALs): Imaging and Treatment Strategies

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²University of Texas Houston Department of Neurosurgery, Houston, TX

Purpose
The first spinal arteriovenous malformation reported in 1888 was described as "hemorrhoids of the pia mater" (1, 2). Spinal cord arteriovenous lesions (SCALs) are divided into arteriovenous fistulas and arteriovenous malformations (3). While rare and understudied, these are a
considerable source of morbidity and serious neurologic insult. This is a comprehensive review of SCALs, with emphasis on imaging and treatment strategies.

Materials and Methods
Analysis of the value of current imaging modalities is rendered, particularly strategies that optimize noninvasive diagnosis. Relevant spinal vascular anatomy is reviewed, including technical considerations in the performance of catheter spinal angiography (CSA). Review of clinical presentation, terminologies and classification schemes, pathophysiology, and treatment of SCALs is undertaken.

Results
Clinical diagnosis of SCALs is a formidable challenge, owing to nonspecific and slow onset symptoms. Appropriate imaging is crucial in suggesting the diagnosis before permanent cord damage occurs. Technological advances has improved the ability of noninvasive tests to accurately diagnose SCALs and optimize the use of CSA (4). Noninvasive angiography (i.e., MRA) has aided greatly in the diagnosis, with the ability to supply dynamic information and localize fistulous connection (4). Such obviates the need for extensive injections during CSA, substantially reducing radiation burden and use of nephrotoxic contrast agents. Selective CSA is utilized to depict small anatomical details and potentially perform endovascular treatment. MRI/MRA may be used for follow up after treatment, avoiding the risks of invasive CSA. While SCALs are complex and challenging to manage, the most widely used classification offers limited treatment guidance (3). Paradigm shift in the understanding of spinal vascular malformations has occurred over the years (3, 5). A proposed classification in 2002 directed treatment based on pathophysiology and location (3).

Conclusions
Advances in imaging have allowed accurate diagnosis of SCALs by noninvasive means and optimized the use of CSA. Prompt recognition and treatment may avert devastating neurologic consequences.
Purpose
Chiari 1 malformation is characterized by cerebellar tonsil herniation greater than 5mm below the foramen magnum. Thirty to fifty percent of individuals with this degree of herniation are asymptomatic. In those with symptoms, the degree of herniation does not correlate with symptom severity. Imaging is vital for diagnosis and management. The search for a method of noninvasively selecting patients who will respond to surgical decompression is an active area of research. This exhibit reviews established and newly developed imaging techniques used to evaluate Chiari 1 malformation.

Materials and Methods
1. Review theories of pathogenesis of Chiari 1 malformation, focusing on cerebrospinal fluid
(CSF) flow dynamics. 2. Describe the evolution of imaging techniques used to evaluate this condition, including conventional MRI, Phase Contrast MR, and Time-spatial labeling inversion pulse (Time-SLIP). 3. Present five examples of pre and postdecompression imaging with Time-SLIP, demonstrating the utility of the technique in patient diagnosis and management.

Results

Conventional imaging is vital for diagnosis of Chiari 1 malformation. The pathogenesis of this disorder is incompletely understood, but altered CSF dynamics are an established factor. Phase contrast MRI (PC MR), provides qualitative and quantitative assessment of CSF flow. While valuable, the technique requires careful management of the velocity encoding value (Venc), and suffers from poor temporal and spatial resolution. Time-SLIP is a variant of the arterial spin labeling technique that magnetically labels CSF with an inversion pulse, allowing for visualization of linear and turbulent CSF flow for up to 5 seconds. Application of Time-SLIP before and after decompression shows changes in flow at the foramen magnum and cervical cord with excellent anatomical detail.

Conclusions

Neuroimaging is vital to the diagnosis of Chiari 1 malformation. Combining established flow sensitive MR techniques and newly developed methods to visualize bulk CSF flow increases diagnostic accuracy and may improve patient management and outcomes.

Phase contrast MRI versus Time-SLIP. Both techniques highlight CSF flow, but note the superior anatomic detail provided by Time-SLIP in the second case.  
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ejEdE-220

Don't Be a Pain in the Back! Tips for a Successful Lumbar Puncture

J Teitelbaum

1

D Powell

2

A Khorsandi

1
Purpose
The main objective is to teach the radiologist about the two main techniques for the
fluoroscopically guided lumbar puncture: the oblique and the paramedian approach. The goal is
to allow the radiologist to easily conceptualize the spinal landmarks with the use of fluoroscopic
and CT reconstructed images. Additional education objectives will focus on a review of
therapeutic and diagnostic indications, proper sterile technique, interpretation of CSF pressure
measurements and cell counts, and management of common postoperative complications such as
postdural puncture headache.
Materials and Methods
The primary teaching method will employ cross correlation of fluoroscopic and CT reconstructed
images to allow for the radiologist to quickly identify landmarks during a lumbar puncture
procedure.
Results
Discussion of the oblique approach will focus on proper patient position of 15 degrees in a slight
right anterior or left anterior oblique position. Focus will be made on how this allows easy
visualization of the interlaminar space allowing for a perpendicular percutaneous approach. We
also will discuss how over rotation of the patient can lead to a potentially harmful transforaminal
needle insertion. Discussion of the paramedian approach will focus on properly positioning the
patient prone, and how this allows for the radiologist to inject the needle between the spinous
process and pedicle towards the umbilicus.
Conclusions
Lumbar punctures frequently are performed by neuroradiologists under fluoroscopy utilizing
these two common techniques. Familiarity with the spinal landmarks is crucial in order to
perform a lumbar puncture safely.
Oblique Technique

₀ - Interlaminar space

Paramedian Technique

₀ - Pedicle
₀ - Spinous process
Dose Reduction Strategies for Spinal Digital Subtraction Angiography

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Purpose

Spinal angiography (SA) is the gold standard modality for the investigation of the spinal vasculature. SA involves the catheterization of each intersegmental artery between L4 and T3/T2, often supplemented by a pelvic angiogram and by studies of the subclavian arteries and their branches. Several strategies used in our practice to keep radiation exposure to patients and staff members as low as possible are presented.

Materials and Methods

Besides classic techniques relying on optimal geometric factors and strict collimation, the following four dose reduction strategies are illustrated: Low dose protocols, using 1.2, 1.8, or 2.4 µGy/fr instead of the standard 3.6 µGy/fr. Variable frame rate (VFR) protocols with progressively decreasing acquisition rates from the arterial to the venous phase (e.g., 2 fr/sec for 4 seconds, 1 fr/sec for 6 seconds, 0.5 fr/sec for the rest of the run). Gridless angiography. Low magnification factors, enhanced by the utilization of a large angiography monitor.

Results

The choice of a specific low dose protocol depends upon the patient's habitus (BMI, bowel artifacts), the region investigated (thorax, abdomen, pelvis), and the indication (e.g., diagnostic versus therapeutic). Alternating protocols during a single procedure therefore is common. Most frequently used in adult patients, the 1.8 and 2.4 µGy/fr protocols bring dose reductions of about 50% and 33%, respectively. VFR protocols impact radiation exposure by reducing the number of acquisitions. They are based on the fact that less information is gained during the venous phase of the angiogram. Fast frame protocols (4 or 6 fr/sec) are only used in specific instances, for example to characterize a fast arteriovenous shunt. A standard 10-second sequence results in 14 acquired images with our VFR protocol, compared to 20 or 30 images with 2 and 3 fr/sec protocols, an exposure reduction of 30% and 53%, respectively. In our practice, the anti-scatter grids are removed by default. They may be re-installed in specific situations (e.g., to better detail a venous phase of poor quality) or, occasionally, used for most of the study in patients with high BMIs. The impact of magnification upon radiation dose often is overlooked. Keeping the magnification factor as low as possible during SA significantly reduces both patients and staff exposure. By offering live images of the same screen size at lower magnification levels, large single angiography monitors represents very efficient dose limitation tools. For example, using a wide display mode with a zoom factor of 2 rather than a zoom factor of 4 in a standard display mode results in a 50% to 60% dose reduction depending on whether collimation is used or not.

Conclusions

The presented dose reduction techniques are simple, easily implemented, and available at no financial cost on the vast majority of modern angiography equipment. Optimal dose limitation
strategies must be tailored to each patient, taking into account individual characteristics as well as clinical need.

**eEdE-226**

**Hardware Related Complications (HRC): Evaluating the Surgical Construct**

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**Purpose**

Spinal fusion and instrumentation (SFI) procedures have increased significantly over the past two decades. This trend is reflected by a surge in device industry sales to greater than 6 billion in 2007, from less than 100 million in 1990 (1, 2). Translated into the reading room, radiologists can expect an increasing load of postoperative spine (PS) evaluations. This presentation aims to familiarize radiologists with commonly encountered surgical techniques and devices, specifically the normal imaging appearance of the PS, and common and uncommon hardware-related complications (HRC).

**Materials and Methods**

This is a pictorial review of the normal imaging appearance of the PS, specifically addressing what to expect after spinal stabilization, fusion, and disc replacement. Complications such as hardware migration, fracture, dislodgment, and infection are presented. The strengths and limitations of imaging tests (i.e., radiography, CT, MRI, and nuclear medicine) are appraised.

**Results**

Instrumentation is performed to maintain or correct anatomical alignment of spinal segments by distributing spinal load (3). Spinal fusion and instrumentation can be performed for restoration of anatomical alignment, stabilization, prevention of displacement, deformity, and neurological damage, and replacement of removed bone (4). The surgical construct must be thoroughly evaluated, particularly in symptomatic patients presenting with pain. Familiarity with various surgical techniques and instrumentation devices and their expected imaging appearance is crucial for accurate diagnosis and identification of HRC and hardware failure (2, 3, 4, 5). Furthermore, knowledge of the type of device and the constituent materials may facilitate the choice of an appropriate imaging modality of the PS (5).

**Conclusions**

Familiarity with surgical techniques and devices are required to accurately diagnose HRC and enable radiologists to provide meaningful contribution to patient care and outcome.
Iatrogenic Spinal Subdural Collections: Lessons Learned

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Purpose
The purpose of this exhibit is to highlight imaging features that help localize iatrogenic spinal collections to the subdural compartment.

Materials and Methods
The intricate anatomy of the thecal sac and spinal compartments will be reviewed. Through a case-based approach, subdural collections of different etiologies depicted by CT, MRI, and fluoroscopy will be presented. Imaging findings that help localize a collection to the subdural compartment will be emphasized. The mechanisms for development of different types of iatrogenic subdural collections will be discussed.
Results
Iatrogenic spinal subdural collections may pose a diagnostic challenge to the radiologist and are important to recognize and characterize. Making a clear distinction between subdural and epidural fluid collections influences clinical management, including surgical approaches, if required.

Conclusions
A clear understanding of thecal sac anatomy, and familiarity with subdural collection imaging findings will aid the radiologist in making accurate diagnoses and valuable contributions to successful clinical management of patients.

Illustrative Cases in Spinal Angiography: The Spinal Arteriovenous Fistulae and Arteriovenous Malformations

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Purpose
The spinal arteriovenous fistulas (AVF) and arteriovenous malformations (AVM) are rare, often complex, but treatable lesions of the spinal cord. The purpose of this exhibit is to review the radiographic and angiographic features of these important vascular lesions in a pictorial essay with select cases. Procedural techniques and endovascular methodology will be discussed briefly.

Materials and Methods
A retrospective analysis was conducted from Jan 2001 - Dec 2014 of all patients with spinal DSA performed at Indiana University Health Hospitals and Eskenazi Hospital. Cases demonstrating various radiographic features of spinal arteriovenous fistulas and arteriovenous malformations were selected and reviewed.

Results
The most common classification scheme for spinal AVMs uses the Type 1 to 4 grading system, though other classification schema exist. Type 1 lesions are dural AVFs in which a radiculomeningeal artery forms a fistulous communication with dural veins at the nerve root sleeve, and result in subsequent arterialization of the perimedullary venous plexus. Type 2 AVMs have an intramedullary nidus with variable ASA and/or posterior spinal artery contributions. Some authors treat conus medullaris AVMs as separate entities, though the angioarchitecture is similar. Type 3 lesions are known as juvenile or metameric AVMs with both extradural and intradural involvement. The classic Cobb syndrome is limited to metameric-origin malformations involving the spinal cord, bone, and skin. The spinal arteriovenous metameric syndrome (SAMS) describes all forms of metameric malformations, even if the AVM does not involve the spinal cord. Type 4 spinal AVMs, refer to ventrally located perimedullary fistulae on the pial surface, within the subarachnoid space, primarily receiving arterial contributions from the ASA. These have been subcategorized into A, B, and C based on size and complexity; venous hypertension and aneurysms are often complications of the latter.

Conclusions
The spinal AVFs and AVMs are complex lesions, each with distinct anatomical and pathophysiologic considerations.

Imaging of Adult Degenerative Scoliosis

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Purpose
Increase in aging adult population has resulted in a rising prevalence of adult degenerative scoliosis. Evolving surgical treatments have necessitated appropriate radiological advances in their management. We discuss the relative utility of plain radiographs, MR and CT imaging in pre-operative and postoperative assessment of this condition and review the current radiological literature.

Materials and Methods
A retrospective review of spinal imaging was carried out between 2007 to 2014 to filter patients
diagnosed with degenerative scoliosis. Patients aged 50 or over and scoliosis of at least 10° in coronal plain were included. Patients with idiopathic, neuromuscular and pathological scoliosis were excluded. Standing radiographs were reviewed for scoliosis indices based on the Scoliosis Research Society nomenclature. Pre-operative CT and MR were analyzed for degenerative changes, effects on neural structures and planning instrumentation. Postoperative imaging was evaluated for positioning of spinal hardware, determining complications and in surveillance for fusion.

Results

This exhibit depicts the imaging of adult degenerative scoliosis. Static and dynamic plain radiographs are essential to evaluate spinal curvatures, alignment and hardware. Appropriate CT and MR techniques should be employed to minimize the artifacts from instrumentation. CT imaging is useful in detecting instrumentation malalignment and failure, postinstrumentation fractures and evaluating fusion. MR imaging is critical in pre-operative determination of effects of spondylosis on neural structures, in evaluating complications of treatment and disease progression. Complications like infection, hematomas, CSF leaks and adjacent segment disease, are identified easily.

Conclusions

Adult degenerative scoliosis is increasingly a major workload in a spinal unit. Static and dynamic plain radiographs are essential in assessing spinal alignment before and after treatment. CT and MR imaging are complementary studies in pre- and postoperative evaluation of fusion and complications.
Instrument malposition

Images of pedicle malposition in diff CT (a) and MR (b)

a) Lateral malposition pedicular screw.
b) Left pedicular s lateral recess.
c) Right pedicular lateral recess.
d) Left pedicular s cord.

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cEdE-219

Imaging of Spinal Metastases after Percutaneous Ablation

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Purpose
1. Showcase multimodality imaging of early and delayed radiofrequency ablation (RFA) and cryoablation treatment changes of spinal metastases. 2. To illustrate imaging characteristics that are indicative of local tumor response versus tumor progression.

Materials and Methods
1. Introduce the role of percutaneous ablation in management of spinal metastases. 2. Show multimodality imaging evolution of ablation zone and periablation changes in the spine after radiofrequency ablation (RFA) and cryoablation. 3. Discuss features with case examples that indicate residual/recurrent tumor or nontarget injury.

Results
1. Introduction: -Role of percutaneous ablation in management of spinal metastases: pain palliation and local tumor control, -Role of imaging in patient selection, treatment planning, and assessment of treatment response. 2. Ablation zone evolution: -Alternating T1/T2 hyper and hypo-intense rings surrounding the center of the ablation zone, -Nonenhancement of ablation zone, -Peri-ablation hyperemia and granulation tissue evolves to thin rim of enhancement. 3. Features that indicate residual/recurrent tumor or nontarget injury: -Nodular enhancement, -New areas of T2/STIR hyperintensity at ablation zone margin, -Hypermetabolic activity on F18-FDG PET/CT, -Spinal cord edema, -Delayed fractures.

Conclusions
Treatment of painful metastatic spine disease is evolving to include image-guided percutaneous RFA or cryoablation for timely control of pain and local tumor control. Radiofrequency ablation uses thermal energy to destroy tissue surrounding an electrode, resulting in cellular necrosis and expected zone of ablation. Cryoablation causes cellular death by cold-induced direct and indirect cellular injury. Understanding the postablation imaging appearance is important for both the interventional and diagnostic radiologist interpreting follow-up imaging to identify early disease progression and prevent misinterpretation of expected treatment changes.
L1 pathologic compression fracture from metastatic breast cancer treated with radiofrequency ablation (RFA)

- At 1 week: Vertebral body has diffuse edema and hyperemia but ablation zone is non-enhancing.
- At 3 months: Thin T2 dark, enhancing rim of granulation tissue and hemorrhagic congestion is seen at ablation zone margin. Ablation zone is nonenhancing T2 hyperintense area. Signal void is from vertebral augmentation cement (*).

(Filename: TCT_eEdE-219_Ablationzoneevolution.jpg)

eEdE-215

Imaging of Typical and Atypical Infections of the Spine

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6:30AM - 3:00PM
Purpose
MR imaging is the most sensitive and specific modality for evaluating spinal infection. The goal of this exhibit is to describe imaging characteristics and present example cases of common and uncommon infections of the spine, with an emphasis on MR imaging.

Materials and Methods
1. Review locations of infection in the spine. 2. Review risk factors and associated infections. 3. Examine sample cases and describe unique imaging characteristics of specific entities.

Results
Introduction to infections of the spine. Classification of infection by location: spinal cord and canal, vertebral column, intervertebral disc space, and surrounding tissues. Types of infectious processes: -Soft tissue abscess, -Vertebral osteomyelitis, -Diskitis, -Epidural abscess, -Pachymeningitis, -Arachnoiditis, -Myelitis. Risk factors. Sample cases of specific disease entities are presented, including:
- Figure 1: Axial (left) and sagittal (right) T2-weighted MR slices of the lumbar spine. The level of the axial slice is indicated by the thin line through the inferior L1 level on the sagittal slice. There is a cystic lesion effacing the anterior cord (arrows) at the L1-L2 levels. The patient has known neurocysticercosis, and these lesions represent additional foci of disease.
- Figure 2: Sagittal T1-weighted postcontrast image of the cervical spine in a patient with tuberculosis. There is a ring-enhancing lesion in the cord (arrow) at the superior aspect of the C7 level, consistent with a tuberculoma. A punctate focus of enhancement in the cord at the C2-3 level with associated cord edema is an additional focus of infection.
- Figure 3: Sagittal T1-weighted postcontrast image of the lumbar spine in a poorly controlled diabetic admitted for sepsis with MRSA growing in the blood. There are changes consistent with discitis-osteomyelitis, most prominent at the L5-S1 level. There is also a large anterior epidural abscess which compresses the thecal sac extending from the inferior L4 through mid-sacral spine levels.
- Figure 4: Sagittal T1-weighted postcontrast image of the lumbar spine in a patient with disseminated coccidioidomycosis, who has an intrathecal pump for treatment. The image shows diffuse enhancement of the thecal sac, as well as leptomeningeal enhancement along the inferior aspect of the spinal cord (arrows).

Conclusions
Infections of the spine may be categorized broadly by location, including: spinal cord and canal, vertebral column, intervertebral disc space, and surrounding soft tissues. The infectious etiologies affecting the spine are associated with certain risk factors such as IV drug use, immunocompromised state, and antecedent surgery. In recent years, the incidence of spinal infections has increased, in part due to the increasing incidence of these risk factors. In this study, a review of the locations and types of infections involving the spine is presented, followed by sample cases with MR imaging of typical and atypical infections. Using the reviewed material, a complete description of the findings and unique characteristics in each sample cases is provided.
Imaging Spectrum of Intramedullary Spinal Lesions

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Purpose
Pathological processes of the spinal cord can produce distinct clinical syndromes yet frequently have both clinical and imaging overlap. A spectrum of diagnostic considerations that may affect the intramedullary spinal cord includes developmental anomalies, inflammatory and infectious processes, degenerative conditions, vascular disease, as well as benign and malignant neoplasms. The purpose of this exhibit is to describe relevant anatomy important for interpretation as well as present typical and atypical imaging findings of various pathological entities.

Materials and Methods
An overview of the normal anatomy of the spine with compartmental classification initially will be provided with diagrammatic representation of cross-sectional anatomy of the cord and its blood supply. An approach to the diagnosis of an intramedullary lesion will be discussed in formulating a differential diagnosis or even a final diagnosis through a pictorial essay.

Results
This educational exhibit will guide the development of a systematic approach to the diagnosis of intramedullary spinal lesions and provide an organized imaging gamut of various pathological processes. The clinical presentation, magnetic resonance imaging characteristics, and differential diagnosis of the intramedullary lesions will be discussed. Additionally, pitfalls in the differentiation of neoplastic from non-neoplastic disease of the spinal cord will be elucidated.

Conclusions
After review of this educational exhibit, the reader will have a well informed understanding of the normal anatomy of the spinal cord and characteristic imaging findings of various intramedullary spinal pathologies.

Is it Polio? MR Imaging of Pediatric Spinal Cord Infections

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Purpose
The goal of this educational exhibit is to illustrate the various magnetic resonance imaging (MRI) patterns of disease that can be encountered in children seen with infectious myelitis. These findings will be compared to patterns of spinal cord disease that can occur with other
disease entities such as inflammation, trauma, neoplasia, demyelination, vitamin B 12 deficiency, vascular abnormalities, radiation injury, and degenerative diseases. The aim of this exhibit is to help the radiologist answer the frequently asked clinical question of "Is it polio?" in a child with myelopathic symptoms warranting an MRI evaluation.

Materials and Methods
A pictorial essay of the imaging spectrum of infectious myelitis, to include bacterial, viral and parasitic infectious etiologies will be presented. Characteristic imaging features will be discussed along with differential imaging considerations. We will provide a table that will show how clinical and laboratory information can help narrow the diagnosis. Abnormal cord signal patterns will be illustrated graphically and displayed with side-by-side MR imaging examples.

Results
When a child presents in the emergency room with acute neurological symptoms referable to the spinal cord, an emergent MRI of the total spine with contrast typically is ordered. Usually, a nonspecific T2 hyperintense cord lesion is demonstrated. The lesion may or may not enhance. It may be located within the central gray of the cord and/or peripheral white matter. It may involve the cord diffusely or it may be confined to a short segment. Understanding the various imaging patterns of infectious myelitis and other pathologic conditions that can affect the cord can aid in narrowing our differential diagnostic considerations.

Conclusions
Spinal cord infections in the pediatric patient can be distinguished from other causes of spinal cord pathology by recognizing the MR imaging patterns that can occur in correlation with clinical and laboratory findings. This exhibit will provide a succinct summary showing the various MR patterns of disease that can be encountered with infectious and noninfectious etiologies of spinal cord pathology.

eEdE-232
6:30AM - 3:00PM

Learning the Pathophysiology, Neuroanatomy, and Neurovascular Anatomy of the Cervical Spinal Cord through Cases of Spinal Cord Infarction

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Purpose
This educational exhibit illustrates the neuroanatomy and neurovascular anatomy of the cervical spinal cord by exploring the pathophysiology of cervical cord infarction through case examples. The spinal cord is made up of several important tracts including the dorsal column medial lemniscus system, corticospinal tracts and the anterolateral system. Injury to one or more of these pathways can result in localizing neurological symptoms. Also contributing to the complexity of spinal vascular pathophysiology is considerable variation to the cervical cord vascular anatomy.

Materials and Methods
We retrospectively reviewed radiology reports over the past 5 years at our institution looking for cases of spinal cord infarction. Images and clinical notes were reviewed in detail.

Results
We identified 10 cases with imaging and clinical features supporting cervical cord infarction. The clinical presentation and imaging findings of these cases help illustrate the functional
anatomy of the cervical cord and the vascular supply. Case 1: A 33-year-old female with a left vertebral artery dissection following neck manipulation presented with an ipsilateral cord infarction with resulting Horner and Brown-Séquard syndromes. We postulate that the vertebral artery dissection occluded a radicular branch resulting in cord infarction. This pattern of deficits occurred as a result of direct injury to the dorsal column-medial lemniscus tracts (sensory) and the corticospinal tract (motor). The contralateral loss of pain and temperature sensation occurred via damage to the anterolateral spinothalamic tract. Coexistent injury to the sympathetic pathway resulted in Horner syndrome (ptosis, miosis, and anhydrosis). Case 2: A 59-year-old male with an epidural abscess and long central segment cord venous ischemia resulting in tetraplegia and sensory loss. In this case, the bilateral descending and ascending pathways were damaged. Case 3: A 58-year-old male presented with left-sided pain and temperature paresthesias. Imaging discovered a left vertebral artery occlusion and contralateral cord infarction involving the anterolateral right hemicord. In contrast to Case 1, this resulted in more focal injury to the spinothalamic tract given the clinical presentation. Case 4: A 58-year-old male presented with renal cell carcinoma metastatic to the left vertebral artery and adjacent C5 vertebral body. The vertebral artery was occluded surgically with a resulting left hemicord infarct involving the corticospinal tract and resulting in left-sided weakness.

Conclusions

Through these cases of cervical cord ischemia, we show the various arterial and venous etiologies, including an often underappreciated contribution of the vertebral vascular supply. Understanding spinal cord function and neuro-anatomy can aid in prompt diagnosis and management of ischemic cord lesions. A thorough clinical exam and appropriate imaging including advanced techniques such as diffusion tensor imaging can be combined to localize the injury and help predict functional outcome.
Lumbosacral Transitional Vertebrae – Classifications, Examples, and Clinical Significance.

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Purpose
Variability in spine numbering in the lumbosacral region is a common challenge in reporting of spine imaging cases. Most worrisome is the possibility of wrong-level spine surgery based upon imaging reports. Additionally lumbosacral transitional vertebrae have been purported as a cause of low back pain, notable in the young. The purpose of this exhibit is to review the anatomical landmarks and criteria used to label transitional vertebra, demonstrate examples, and discuss the approach to reporting as well as clinical significance.

Materials and Methods
Various criteria for labeling lumbosacral transitional vertebrae, including Castellvi classification, are reviewed. Lumbosacral MRI, CT and radiographs are used to demonstrate this variant anatomy and show cases according to various classifications. Discussion is provided on how to
approach the lumbosacral transitional vertebra and how to report in these cases. Additionally discussion is made on the clinical significance of these anatomical variants.

Results
Various classifications are currently available for evaluation of the lumbosacral transitional vertebra. These include Castellvi classification according to transverse process morphology and O'Driscoll classification based on first sacral intervertebral disc morphology. Several other parameters and landmarks used to assess lumbosacral transitional vertebra level include the iliolumbar ligament denoting the lower lumber type vertebral segment and the lumbosacral junction; lumbosacral intervertebral disc angle, morphology of the first sacral vertebral body as squaring of the S1 vertebral body with well formed lumbar shaped facet joint, and vascular structure landmarks such as aortic bifurcation, right renal artery origin, and IVC confluence.

Conclusions
This exhibit reviews the appearance and classifications of lumbosacral transitional vertebra and discusses the importance of accurate reporting, notably for surgical planning.

eEdE-243a

6:30AM - 3:00PM

Manifestations of Schwannoma in the Neuraxis: A Complete Radiological Spectrum

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Purpose
The general imaging appearance of schwannoma or neurilemmoma is well known in the radiology literature and has been described as a sharply marginated enhancing mass with smooth enlargement of the bony foramen involved. However, atypical location and appearance of schwannomas are occasionally seen. The purpose of this exhibit is to illustrate and review the imaging spectrum of schwannomas throughout the neuraxis on multidetector computed tomography (MDCT) and magnetic resonance imaging (MRI) studies.

Materials and Methods
A retrospective review of schwannomas imaged over a 5-year period (2009-2014) at a tertiary referral center was performed with radiological and pathological correlation. The lesions were classified by location with unique imaging features described.

Results
Schwannomas typically are located along the known path of peripheral nerves. In the neural axis, these include the spinal nerves, cranial nerves and nerves of head and neck regions. Although the classic description of schwannomas generally was observed, a spectrum of distinct imaging features was identified. Unusual location (e.g., sympathetic plexus, retropharyngeal, base of tongue, etc.) and variable appearance of these lesions (e.g., very large size and irregular margin) may mimic a malignant process. Illustrative cases will highlight these imaging characteristics.

Conclusions
Schwannomas can have dramatic, occasionally misleading appearances and location. Recognition of the radiological spectrum of schwannomas will assist the radiologist in making an accurate diagnosis.
Multimodality Management of Hypervascular Vertebral Lesions: Biopsy, Preoperative Embolization, Decompressive and Reconstructive Surgery and Radiation Therapy

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Purpose
To review imaging features of hypervascular spinal masses as well as the available imaging, interventional and surgical tools and techniques available for diagnosis and management of lesions requiring surgical decompression. To utilize a case-based approach to review the diagnostic imaging, biopsy, angiography, histology and operative imaging. To demonstrate effective pathways of multidisciplinary care coordination in the management of these complex patients.

Materials and Methods
Retrospective review of imaging and clinical/surgical records was performed on a series of neurosurgical and orthopedic patients with hypervascular spine lesions requiring pre-operative embolization and decompressive surgery. Patient demographics, symptoms, imaging diagnosis, biopsy, embolization and embolic agent, surgery site and type, blood loss, histology and radiation, if utilized, were recorded and both short and long term clinical outcome were assessed.

Results
MR imaging was the mainstay of the diagnostic imaging evaluation supplemented by CT and plain films when instability was an issue. The majority of biopsies were performed using CT guidance although fluoroscopy-guided biopsy at the time of vertebral augmentation also was performed. Myelography was used only for initial diagnosis when there was a contraindication to MRI (pacemaker, etc). Angiography and pre-operative embolization using particles, coils or liquid acrylic embolic agents was employed between 24 and 2 hours prior to surgery. Same day procedures allowed a single intubation and a single anesthetic session requiring care coordination between the angiography suite and the operating room. Surgical procedures included minimally invasive and traditional decompressive surgical methods with instrumentation as needed for stabilization. For benign hypervascular lesions, no further therapy was employed, however conventional and stereotactic radiation therapy for hypervascular metastatic lesions was added when residual tumor remained in the region.

Conclusions
Understanding the role of imaging and minimally invasive interventions in the management of patients with hypervascular vertebral lesions is important for the neuroradiologist and is best exemplified in the Spine Tumor Board model where cases are discussed and optimal management plans devised. Efficient coordination of diagnostic imaging, CT-guided biopsy, pre-operative embolization, and surgery with or without an operative radiation can minimize patient delays and optimize patient care. Spine Tumor Board is a great forum for development of these management plans and fosters multidisciplinary cooperation.

cEdE-231
6:30AM - 3:00PM

Non-invasive Magnetic Resonance Myelography in Spontaneous Spinal Cerebrospinal Fluid Leak

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Purpose
To review the utility of noninvasive magnetic resonance myelography for detecting spinal cerebrospinal fluid (CSF) leaks in spontaneous intracranial hypotension.

Materials and Methods
A literature review of studies investigating noninvasive magnetic resonance myelography as well as other diagnostic imaging for detection of cerebrospinal fluid leaks. The other diagnostic imaging modalities include computed tomography myelography, radionuclide cisternography, invasive magnetic resonance myelography and conventional spinal magnetic resonance. Also, case examples of patients who underwent radionuclide cisternography and spinal magnetic resonance imaging were reviewed for spinal cerebrospinal leaks in suspected cases of spontaneous intracranial hypotension.

Results
A literature search showed three studies investigating noninvasive magnetic resonance myelography. The first article compared heavily T2-weighted magnetic resonance compared to computed tomographic myelography. The cerebrospinal fluid leak detection rates did not differ among the two modalities. Another article compared noninvasive magnetic resonance myelography to radioisotope cisternography. It demonstrated agreement between the two modalities for clinical diagnosis of cerebrospinal leaks. The last article compared 3D fast spin echo magnetic resonance and radioisotope cisternography. It also demonstrated agreement between the two studies except for a few cases of slight cerebrospinal fluid leakage on radioisotope cisternography. Case examples showed findings of spinal cerebrospinal fluid leak on dedicated noninvasive magnetic resonance myelography and corresponding radioisotope cisternography. One case demonstrated no findings of spinal cerebrospinal fluid leak on initial conventional spinal magnetic resonance, but positive findings on subsequent dedicated noninvasive magnetic resonance myelography.

Conclusions
The authors believe noninvasive magnetic resonance myelography is a first-line tool for diagnosing spinal cerebrospinal fluid leaks in spontaneous intracranial hypotension. By the conclusion of the educational exhibit, the reader will be able to identify imaging findings of spinal cerebrospinal fluid leaks on various modalities as well as potential advantages and disadvantages of each modality.

Non-tumoral Dorsal Thoracic Cord Deformity: Differential Diagnosis, Pre-Operative Imaging Evaluation and Intraoperative Correlation

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Purpose
To describe the imaging findings and differential diagnosis of nontumoral dorsal thoracic cord deformities. An approach to pre-operative imaging evaluation will be discussed with technical considerations highlighted. Pre- and postoperative clinical correlation, as well as intra-operative correlation also will be discussed.
Materials and Methods
Case examples will be used to illustrate pathologies encountered with nontumoral dorsal thoracic cord deformities. Imaging techniques used to narrow the pre-operative differential diagnosis will be demonstrated. Pre and postsurgical symptoms will be described for each case example, with intra-operative correlations described.

Results
Nontumoral dorsal thoracic cord deformity can be due to intradural arachnoid cyst, arachnoid web, anterior cord adhesion or anterior cord herniation. High resolution T2-weighted imaging and CT myelography can be used to narrow the pre-operative differential diagnosis. Intra-operative findings have been correlated to imaging findings. Changes in pre- and postoperative clinical symptoms suggest the importance of timely surgical intervention.

Conclusions
Nontumoral dorsal thoracic cord deformity has a specific differential diagnosis based on imaging. Tailored pre-operative imaging, such as high resolution MRI or CT myelography, can be used to further narrow the pre-operative differential diagnosis.

eEdE-216
6:30AM - 3:00PM

Percutaneous CT-Guided Facet Joint Synovial Cyst Rupture: Success with Refractory Cases and Technical Considerations

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Purpose
Percutaneous rupture of synovial cysts has been correlated with avoiding subsequent surgery in half of treated patients (1). In one large series, in 19% of cases, cyst rupture could not be confirmed fluoroscopically (1). We describe the technique for CT-guided lumbar facet synovial cyst rupture with emphasis on technical considerations for success in refractory cases.

Materials and Methods
Cases of seven consecutive patients with symptomatic lumbar facet synovial cysts referred for percutaneous rupture were reviewed. Using serial CT guidance, a 22-gauge spinal needle was advanced into the degenerated facet joint associated with the cyst, and dilute contrast was injected into the joint. In all cases, contrast filled the cyst. The cyst was filled with increasing pressure using normal saline until loss of resistance was achieved. In one case, a second spinal needle was advanced via an interlaminar approach and was used to fenestrate the cyst. After CT confirmation of successful rupture, a steroid and local anesthetic mixture was injected into the joint, some of which entered into the epidural space via the new defect in the synovial cyst.

Results
Five patients had prior unsuccessful fluoroscopy-guided cyst drainage and/or rupture (in one patient, the facet joint could not be accessed due to extensive osteophyte formation). The other two patients were referred directly for CT-guided drainage. Figure 1A is an axial T2-weighted image of patient 1, showing a left L4-L5 facet synovial cyst impinging upon the left L5 nerve root. All seven patients underwent successful synovial cyst rupture, which was confirmed by CT.
showing loss of cyst contour and dilute contrast in the surrounding epidural space. Figures 1B and 1C show axial CT images immediately before and after cyst rupture in patient 1. Figure 1D shows patient 2; the lateral needle was used to access the facet joint and fill the cyst with contrast, and the medial needle was used for interlaminar cyst fenestration. Two patients with recently performed cyst rupture did not have available clinical follow up. Four of the other five patients experienced significant relief of radicular symptoms related to nerve root compression (with follow up up to 1, 3, 9, and 12 months).

Conclusions
CT-guided lumbar facet synovial cyst rupture can be successful in cases refractory to fluoroscopy-guided drainage/rupture.
Percutaneous Rupture of Lumbar Synovial Cysts: When We Do It, and How We Do It?

Y Kumar¹, K Hooda¹, D Hayashi², N Parikh¹, S Sharma¹, M Meszaros³
Purpose
1. To review the indications of percutaneous rupture of lumbar synovial cysts. 2. To describe the techniques and limitations of percutaneous rupture of lumbar synovial cysts. 3. To discuss outcomes of percutaneous rupture of lumbar synovial cysts.

Materials and Methods
A retrospective review and subsequent interviews were conducted to collect pretreatment and post-treatment pain and disability scores along with details of subsequent treatment interventions.

Results
Fluoroscopic and clinical success rates of the synovial cyst rupture were calculated and compared with other similar larger studies. Successful rupture/decompression of the cysts was achieved in all cases. Contiguity of contrast from the facet joint into the cyst was 100%. All patients reported significant improvement in pain.

Conclusions
Lumbar facet joint cysts are a more and more recognized cause of low back pain. Procedural treatments have ranged from epidural steroid injections, facet joint injections to surgical resection. For many radiologists, whether interventional, neuroradiologist, or musculoskeletal who have embarked to treat spine patients, CT-guided lumbar facet joint cyst rupture/decompression appears to be a viable treatment option for their patients.

Percutaneous Spinal Cord Stimulator Placement: The Do’s, The Don’ts, and The How.

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Purpose
Neuromodulation with implantable spinal cord stimulators has been shown to be an effective method for controlling certain pain conditions. Spinal cord stimulators frequently can be placed percutaneously, under conscious sedation. The purpose of this exhibit is to familiarize the radiologist with key guidelines and techniques for placement of spinal cord neuromodulation devices.

Materials and Methods
Prior trials and studies evaluating the efficacy and safety of spinal cord stimulation will be reviewed. Guidelines for patient selection, including indications and contraindications, will be discussed. Lastly, we aim to review methods and techniques for percutaneous placement of spinal cord stimulator devices. In this exhibit, we will discuss our experience with a consecutive series of 150 percutaneous spinal stimulator procedures performed under conscious sedation in a fluoroscopy suite over 7 years, without complication.

Results
The physiology of spinal cord neuromodulation in controlling intractable pain is not well understood. However it can provide extensive symptomatic relief in patients in whom
conservative medical and surgical management have failed. Placement of spinal cord stimulators can be performed reliably under conscious sedation, allowing for quick recovery and lowering the risks involved with general anesthesia. Spinal cord neuromodulation is unique in that a trial period with a temporary stimulator is first conducted to see if the patient's pain is adequately relieved. Additionally, communication between the patient and physician is paramount to ensure adequate dermatomal coverage of paresthesia.

Conclusions
Spinal cord neuromodulation can provide relief in patients with long-standing neuropathic or ischemic pain, following failed medical or surgical management. While technical knowledge involved in spinal cord stimulator placement is key, a firm understanding of current guidelines and practices optimizes successful results by appropriate patient selection.

eEdE-243b

Post Operative Imaging of Spinal Fusion: A Systematic Review of Literature and Case Series

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Purpose
Fusion of the diseased spinal segments frequently is used as a treatment strategy in degenerative diseases, trauma, tumors and infection of the spine. The implantation of artificial prostheses to achieve this causes challenges in the interpretation of imaging. This review discusses various imaging modalities that can be employed to assess postoperative spinal fusion. Pertinent imaging findings suggestive of nonfusion also are described.

Materials and Methods
We reviewed the imaging findings of patients treated with the intent of achieving spinal fusion presenting to our tertiary neurosciences and spinal center over the past 7 years. A MEDLINE and EMBASE literature review on assessing spinal fusion was carried out.

Results
Computed tomography (CT) and magnetic resonance imaging (MRI) are the mainstay in the radiological assessment of spinal fusion. While the superior soft tissue resolution of MRI is appealing, it previously has been limited by the amount of artifact from metallic implants. Newer implant materials which cause fewer artifacts, in conjunction with improving MRI image acquisition techniques hold promise. Plain and dynamic radiographs are limited by measurement reliability, disagreement on allowable motion, and their two-dimensional nature. The use of radionucleotide imaging remains restricted to the determination of pseudarthrosis, infection or metastases.

Conclusions
Static radiographs long have been used as a practical method of fusion assessment, but tend to significantly overestimate the presence of a solid fusion. Dynamic radiographs improve accuracy but are limited due to measurement reliability, disagreement on allowable motion, and the two-dimensional nature of radiographs. Fine-cut CT with multiplanar reconstruction and metal artifact reduction software has increased the ability to assess fusion on CT. Although MRI soft
tissue definition makes it an attractive prospect, its utility in assessing fusion remains unproven. Understanding the limitations of each technique allows judicious use of radiology in the assessment of spinal fusion.

**Intervertebral body fusion techn**

![Intervertebral body fusion technique images](TCT_eEdE-243b_fusion.GIF)

(a) Frontal radiograph images showing screws and interbody spacer.
(b) Axial CT images showing screws and interbody spacer.
(c) MRI images showing screws and interbody spacer.

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**eEdE-234**

**Radiation and Chemotherapy Changes in Spine and Spinal Cord**

J Ramalho¹, M Castillo²
Purpose
Radiation and chemotherapy are used as potential curative or palliative treatments for a variety of disease processes, including childhood and adult malignancies. Despite well established survival benefits, both modalities have important short and long term secondary effects. The purpose of this presentation is to review the clinical and magnetic resonance imaging (MRI) findings of treatment-induced changes in the spine and spinal cord.

Materials and Methods
MR imaging is the only imaging technique that allows direct visualization of bone marrow and spinal cord with high spatial and contrast resolution, and consequently the imaging method of choice for treatment follow up. The short and long term side effects of radiation and chemotherapy will be discussed, with particular attention for bone changes, bone lesions and treatment-induced myelopathy and radiculopathy. All cases were obtained by searching our teaching files.

Results
Side effects from radiation usually are limited to the area confined to the treatment field and most are predictable and expected. Main effects on bone include: marrow fatty conversion, disruption of normal growth and maturation, scoliosis, osteonecrosis, insufficiency fractures and secondary neoplasms. Radiation therapy also may cause toxicity to either the central or peripheral nervous system resulting from compressive radiation-induced fibrosis, ischemia or both. Various chemotherapeutic agents are associated with toxic myelopathy and neuropathy including cisplatin, cladarabine, doxorubicin, vincristine, cytosine arabinoside, and intrathecal methotrexate. Administration of chemotherapy intrathecally increases the incidence of myelopathy related to the agent itself or to preservatives and diluents used in the agents.

Conclusions
Treatment-induced changes in bone marrow may be difficult to differentiate from progressive or recurrent disease. Myelopathy and radiculopathy are serious complications of radiation and/or chemotherapy therapy with considerable impact on quality of life, particularly in patients considered cured of their primary malignancies. These side effects must be recognized by the radiologist to assure its appropriate clinical management.

eEdE-240

Spinal Dural Arteriovenous Fistulas: MR Imaging Characteristics and Clinical Significance

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Purpose
Spinal dural arteriovenous fistulas (SDAVFs) are a rare and often underdiagnosed entity, yet they represent the most common spinal vascular malformation and have quite an important clinical significance. Clinical findings often are vague and confounding though progressive and debilitating, while MR findings can be subtle. Early diagnosis and treatment has excellent
outcomes and can prevent severe neurological deficits. Thus, it is essential for the neuroradiologist to accurately identify the SDAVF to ensure timely management of this disease entity.

Materials and Methods
In this electronic education exhibit, we aim to: -Review the clinical and epidemiologic features of spinal dural AV fistulas (SDAVFs). -Demonstrate and discuss MR imaging findings in an interactive graphical format. -Discuss therapeutic options of SDAVFs.

Results
Spinal vascular malformation is a term which refers to a spectrum of disease entities including spinal dural arteriovenous fistulas, spinal cord arteriovenous malformations, and spinal cord arteriovenous fistulas. The Type I spinal vascular malformation, the spinal dural arteriovenous fistula, is the most common and will be discussed in this presentation. SDAVFs typically occur in males in their 6th decade of life. Sixty percent occur spontaneously, with the remainder related to trauma. Clinical symptoms have an insidious onset and are nonspecific, most often including lower extremity paresthesias, sensory loss, and radicular pain starting at the lumbosacral levels and progressing superiorly. Clinical diagnosis is difficult and can be confounded with more common degenerative disease or neoplasm. Radiological evaluation by CT or MR is essential to making the diagnosis. MR findings may include serpentine flow voids on the dorsal spinal cord surface, cord enlargement with intramedullary T2 hyperintensity, and peripheral T2 hypointensity related to dilated pial capillaries secondary to venous hypertension. Subacute necrotizing myelopathy can be associated with SDAVFs. Hemorrhage is rare. Treatment options include surgical occlusion of the intradural nidus vein or endovascular occlusion of the feeding radiculomeningeal artery and proximal draining vein.

Conclusions
Spinal dural arteriovenous fistulas are rare and have a nebulous clinical picture, often leading to underdiagnosis and suboptimal management. Early diagnosis is crucial and can significantly improve neurologic outcomes. It is thus essential for the neuroradiologist to be familiar with and identify the spinal dural arteriovenous fistula.

Spinal Hemangiomas: Double Face of Janus.

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Purpose
Spinal hemangiomas (SH) are the most common benign spinal neoplasms. The majority of SH are incidental finding, called nonaggressive SH (NASH), however approximately 1% of SH become symptomatic by causing pain, neurologic deficit, or both and are considered aggressive SH (ASH). NASH and ASH have distinct presentations, behaviors and require different approaches for treatment and follow up.

Materials and Methods
Systematic review of literature from the Pubmed and an analysis of database from the Mercy Catholic Medical Center (Philadelphia, PA).
Results
Review clinical and imaging presentations of NASH and ASH; illustrate and explain possible causes of the compressive radiculomyelopathy in ASH: 1) epidural soft tissue component of the tumor; 2) fractured vertebral body fragment; 3) epidural hematoma; 4) vertebral bony expansion. Illustrate the pathologic findings that correspond to specific imaging features depending on histological types of SH: capillary, cavernous, and mixed. Review the most recent literature of NASH and ASH with guidelines for evaluation with CT, MRI, and bone scintigraphy including typical radiological features of NASH and specific imaging characteristics of ASH. Provide practical algorithm for diagnosis of NASH and evaluation of suspected ASH. Review treatment options for ASHs including vertebroplasty, intralesional alcohol injection, endovascular and transcatheter embolization, radiotherapy, including Cyberknife therapy, and surgical decompression.

Conclusions
This exhibit provides a comprehensive review of literature, clinical characteristics, histological types and imaging features of NASH and ASH; summarizes the treatment options, and offers a practical algorithm for clinical translation of radiological finding in ASH and NASH.
Thyroid Spinal Metastasis: What Radiologists Need To Know

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Purpose
Thyroid cancer (TC) spinal metastases (SM) represent an important subgroup of TC patients and significantly differ from SM of other primary cancers. The aim of this exhibit is to perform a comprehensive review of the clinical manifestations, imaging appearance, prognostic significance and treatment options of TC SM.

Materials and Methods
Systematic literature review, an analysis of databases from the Mercy Catholic Medical Center (Philadelphia, PA) and Medstar Washington Medical Center (Washington, DC).

Results
Review common clinical presentation of TC SM: • 35% of patients with TC SM have SM as the initial presentation of TC, most frequently with follicular TC (FTC). Papillary TC (PTC) SM typically are diagnosed after TC diagnosis. • FTC SM usually presents with neural compression symptoms while PTC SM often are asymptomatic and detected during radioiodine scanning.
Illustrate the imaging appearances of TC SM, role 131-I in diagnostic and treatment of TC SMs: • Only 58% of all SM are 131-I avid, FTC SM more often than PTC SM. • MRI and PET/CT remain the best techniques for I-131-negative TC SM diagnosis. • Need for long term follow up since TC SM may occur up to 372 months after TC diagnosis. Review a recently introduced three-tiered approach for TC SM treatment. As 30% of all patients and 50% of patients with single-site SM have no other metastases at the time of presentation, and thus may be candidates for radical therapy.

Conclusions
1. FTC SM and PTC SM have distinct presentations, behaviors, and treatment approach and should be categorized separately. 2. Imaging plays a fundamental role in diagnosis and treatment planning of TC SM. 3. Knowledge of specific features TC SM may help radiologist to plan appropriate radiological work up and follow up. 4. Radiologists play crucial role in identification of TC SM patients without other distant metastases for possible radical treatment.
Toxic and Metabolic Myelopathies - Magnetic Resonance Imaging Findings and Clinical-Pathophysiologic Correlation.

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Purpose
Myelopathy describes any neurologic deficit related to the spinal cord. It usually is compressive in nature, typically associated with neoplasm, degenerative disease, trauma, or infection. Less common noncompressive myelopathies include inflammatory etiologies, such as autoimmune, demyelinating, paraneoplastic, or infectious diseases and noninflammatory myelopathies, such as metabolic, toxic or vascular disorders. The purpose of this presentation is to review the clinical presentation, pathophysiologic mechanism and magnetic resonance imaging (MRI) findings of myelopathies that have underlying metabolic or toxic etiologies.

Materials and Methods
Metabolic myelopathies associated with an identified nutrient deficiency, including cobalamin/B12 vitamin, folate, copper or vitamin E deficiencies, and toxic myelopathies associated with different drugs and chemical agents such as heroin abuse, organophosphate poisoning, clioquinol, chemotherapeutic agents and radiation therapy will be reviewed. Rare disorders with a geographical predilection such as lathyrisism and Konzo, seen in India, Bangladesh, and Ethiopia as well as surfer's, jellyfish-induced and the toxic hepatic myelopathy also will be discussed.

Results
Conditions affecting the spinal cord must be recognized as early as possible in order to prevent progression, which may lead to permanent disability. Biopsy of the spinal cord is rarely performed, thus the diagnosis and management rely on patient's history, physical examination, laboratory results and imaging findings. Toxic and metabolic myelopathies may have clinical, electrophysiologic, neuropathologic and imaging features in common. Variable degrees of peripheral nerve and/or optic nerve involvement may be present, usually known as myeloneuropathy. Preferential involvement of the dorsal columns and/or corticospinal tracts is commonly seen in all these myelopathies.

Conclusions
Metabolic and toxic myelopathy and myeloneuropathy are not rare clinical conditions. Acquaintance with these entities may lead to accurate diagnosis with successful identification of the underlying cause and appropriate treatment to revert or prevent further progression of the symptoms associated with these incapacitating disorders.

eEdE-236
6:30AM - 3:00PM

Update in Subaxial Cervical Trauma; What the Clinician Needs to Know

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Purpose
Greater than 60% of all cervical spine fractures and more than three-fourths of the dislocations are sub axial. However, because of controversy concerning the affect classification systems have on clinical outcome, most imagers have resorted to using descriptive terminology to describe
patterns of injury. The Allen and Fergusson classification has prevailed as the most utilized system for description of fractures. This system groups cervical fractures based on mechanism of injury: compressive flexion, vertical compression, distractive flexion, compressive extension, and lateral flexion. Different stages exist within each group for a total of 21 different possible types. This system does not quantify the severity of a lesion or guide treatment which is considered a limitation. Harris et al (1) expanded this classification in the mid 1980s, today this expansion is used rarely in clinical practice, where a combination of description and mechanism of injury usually are used. Recent efforts to further classify subaxial lesions have been made giving rise to the subaxial ligamentous injury (SLIC) and the cervical spinal severity score (CSISS) classifications. This exhibit will review the two classifications and discuss the clinical implications of them.

Materials and Methods

Results
Greater than 60% of all cervical spine fractures and more than three-fourths of the dislocations are subaxial. However, because of controversy concerning the affect classification systems have on clinical outcome, most imagers have resorted to using descriptive terminology to describe patterns of injury. The Allen and Fergusson classification has prevailed as the most utilized system for description of fractures. This system groups cervical fractures based on mechanism of injury: compressive flexion, vertical compression, distractive flexion, compressive extension, and lateral flexion. Different stages exist within each group for a total of 21 different possible types. This system does not quantify the severity of a lesion or guide treatment which is considered a limitation. Harris et al expanded this classification in the mid 1980s, today this expansion rarely is used in clinical practice, where a combination of description and mechanism of injury usually are used. Recent efforts to further classify subaxial lesions have been made giving rise to the subaxial ligamentous injury (SLIC) and the cervical spinal severity score (CSISS) classifications.

Conclusions
The subaxial ligamentous injury (SLIC) and the cervical spinal severity score (CSISS) classifications are a new effort to classify subaxial traumatic cervical injuries. Neuroradiologists should be aware of the clinical implications of using these classifications, and how they can provide improvement in patient outcomes.
Utilization of Abbreviated MR Protocol to Exclude Cauda Equina Syndrome in the Emergency Setting: A Retrospective Review

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Purpose
Cauda equina syndrome (CES) is a relatively uncommon, yet serious condition that has potentially devastating consequences if prompt diagnosis is not made. Symptoms vary widely and include saddle anesthesia and urinary, bowel, and/or sexual dysfunction. Given the variation in symptoms and clinical exam findings, imaging often is relied upon in the emergency setting to exclude CES. Standard imaging, including radiographs and routine lumbar spine MRI, can be time consuming and does not evaluate the thoracic spine. We propose that a rapid MR protocol, which includes the thoracic spine, can more quickly and effectively screen for CES and identify mimickers not otherwise detected on standard lumbar MRI.

Materials and Methods
An MR protocol taking less than 10 minutes was developed utilizing sagittal 3D T2 imaging of both the thoracic and lumbar spine. Emergency room patients presenting with symptoms concerning for CES were selected for imaging with this protocol. Patients with a history of malignancy or recent trauma were excluded and underwent standard imaging. A 6-month retrospective review of these patients was conducted.

Results
Fifty-seven patients presented with symptoms concerning for CES. Fifty-two were scanned using the rapid MR protocol, and five were imaged with standard MR sequences. Of the 57 patients scanned, five were determined to have CES. Thirteen patients had other significant pathology including demyelinating lesions, tumor, compression fracture, and severe spinal canal stenosis. Nine of these 13 patients underwent follow-up imaging using conventional MR, CT, or radiographs. One of these nine patients had a migrated free disc fragment lateral to the neuroforamen discovered on conventional MR that was not identified on rapid MR imaging. Findings from the remaining follow-up exams either supported or confirmed rapid MR imaging findings.

Conclusions
Rapid recognition of CES is advantageous, as treatment within 24 hours is associated with the best outcomes. A variety of pathologies can elicit symptoms of CES, and some of these entities may not be detected on conventional imaging focused on the lumbar spine. Implementation of the rapid MR protocol in the emergency setting can provide earlier identification of CES, improved emergency department workflow, and detection of a variety of etiologies for patients' symptoms.
Vascular imaging investigations and embolization before spinal surgery and percutaneous treatment.

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Purpose
Informations concerning the vascularization of the spine and the medulla is a major concern before percutaneous ablation therapy and surgery of spinal tumor. The rationality of pre-operative imaging is discussed. Noninvasive imaging also has been proposed to determine the degree of vascularization of the lesion. Arteriography may be proposed in second intention and may be the first step of pre-operative embolization. The interest of pre-operative embolization of primitive lesions or metastases of the spine is presented.

Materials and Methods
Firstly a review of the anatomy of the spinal vascularization is proposed with the aim of understanding the potential impact of a radicular or radiculomedullary artery occlusion. Secondly we propose a review of the literature concerning the problem of occlusion of radicular arteries during aortic repair, spinal surgery and embolization. Thirdly we present our experience concerning the ligature of radicular arteries giving radiculomedullary arteries and the consequence on the vascularization of the medulla. Finally, principle and interest of embolization and percutaneous tumoral ablation will be presented regarding the anatomy of the spinal vasculature.

Results
Planned surgical approach has to take into account the topography of the great radiculomedullary artery (GRMA) in order to avoid possible cord ischemia. This also may be true for all radiculomedullary arteries. However, previous reports have emphasized the importance of the "spinal collateral network", showing that occlusion of radicular arteries giving a radiculomedullary artery may be free of spinal cord ischemia. These results have been largely described after surgical or endovascular treatment of aortic disease. In this context, the systematic research of radiculomedullary arteries is discussed. CT scanner and MRI protocols have been published, showing great results in determining the localization of the GRMA. Pre-operative embolization is considered as mandatory before ablation of hypervascular spinal lesions allowing a decrease of operative blood loss. If surgical proximal ligature of segmental arteries giving a radiculomedullary artery may be performed without spinal cord ischemia, the interventional radiologist has to be sure that the segmental artery does not give a radiculomedullary artery, directly or thanks to the spinal arterial network.

Conclusions
Determining the localization of radiculomedullary arteries before spine surgery and arterial embolization aims to avoid spinal cord ischemia. Reports concerning occlusion of the origin of segmental arteries giving a radiculomedullary artery emphasize the importance of the spinal arterial network, which may be developed sufficiently to avoid spinal cord ischemia. Noninvasive imaging may be useful to precise the localization of radiculomedullary arteries and the degree of vascularization of the lesion, even if limitations exist. Embolization may be helpful to decrease the blood loss during surgery and must not be performed in case of radiculomedullary artery coming from the segmental artery.
Cerebellopontine Angle Cavernous Angioma Occurring in the Setting of Multiple Familial Cavernous Malformations

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Purpose
We present a case of an extra-axial cerebellopontine angle (CPA) cavernous angioma occurring in the setting of multiple familial cavernous malformations. The distinguishing imaging and clinical features of this rare lesion, which was initially presumptively diagnosed as a vestibular schwannoma, will be highlighted.

Materials and Methods
The patient presented in 2004 with multiple insidiously progressive neurologic deficits including neurogenic bladder, poor right leg motor and balance function, dizziness and right sided hearing loss. Initial MRI demonstrated multiple intracranial and spinal cord cavernous malformations consistent with familial multiple cavernous malformation syndrome. A right CPA mass also was identified and presumed to represent an incidental vestibular schwannoma. Vestibular and audiometric testing showed decreased right sided function; however, the patient elected to forego any surgical intervention or gamma knife therapy due to the stability of his deficit. Subsequent follow-up imaging was performed over the next decade, most recently due to hemorrhagic complication of multiple intracranial and spinal cord angiomas with eventual resection. Follow-up MR imaging included high resolution FIESTA and susceptibility-weighted sequences.

Results
Right CPA lesion located at the porus acusticus, characterized by T1 hyperintense focus (upper left), mild heterogeneous enhancement (lower left), and heterogeneous T2 signal (upper right). Multiple lesions within the posterior fossa including the right CPA lesion demonstrating blooming on susceptibility-weighted imaging (lower right). The CPA lesion size remained stable over the 10-year imaging interval.

Conclusions
Cavernous angiomas of the CPA are rare entities, but consideration of this diagnosis is important when specific imaging and clinical features are present. Hyperintense T1 signal within the lesion and blooming on susceptibility-weighted imaging indicative of chronic hemorrhage are suggestive of this lesion, and essentially diagnostic in individuals with multiple familial cavernomas. Accurate pre-operative diagnosis is important for planning appropriate surgical removal of this highly vascular mass.
Purpose
While fungal infections are increasingly common in an immunocompromised pediatric population, infection with Dactylaria Gallopava, more commonly called ochroconis, is exceedingly rare. In this excerpta, we present salient characteristics of a fungal abscess identified clinically and radiologically.
Materials and Methods
A 19-year-old male with a past medical history of short gut syndrome secondary to volvulus, status post small bowel transplant, initially presented with an opportunistic Ochroconis pulmonary infection. Immunosuppression was halted, leading to rejection of the small bowel transplant. This required subsequent removal of the transplant and halting of immunosuppression. Several days after discontinuation of immunosuppression, the patient began to develop delirium and increased somnolence. EEG demonstrated nonconvulsive status epilepticus. Subsequent contrast-enhanced MRI identified a lesion concerning for fungal infection versus neoplastic process. Brain biopsy identified the lesions as a fungal abscess. Triple antifungal therapy was initiated, however, little response was seen radiologically or clinically. The patient expired approximately 3 months after initial diagnosis despite therapy.

Results
Contrast-enhanced MR identified multiple nodular and necrotic enhancing lesions congregated in a mass-like fashion in the right parietal deep matter with a significant amount of vasogenic edema, a small amount of ring-like diffusion restriction, and mild mass effect and midline shift. MR spectroscopy identified a lactate peak. Follow-up imaging 1 month later demonstrated stability of these lesions despite antifungal therapy.

Conclusions
Infection secondary to ochroconis, a dematiaceous fungus, is an exceedingly rare phenomenon. It should, however, be considered as a potential pathogen in any cerebral abscess of an immunocompromised patient.

Axial T1 + Contrast
(Filename: TCT_EE-18_fungalabscessaxialT1C.jpg)
Axial T2 FLAIR

Coronal T1 + Contrast
Differentiation of Peri-Ictal Pseudoprogression from Tumor Recurrence in a Patient with Treated Glioma: Value of Diffusion Weighted and Perfusion Imaging.

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Purpose
In patients who received standard chemoradiation following resection of a glioma, the presence of a new enhancing lesion represents a diagnostic dilemma between post-treatment changes versus tumor recurrence. Peri-ictal pseudoprogression (PIPG) is a rare condition (< 1%) that occurs in long term survivors of glioma who have undergone radiotherapy. We describe the imaging findings of PIPG on serial MR examinations including diffusion and perfusion imaging.

Materials and Methods
A 36-year-old man who presented with several simple and complex partial seizures with and without generalization. He had a history of left frontal anaplastic astrocytoma (III/IV) treated by surgery, adjuvant radiation (60 Gy in 6 weeks) with concomitant and adjuvant Temozolomide completed 31/2 years earlier. He was treated with phenytoin and levetiracetam with no recurrence of seizures.
Results
The MRI at presentation showed unchanged surgical cavity in the left frontal lobe. However, there was cortical thickening and T2/FLAIR hyperintensity in the gyri superior to the surgical cavity (Figure 1A) with associated new cortical/leptomeningeal enhancement (Figure 1B) and increased relative cerebral blood volume on dynamic susceptibility-weighted contrast perfusion study. The DWI revealed corresponding cortical/gyriform restricted diffusion in the left frontal gyri (Figure 1C and D). Follow-up MRI 2 months later showed complete resolution of the imaging abnormalities.

Conclusions
Peri-ictal pseudoprogression is a rare entity seen in long term survivors of brain tumors presenting on imaging with new signal abnormalities, cortical and leptomeningeal enhancement and increased perfusion mimicking tumor progression. The extensive cortical/gyriform pattern of diffusion restriction that can be seen in any peri-ictal phase suggests PIPG as an underlying cause for the imaging abnormalities rather than true disease progression in this patient population.
Diffuse Encephalitis Diagnosed on PET/CT Acquired in a Patient in Status Epilepticus with Negative MRI.

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Purpose
To describe a case of encephalitis diagnosed on PET/CT performed in a ventilated patient.

Materials and Methods
A 23-year-old previously well female presented with seizures, reduced GCS, left sided neglect and left focal motor seizures. A focal abnormality was identified in temporal region on EEG. Patient entered prolonged period of status epilepticus, not controlled with quadruple anticonvulsants. Intubated and ventilated in ICU.

Results
CT head – normal. MRI brain – normal. PET/CT (FDG) – diffuse reduced tracer uptake (hypometabolism) in posterior frontal, temporal, occipital and parietal lobes bilaterally, with relative sparing of the anterior frontal lobes and posterior fossa. Diagnosed with anti MNDA receptor encephalitis on CSF analysis.

Conclusions
PET/CT is able to detect hypo-metabolism in encephalitis even in the presence of normal MRI imaging. The case demonstrates a possible role of performing PET/CT in such patients.
EE-02

Diffusely decreased cerebellar metabolism on FDG-PET/CT imaging in a patient with rhomboencephalosynapsis

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Purpose
Rhomboencephalosynapsis is a midline brain malformation characterized by the absence of the cerebellar vermis and fusion of the cerebellar hemispheres. We report the unusual finding of diffusely decreased cerebellar metabolism on fluorodeoxyglucose (FDG)-PET/CT in a patient with rhomboencephalosynapsis, which to our knowledge has not been reported previously in the literature.

Materials and Methods
A 33-year-old man, with a history of schizophrenia, underwent routine FDG-PET/CT and brain MR imaging for unrelated research purposes.
Results
Coronal and axial T1-weighted MPRAGE MR images through the brain demonstrate fusion of the cerebellar hemispheres with transversely oriented cerebellar folia and hypogenesis of the vermis (A and B). Sagittal MIP PET and axial fused PET/CT images demonstrate diffusely decreased FDG activity in the cerebellum and brainstem relative to the cerebrum (C and D). Fluorodeoxyglucose uptake is preserved in the expected location of the dentate nuclei, and extends towards the midline, posterior to the 4th ventricle (D).

Conclusions
Rhomboencephalosynapsis is a rare dysplasia of the cerebellum characterized by absence or incomplete development of the vermis, fusion of the cerebellar hemispheres, and fusion or apposition of the dentate nuclei. It can be associated with other defects, including thalamic fusion, absent olfactory bulbs, dysgenesis of the corpus callosum, holoprosencephaly, and absence of the septum pellucidum, as seen in our patient. It may be seen in isolation or with other syndromes, including Cerebello-Trigeminal Dermal Dysplasia and VACTERL (vertebral anomalies, anal atresia, cardiovascular anomalies, tracheoesophageal fistula, renal anomalies, and limb defects) syndrome. The FDG-PET/CT findings in our patient indicate decreased metabolism of the cerebellar hemispheres; presumably secondary to pathophysiological effects related to the underlying congenital disorder. Other diagnostic considerations for diffusely decreased FDG uptake in the cerebellum include chronic alcohol abuse, long term use of antiepileptic medication, neurodegenerative disorders such as multiple system atrophy, and diffuse idiopathic cerebellar calcification.
Don't Blow It: Pneumoparotid related to Overzealous Distension of the Oral Cavity During Puffed-Cheek CT Scans.

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Purpose
Mucosal lesions of the oral cavity, particularly buccal or lateral (buccal) gingival lesions, often are difficult to diagnosis radiographically. Apposition of the mucosal surfaces may obscure lesions that are clinically obvious, when utilizing standard CT imaging techniques. Puffed-cheek CT scans allow for better evaluation of the buccal, labial and alveolar mucosa and are performed by distending the oral cavity with air (1). Pneumoparotid is a rare consequence that has been encountered when performing this technique. Pneumoparotid can be caused by various mechanisms that increase intraoral pressure and can be seen in wind musicians, glassblowers and
divers. Although typically asymptomatic and self-limited, recurrent pneumoparotid can lead to infection and sialocele (2).

Materials and Methods
Pneumoparotid was identified incidentally in two patients during head and neck CT exams obtained for evaluation of the oral cavity. Pneumoparotid likely was related to overzealous performance of the puffed-cheek technique during CT. No additional related abnormalities or secondary inflammatory changes were identified on imaging.

Results
Radiographically, pneumoparotid is seen when elevated intraoral pressure causes air to reflux into Stensen's duct. Pneumoparotid presents on imaging as air within Stensen's and may reflux into the intraparotid ducts. In extreme cases, air actually can rupture the parotid acini and capsule. When capsular rupture occurs, air can disseminate within the soft tissues of the head and neck and mediastinum (3). Confirmation of air in these locations easily is made utilizing lung windows.

Conclusions
Puffed-cheek CT scans are useful in the evaluation of oral cavity mucosal lesions. Increased intraoral pressures created during the performance of the puffed-cheek technique rarely can result in pneumoparotid. Reflux of air into the salivary system typically is inhibited by the ostium of Stensen's duct, a slit-shaped orifice surrounded by redundant mucosal folds. When intraoral pressures increase, these mucosal folds seal off the ostium and prevent retrograde flow into the duct. Distension of the oral cavity also causes increased angulation of Stensen's duct, allowing for better compression of the duct by the adjacent buccinator muscle. When these mechanisms break down due to anatomical abnormalities including patulous duct and weak buccinator muscle, or are overcome by oral hyperpressure, pneumoparotid can occur (4).
Finding the Zebra in a Herd of Horses: Using Diffusion Tensor Imaging Metrics to Aid in Diagnosis of Hemangiopericytoma—Radiologic-Pathologic Correlation

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Purpose
Hemangiopericytomas are rare extra-axial central nervous system (CNS) tumors (0.4% of primary CNS tumors) that share imaging features with the 50-60 times more common meningiomas on conventional MRI, however differ in management and prognosis. MR spectroscopy (MRS) features of hemangiopericytomas have been described as a possible method to distinguish them from meningiomas. Diffusion tensor imaging (DTI) metrics have shown
potential in the characterization of different grades and subtypes of meningioma; however, the application of this technique to identify hemangiopericytoma and differentiate from meningioma has not been described yet. Diffusion tensor imaging metrics may aid in pre-operative diagnosis of hemangiopericytomas.

Materials and Methods
A retrospective review of the pathology and radiology databases revealed 18 patients with pathologically proven hemangiopericytomas, two of which underwent pre-operative MR studies including DTI. These patients include a 27-year-old woman presenting with vertigo and ataxia with a 4.3 cm left tentorial mass (Case 1), and a 72-year-old man presenting with balance difficulty and facial numbness with a 4 cm mass in the floor of the right middle cranial fossa (Case 2). Diffusion tensor imaging data were processed to obtain fractional anisotropy (FA), linear (CL), planar (CP), and spherical (CS) coefficient anisotropy maps. These data were correlated with the histopathologic features.

Results
Case 1 demonstrates low anisotropy, whereas Case 2 demonstrates moderately higher anisotropy on FA (Figure 1), CL and CP maps. The pathologic specimens differ in cellular and extracellular features. Specifically, the amount of collagen in the extracellular matrix was more abundant in Case 2 (Figure 1), which can explain the higher anisotropy observed. Elevated myo-inositol in Case 1 on MRS is in agreement with previous reports.

Conclusions
Diffusion tensor imaging metrics analysis may aid in the pre-operative diagnosis of hemangiopericytomas. The variable anisotropy of these tumors on DTI metrics may be due to observed differences in tissue composition.
Head Holder Image Artifact: Shadows in the midst of Light, and How We Fixed It.

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Purpose
We will elucidate the etiology of a head CT image artifact which may hinder image interpretation, and how to avoid creation of this image artifact.

Materials and Methods
A noncontrast head CT was ordered in the setting of head trauma to assess for acute traumatic injury such as intracranial hemorrhage. While this clinical scenario is commonplace and the imaging indicated, we began to notice an image artifact in the midst of the axial images that was occurring for multiple head CT examinations without explanation.

Results
A single slice in the axial stack of images was darkened entirely. While sometimes this darkened...
image occurred near the floor of the anterior fossa or middle fossa, sometimes it would occur in
the middle of the brain parenchyma with a significantly attenuating calvarial landmark neither
within the image nor any adjacent image. Multiple maintenance efforts were attempted, but the
image artifact persisted. Finally, it was determined that the head holder was attenuating the x-ray
beam, and the artifact was produced when the gantry was tilted at the same angle as the head
holder and passed through the gantry and x-ray beam. To avoid this image artifact, our protocols
now call for the patient to be positioned with the head as far into the head holder as possible,
avoiding the head holder all together on head CT examinations.

Conclusions
Patient positioning is critical to avoid image artifacts from the head holder. Educating the CT
 technologists to position the patient with the head at the maximal cephalad position within the
head holder will help avoid this image artifact.

EE-04
6:30AM - 3:00PM

High-resolution vessel wall MR imaging findings in Varizella-zoster virus vasculitis

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Purpose
Varizella Zoster vasculitis presenting with acute stroke is a rare but known entity. We describe a
case of a patient who presented with acute stroke several months following an episode of herpes
zoster ophthalmicus (HZO), with ipsilateral vascular territory involvement. High resolution
vessel wall MR imaging played an instrumental part in raising suspicion for vasculitis, later
confirmed with cerebrospinal fluid (CSF) positivity for Varizella Zoster virus (VZV).

Materials and Methods
A 69-year-old woman presented with what she described as new left arm tingling and left lower
extremity paresis. Positive findings at admission included a left lower facial droop and left
hemiparesis. Systemic work up for stroke was largely negative including a normal
transesophageal echocardiogram. Upon further interview, patient reported to have HZO 6
months prior to the current admission. Cerebrospinal fluid analysis then was performed and
demonstrated 23 white blood cells with a lymphocytic predominance of 82%, 62 mg/dL protein
and 51 mg/dL glucose. Quantitative VZV PCR from CSF demonstrated 4500 copies/ml.

Results
On initial MRI examination, diffusion-weighted imaging (DWI) demonstrated multifocal
acute/subacute right cerebral infarcts. Time-of-flight MR angiography (MRA) demonstrated
diffuse asymmetric irregularity of the right anterior cerebral artery (ACA) with stenosis
involving the A1 and A2 segments. Focal areas of stenosis also were identified in the distal M1
and proximal M2 segments of the right middle cerebral artery (MCA). Intracranial vessel wall
imaging (VWI) was recommended and performed using a high resolution, 3T, contrast-enhanced
MRI. The arterial wall imaging protocol consisted of pre and postcontrast axial and coronal high
resolution T1-weighted images. Vessel wall imaging demonstrated multifocal narrowing
involving the right ACA and MCA with associated, intense circumferential wall enhancement
(Figure).
Conclusions
With the advent of higher field strength magnets and higher spatial resolution imaging, arterial wall characteristics of thickening and enhancement have been described for intracranial arterial diseases. In this report we have described a case of cerebral infarctions due to VZV vasculitis confirmed with positive CSF analysis. High resolution VWI demonstrated a pattern of vessel wall enhancement compatible with vasculitis. To our knowledge this is the first case of VZV vasculitis studied and characterized with high resolution VWI.

(Filename: TCT_EE-04_Figure.jpg)

**EE-20**

**Imaging findings of Atypical Teratoid/ Rhabdoid tumor in a 11-Year Old boy-Case Report and Literature Review**

H NAKAMURA¹, T Suzuki², M Uchida², M Doi³, M Takagi⁴, Y Tanaka², Y Nakajima²

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**
Atypical teratoid/rhabdoid tumors (AT/RT) are rare aggressive neoplasms occurring in children younger than 5 years of age. Tumor localization is reported most often as infratentorial. We demonstrate an atypical case of supratentorial AT/RT in a 11-year-old boy.

**Materials and Methods**
A 11-year-old boy came to our hospital complaining of mild headache and nausea, which had been continued for a month. On computed tomography (CT), large mass can be seen in the left frontal lobe. Comparing the size, edema is less prominent. Magnetic resonance imaging (MRI) shows solid and cystic mass with hemorrhage. However, we considered the benign tumor because of the mild symptom. The operation was performed. The mass can be removed totally without difficulty. No leptomeningeal spread was seen. The pathological diagnosis proved to be
AT/RT surprisingly. After operation, the whole brain radiation and chemotherapy was performed.

Results
CT and MRI shows a large heterogeneous mass with solid and cystic component in the left frontal lobe. Solid component shows high signal on diffusion-weighted image (DWI) and moderate contrast enhancement on contrast-enhanced (CE) T1-weighted image (WI). On the other hand, cystic component shows low signal on DWI and shows no enhancement on CE T1WI. T2* shows the internal low signal representing hemorrhage. Magnetic resonance spectroscopy shows elevated choline and prominent lactate peak. The differential diagnosis includes pleomorphic xanthoastrocytoma, pilocytic astrocytoma, primitive neuroectodermal tumor, desmoplastic infantile ganglioglioma, anaplastic ependymoma, desmoplastic infantile astrocytoma, supratentorial ependymoma, AT/RT.

Conclusions
As far as we review the literature (1, 2,) the supratentorial lobe is much more common than infratentorial when the patient is older than 5 years of age. In conclusion, AT/RT should be included in the differential diagnosis when we see the supratentorial solid mass of the patient occurring in patients older than 5 years of age. .
Longus Colli Tendinitis: Clinical – Radiological Correlation in Resorptive Phase

S Mathur¹, P Howard², K Higgins², P Jabehdar Maralani²

¹University of Toronto, Toronto, Ontario, ²Sunnybrook Health Sciences Centre, University of Toronto, Toronto, ON
Purpose
Awareness of typical clinical and imaging features of longus colli tendinitis can lead to timely and accurate diagnosis and appropriate management. Our case demonstrates the imaging findings in the symptomatic resorptive phase of this condition with clinical correlation.

Materials and Methods
A 44-year-old male with 1 day history of progressive neck pain, painful movements, odynophagia, hot potato voice. No history of trauma. He had left submandibular space infection requiring incision and drainage more than 20 years ago. On examination there was no fever, palpable neck masses or adenopathy, painful neck and jaw movements. White blood cell (WBC) count was borderline high. Serum electrolyte concentrations were normal. Contrast-enhanced CT (CECT) revealed prevertebral effusion and longus colli calcification. Clinical diagnosis of longus colli tendonitis was made and NSAIDs were started. The symptoms resolved over 5 days. Contrast-enhanced CT performed after 3 days of presentation revealed marked resolution of findings and more fluffy and amorphous longus colli calcification. Four stages of calcific tendinitis have been described, namely formative/precalcific, calcific/resting phase, resorptive and reparative phase. Calcifications are fluffy and amorphous in resorptive phase. Our case demonstrates interval change in morphology of calcifications in the resorptive phase. It is hypothesized that the symptoms of pain and reduced mobility are associated with the resorptive phase. Our case supports this hypothesis and highlights the pathophysiology of this condition.

Results
Contrast-enhanced CT study performed at presentation revealed prevertebral effusion extending from C2 to C6 vertebral level with no abnormal enhancement within or around this lesion. No fat stranding in surrounding soft tissue. Small area of hyperdensity at the level of C1-C2, suggestive of longus colli calcification. Contrast-enhanced CT study performed 3 days after the first study revealed marked interval decrease in size of prevertebral effusion. Longus colli calcification shows interval change in morphology which appear more fluffy and amorphous.

Conclusions
Longus colli tendinitis should be the major diagnostic consideration in a patient who has neck pain, range-of-motion limitation, prevertebral effusion and calcification anterior to C1-C2 on imaging studies. Our case supports the hypothesis that the symptoms of pain and reduced mobility are associated with the resorptive phase of calcific tendonitis by demonstrating short interval change in the morphology of calcifications and highlights the pathophysiology of intratendinous calcific depositions.
Metastasis Mimicking Retinal Hemorrhage in the Setting of Trauma

R Dewan¹, G Lagemann¹

¹University of Pittsburgh Medical Center, Pittsburgh, PA

Purpose
Neuroendocrine tumor metastasis is a rare cause of retinal mass. Imaging features are nonspecific and make diagnosis by imaging difficult. We present a case of a retinal
neuroendocrine tumor metastasis from a thymic carcinoid tumor mimicking a traumatic retinal hemorrhage.

Materials and Methods
A 71-year-old male presented to the emergency department after accidental trauma to the right forehead from a crowbar. Despite imaging findings suggesting a traumatic retinal hemorrhage, the patient had no visual symptoms, and direct ophthalmologic exam showed instead a vascular but nonhemorrhagic mass. Further work up revealed that the patient had widely metastatic thymic carinoid and the lesion was a neuroendocrine metastasis.

Results
Initial noncontrast head CT showed some right facial swelling and a discrete, lentiform, dense, 9 x 5 mm collection along the right posterior retina. MR imaging showed a similar appearing homogenous, T1- and T2-hyperintense mass with no definite enhancement. The collection initially was presumed to represent a traumatic retinal hemorrhage, but clinically the patient had no visual symptoms. Ophthalmologic ultrasound showed a dome-shaped, hyperechoic retinal mass. Positron emission tomography (PET) CT showed the mass to be FDG avid. Direct ophthalmologic visualization showed a well demarcated, nonhemorrhagic, amelanotic mass.

Conclusions
Vascular tumors, including metastatic neuroendocrine tumors, should be included as a possibility when encountering a retinal mass, even in the setting of trauma. Comprising only about 0.5% of all malignancies, carcinoid tumor is an uncommon neoplasm arising from enterochromafin cells within the gastrointestinal tract and bronchial tree. There are currently only a handful of reports regarding orbital metastasis within the radiology and ophthalmology literature. However, as treatment options improve and survival increases, new metastatic patterns have emerged, and orbital metastases can be expected to become more common.
Neuroimaging Findings of Unilateral Temporomandibular Joint Monoarthritis caused by CPPD Crystal Deposition Disease

U Tariq¹, E Wun¹, J Smith¹, W Millar¹

¹Geisinger Health System, Danville, PA

Purpose
To describe the clinical presentation and neuroimaging findings of a rare and unusual case of unilateral temporomandibular joint (TMJ) arthritis due to calcium pyrophosphate dihydrate (CPPD) crystal deposition disease.

Materials and Methods
We present the case of a 66-year-old diabetic and hypertensive female who presented to our institution for evaluation of severe chronic intermittent pain in left TMJ for multiple years, worse with chewing and jaw activity. Physical examination of bilateral TMJ and other joints was
unremarkable. The relevant blood work was unremarkable. Findings of the computed tomography (CT) scan of the head are mentioned below. Recommended plain films of the bilateral hand and knees were negative. Subsequently, patient underwent surgical resection and excisional biopsy of left TMJ mass, condylectomy, and diskectomy. The mass mimicked tophaceous gout intra-operatively. Pathology confirmed it to be CPPD crystal deposition disease of left TMJ mass, condyle and articular disk. Postoperatively patient did well and the left TMJ pain was resolved.

Results
CT scan of the head obtained at the time of presentation showed a calcified lesion around left TMJ extending posteriorly to external acoustic meatus, and superiorly to skull base. There were superimposed degenerative/erosive changes at the left mandibular condyle and along the medial margin of the mandibular fossa. CPPD crystal deposition disease was suggested as a probable diagnosis. Right TMJ was unremarkable (not shown). Subsequent, magnetic resonance imaging (MRI) confirmed the CT findings.

Conclusions
We describe the clinical and neuroimaging profile of unilateral monoarthritis of TMJ caused by CPPD crystal deposition disease. Early identification of this finding may orient clinicians in timely diagnosis and treatment.
Odontogenic Sinusitis

J Musco¹, D Raghu¹
¹Harry S Truman Memorial Veterans' Hospital, Columbia, MO

Purpose
Discuss a relatively common yet often overlooked cause of recalcitrant/chronic maxillary sinusitis.

Materials and Methods
A 30-year-old male with chronic left sided sinus congestion and pain for the past 1.5 years. Antibiotics were prescribed by the patient's PCP, this resulted in little if any improvement in the patient's symptoms. Plain radiographs of the sinuses then were obtained and demonstrated opacification of the left maxillary and sphenoid sinuses. Nasal steroids and second course antibiotics again provided minimal temporary improvement in the patient's symptoms. A noncontrast CT of the sinuses was obtained 3 months after the initial radiographs with redemonstration of left sided sinus disease along with a unilocular low attenuating cystic lesion with sclerotic rim extending to the roots of the left maxillary third molar (tooth #16) with thinning and erosion of the inferior posterolateral walls of the left maxillary sinus. Findings were most consistent with odontogenic sinusitis secondary to a radicular cyst. Dentistry consult with comprehensive oral exam revealed dental caries involving teeth #7 and #16, tooth #16 also was noted to be moderately percussive positive. Dentistry consult note also states that patient recently experienced a mild amount of drainage around tooth #16 x 2 days. Tooth #16 subsequently was extracted. At the 1 month follow-up exam the patient's left sided sinus congestion and pain had resolved completely. A follow-up noncontrast CT of the sinuses demonstrates uncomplicated removal of tooth #16 and radicular cyst with resolution of sinus disease.

Results
Plain films of the sinuses: Complete opacification of the left maxillary and frontal sinuses. Initial noncontrast CT sinuses: Complete opacification of the left maxillary, sphenoid, and frontal sinuses along with partial opacification of the left ethmoid air cells. A unilocular low attenuating cystic lesion with sclerotic rim extending to the roots of the left maxillary third molar (tooth #16) with thinning and erosion of the inferior posterolateral walls of the left maxillary sinus. Findings were most consistent with odontogenic sinusitis secondary to a radicular cyst at the apex of tooth #16. Postextraction noncontrast CT sinuses: Uncomplicated interval extraction tooth #16 with resolution of left sided sinusitis.

Conclusions
Odontogenic sinusitis is a well recognized condition and accounts for approximately 10% to 12% of cases of maxillary sinusitis. An odontogenic source should be considered in patients with symptoms of maxillary sinusitis who are resistant to standard therapy. A few focused questions regarding dentition and a brief oral exam can help the primary care hone in on this diagnosis, thus reducing the use of unnecessary antibiotics and steroids and treatment delays. As radiologists we should consider including odontogenic sinusitis in our differential diagnosis.
when appropriate to remind our clinical colleagues of this often overlooked condition that can result in recalcitrant/chronic sinusitis.
Radiologic features of leontiasis ossea

M Dogar

King Faisal Specialist Hospital and Research center, Riyadh, Saudi Arabia

Purpose
To discuss characteristic radiologic features of leontiasis ossea.

Materials and Methods
We present case report of two patients (12-year-old girl and 29-year-old male) presenting with jaw masses. Both of these patients had known diagnosis of renal failure and they were on hemodialysis. They presented at King Faisal Specialist Hospital and Research Center Riyadh with gradual onset of mass lesion involving mandible.

Results
Facial skeletal changes associated with hyperparathyroidism are encountered infrequently and assume radiographic patterns. The classic form is termed "osteitis fibrosa cystica" and presents with a combination of increased bone cell activity, peritrabecular fibrosis, and cystic brown tumors. Radiographically, this appears as a constellation of cortical thinning of multiple bones, coarsened trabecular patterns, osteolytic lesions, and "salt-and-pepper" appearance of the skull, which is the result of mixed osteolytic and sclerotic bone. The second form resembles fibrous dysplasia, with a classic ground-glass pattern on both conventional films and CT. Unlike true fibrous dysplasia, these findings can be diffuse and generalized, with poor corticomedullary distinction, an imaging finding not present in fibrous dysplasia. The third and the rarest form is uremic leontiasis ossea (1). In our patients CT scan was obtained which shows mass-like lesions in mandible and maxilla. These lesions in both patients have peculiar pattern of serpentine channels or leopard skin appearance. Other features of renal osteodystrophy including diffuse calvarial thickening and subchondral resorption also were present. Ultrasound examination showed enlarged parathyroid glands in both of them.

Conclusions
Leontiasis ossea is a rare disorder but has characteristic imaging findings. Familiarity with these findings can help in diagnosis and avoid unnecessary biopsy and further work up.
Review of Neck CT Studies Without CNS Windows Can Miss Crucial Spinal Cord Findings

J Murnick
Children’s National Medical Center, Washington, DC

Purpose
CT examinations of the neck typically are reviewed in bone windows and soft tissue windows. Bone windows (width ~2000 HU) optimize contrast between bone and soft tissues. Soft tissue windows (width ~400 HU) are designed to optimize contrast between fat and other soft tissues. It is less common to review these exams in central nervous system (CNS) windows (width ~150 HU), which optimize contrast between cerebrospinal fluid (CSF) and neural tissue and are used more commonly when reviewing CT exams of the brain. This presentation describes cases of three children with CT studies of the face or neck. Each patient has important findings in the spinal canal, which are difficult or impossible to see using the usual neck soft tissue or bone windows, but are readily apparent with CNS windows. In all of the cases, the spinal cord findings are the cause of the patient's presenting symptoms. In all three cases, these important findings were missed on initial review, and in two of the three cases, diagnosis was delayed by 5-7 days until further imaging studies were performed. One of the cases also illustrates an unusual cause of trismus: Chiari malformation with syringobulbia.

Materials and Methods
Three cases are presented: 1) An 8-year-old girl with neck pain after a fall at gymnastics practice. CT of the cervical spine was performed and reported as no evidence of fracture. Diagnosis: Glioblastoma of the cervical spine. 2) An 18-month-old girl with neck stiffness and sore throat. CT of the neck was performed and initially reported as no retropharyngeal abscess. Diagnosis: Spinal epidural hematoma. 3) A 3-year-old boy presented with trismus. CT of the face was performed and reported as minimal periosteal reaction at the right temporomandibular joint. Diagnosis: Chiari I malformation, with associated syringomyelia and syringobulbia.

Results
Patient 3's images are pictured, showing the CT in soft tissue windows and CNS windows. Since the CT was not reviewed in CNS windows, the spinal cord findings were missed. The diagnosis was made 7 days later by MRI, when the patient was admitted to the hospital for malnutrition due to prolonged trismus.

Conclusions
It is important to review CT studies of the neck with CNS windows, narrower than the usual soft tissue windows, and optimized for CSF/neural tissue contrast. Otherwise, important spinal cord and canal findings can be missed. Additionally, Chiari I malformation can present unusually with syringobulbia and trismus.
The “Guitar pick” Sign: An Expanding Repertoire of Orbital Pathology

V Dam1, J Stein1, S Mohan1

1Hospital of the University of Pennsylvania, Philadelphia, PA

Purpose

Posterior globe tenting, referred to as the "guitar pick" sign, has been associated with acute, sometimes permanent, visual impairment. While prior reports have described this finding in the setting of ocular trauma and other acute inflammatory pathologies, little has been reported in the setting of progressive infiltrating neoplasm. Furthermore, previous reports have described this
finding on CT and more recently on ultrasound, but it has not been described on MR. We report a case of posterior orbital tenting in the setting of progressive neoplasm resulting in acute visual compromise.

Materials and Methods
A 61-year-old man with locally advanced sinonasal adenoid cystic carcinoma and resultant left eye blindness presented to outpatient clinic with acute right eye blindness for 12 hours. The patient was transferred to the emergency department in which an unenhanced maxillofacial CT, followed by an MRI, was obtained. Based on the imaging findings, the patient was admitted and given a course of high dose corticosteroids as well as targeted radiation. Right eye vision returned after treatment and imaging evaluation 1 month later demonstrated improved left, and resolution of right, posterior orbital tenting.

Results
Axial maxillofacial CT (a) and orbital MRI (b) performed 1 day apart demonstrate extensive infiltrating neoplasm involving the sinonasal cavity with resultant bilateral "guitar pick" signs, left greater than right, due to circumferential orbital involvement (c). Follow-up MRI after treatment demonstrates resolution of the right orbital tenting and decreased extent of infiltrating skull base tumor (d).

Conclusions
In addition to prior reports, the guitar pick sign can be seen with infiltrative neoplasms on both CT and MR imaging modalities and corresponds to acute visual impairment. Prompt medical intervention is essential and can prevent permanent visual damage.
EE-09

6:30AM - 3:00PM

Traumatic Thrombosis of Posterior Condylar Vein with Extension to Internal Jugular Vein

S Nabavizadeh¹, A Bress¹, B Pukenas²

¹University of Pennsylvania, Philadelphia, PA, ²Hospital of the University of Pennsylvania, Philadelphia, PA
Purpose
The posterior condylar canal is located posterior to the occipital condyle and transmits the posterior condylar vein which is one of the largest emissary veins in the retromastoid region. We report a patient with an occipital bone fracture coursing through the posterior condylar canal causing thrombosis of posterior condylar vein with extension to internal jugular vein.

Materials and Methods
A 50-year-old patient was brought to the emergency department following a fall from 15 steps.

Results
Initial head CT scan demonstrated a linear occipital bone fracture extending to the posterior condylar vein on the right side. There was no extension of fracture line to the major dural venous sinuses. Subsequent CT venography demonstrated thrombosis of right posterior condylar vein with extension to upper aspect of right internal jugular vein causing nonocclusive thrombosis. Patient was managed conservatively with no evidence of hemorrhagic infarction or clot extension on follow-up imaging.

Conclusions
The role of traumatic close head injuries as an important etiology of cerebral venous sinus thrombosis has been demonstrated in multiple studies. In these studies, the criteria for performing CTV was extension of skull fracture line to the major dural venous sinuses including superior sagittal sinus, transverse sinus, sigmoid sinus, or jugular bulb, and to the best of our knowledge traumatic thrombosis of posterior condylar vein with subsequent extension to major venous sinuses has not been reported yet in English literature. Increase awareness of radiologists to this anatomical structure and routine CT venograms for concerning skull fractures is important for appropriate diagnosis.
Dysembryoplastic neuroepithelial tumor (DNET) is a WHO grade 1, benign, cortically based brain neoplasm. This pathologically distinct tumor is most common in the pediatric age group, and most commonly presents clinically as drug-resistant seizures. Anatomically, DNETs most commonly present as "bubbly" intracortical masses, typically arising from the temporal lobe. We present here a case of DNET with an uncommon clinical presentation, in an uncommon location, with a very specific imaging finding; the T2 FLAIR hyperintense ring sign.

Purpose
Dysembryoplastic neuroepithelial tumor (DNET) is a WHO grade 1, benign, cortically based brain neoplasm. This pathologically distinct tumor is most common in the pediatric age group, and most commonly presents clinically as drug-resistant seizures. Anatomically, DNETs most commonly present as "bubbly" intracortical masses, typically arising from the temporal lobe. We present here a case of DNET with an uncommon clinical presentation, in an uncommon location, with a very specific imaging finding; the T2 FLAIR hyperintense ring sign.

Materials and Methods
We report a case of a 26-year-old female with a history of thalassemia and chronic migraines that presents with chronic headaches that had worsened in the preceding 2 weeks. She described the
headaches as severe, bifrontal, and worse when rising in the morning or lying supine. She had some relief with the use of Topamax. An MRI brain was performed, demonstrating a well circumscribed cystic lesion at the Foramen of Monroe with obstructive hydrocephalus. She subsequently was taken to the operating room for resection of a presumed colloid cyst. Grossly, the lesion was cystic with a thin fibrous capsule. Surgical pathology revealed the lesion to be a DNET.

Results
Pre-operative imaging work up consisted of an MR brain. This demonstrated a well circumscribed, T1 hypointense/T2 hyperintense, nonenhancing mass arising from the medial wall of the lateral ventricle adjacent to the foramen of Monroe. Additionally, the lesion had a thin T2 FLAIR hyperintense rim. Ventriculomegaly with transependymal CSF resportion also were noted.

Conclusions
Dysembryoplastic neuroepithelial tumor represents a potentially recurring, benign neoplasm that frequently causes drug resistant epilepsy in children and young adults. Many of the classic imaging findings associated with DNETs are nonspecific. The T2 FLAIR hyperintense rim sign, is a fairly specific MR finding that can help narrow the differential diagnosis, and help monitor for recurrence following resection.
Purpose
Demonstration of Woodhouse Sakati syndrome (WSS) with MRI findings in an adult female. Woodhouse Sakati syndrome is an uncommon inherited condition which results in extrapyramidal symptoms, alopecia, mild deafness, intellectual disabilities and hypogonadism.

Materials and Methods
We submit a case of a 38-year-old female from the Middle East who had a normal birth and development, but at the age of 13, started developing muscle weakness with dystonia. She subsequently experienced a progressive decline in health: she never developed any secondary sexual characteristics, nor reached menarche. Later, she experienced difficulty opening her mouth, markedly impaired verbal communication, and developed alopecia and hearing impairment. Family history revealed four of her seven siblings, male and female, had similar symptoms. All children were the product of a consanguineous marriage (first cousins). MR imaging findings are detailed below. The genetic test for Woodhouse Sakati syndrome was positive (DCAF17 mutation).

Results
MR imaging demonstrated innumerable areas of T2 hyperintensity within the subcortical and deep white matter of both cerebral hemispheres; this had progressed since an MRI 8 years prior. There was marked low susceptibility signal within both globi pallidi and the pars reticulata of both substantia nigra, which was compatible with brain iron accumulation.

Conclusions
Previously reported MRI findings have ranged from normal to patchy and confluent periventricular white matter abnormalities and centrum semiovale signal intensities on T2 images suggesting iron accumulation to pituitary abnormalities. To our knowledge, none has shown findings consistent with iron accumulation on susceptibility-weighted images (SWI). Moreover, reportedly normal cases previously did not include SWI. Radiologists should consider the use of SWI when WSS is suspected as imaging findings can help prompt genetic testing in the appropriate clinical scenario.
Michel, M.
Medical College Of Wisconsin/Froedtert Hosp.
Milwaukee, WI

01A-2
7:50AM - 8:10AM
Skull Base Post-Traumatic and Iatrogenic Vascular Lesions
Tampieri, D.
Montreal Neurological Hospital and Institute
Montreal, Quebec

01A-3
8:10AM - 8:30AM
Trauma
Baugnon, K.
Emory University School of Medicine
Atlanta, GA

Monday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

02A - KEYNOTE SYMPOSIUM: GETTING PERSONAL......
02A-1
8:30AM - 9:00AM
Patient Safety, Quality and Transparency
Daley Ullem, B.
Governance Expert - Quality and Safety First
-, CA

02A-2
9:00AM - 9:30AM
Comeback: Psychological and Sensory Consequences of Head & Neck Tumors
Achatz, C.
Head & Neck Cancer Survivor, American Chef and Restaurateur
Chicago, IL
Contemporary Management of Sports Concussion: Emerging Themes

Bailes, J.
NorthShore Medical Group
Evanston, IL

Monday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

03A - ASHNR: EMERGING TECHNOLOGIES IN HEAD AND NECK NEOPLASIA

03A-1

3.0 Tesla Imaging in Head and Neck Neoplasia

Casselman, J.
AZ St. Jan Brugge AV
Brugge

03A-2

Applications for Dual Energy CT in Head and Neck Cancer: Best Practices

Forghani, R.
Jewish General Hosp & McGill Univ
Montreal, QC

03A-3


Som, P.
Ichan School of Medicine at Mount Sinai
New York, NY

03A-4

11:30AM - 12:00PM
Diffusion Imaging in Treated Head and Neck Cancer

Becker, M.
Geneva University Hospital
Geneva

Monday
10:30AM - 12:05PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)

03B - ASPNR: CEREBELLUM SMALL BRAIN, BIG CONFUSION

03B-1
10:30AM - 10:50AM

Dysmetria of Thought: Anatomical Substrates and Functional Implications in Children

Schmahmann, J.
Massachusetts General Hospital
Boston, MA

03B-2
10:50AM - 11:10AM

Joubert Syndrome: From the Molar Tooth to Primary Cilia and Axonal Guidance

Poretti, A.
Johns Hopkins University School of Medicine
Baltimore, MD

03B-3
11:10AM - 11:25AM

Building Relationships

Mack, S.
The Chicago School of Professional Psychology
Grayslake, IL

03B-4
11:25AM - 11:45AM

Chiari I Revisited: Neuroimaging, Pathogenesis, and Management

Raybaud, C.
Hospital for Sick Children
Toronto, ON
03B-5  
11:45AM - 12:05PM  
Cerebellar Atrophy in Children: A Pattern-Recognition Approach for Daily Practice  
Blaser, S.  
The Hospital for Sick Children  
TORONTO, Ontario

Monday  
10:30AM - 12:00PM  
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

03C - YOUNG PROFESSIONAL I: CAREER CHOICES AND PROFESSIONAL DEVELOPMENT

03C-1  
10:30AM - 10:45AM  
Benefits of Academic Practice  
Chokshi, F.  
Emory University School of Medicine  
Marietta, GA

03C-2  
10:45AM - 11:00AM  
Benefits of Private Practice  
Saket, R.  
Santa Clara, CA

03C-3  
11:00AM - 11:15AM  
Patient Perspectives of the Radiologist: How We are Seen  
Cantwell, G.  
GBM Survivor & Inspirational Speaker, Founder & President of Greg's Mission, 1-1 Brain Tumor Support  
Coralville, IA
Radiologist Employment Models
Bradley, W.
University of California San Diego
San Diego, CA

03C-5
Negotiating Radiology Employment Contracts
Barr, R.
Mecklenburg Radiology Associates, P.A.
Charlotte, NC

03C-6
Discussion

Monday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)

03D - NEUROMODULATION AND NEUROPSYCHIATRIC DISEASE: DEEP BRAIN STIMULATION (DBS)
03D-1
Imaging for DBS: What the Neuroradiologist Needs to Know
Jones, S.
Cleveland Clinic
Cleveland, OH

03D-2
Update on Subcallosal cingulate DBS for Treatment Resistant Depression

11:15AM - 11:30AM
11:45AM - 12:00PM
12:00PM - 12:15PM
10:30AM - 10:55AM
10:55AM - 11:15AM
Riva-Posse, P.
Emory University
Atlanta, GA

03D-3

DBS for Neurological and Neuropsychiatric Disorders

Abosch, A.
University of Colorado School of Medicine
Aurora, CO

03D-4

Tractography and DBS: Pushing the Imaging Envelope to Predict Individual Response

McIntyre, C.
Case Western Reserve University School of Medicine
Cleveland, OH

Monday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

03E - PARALLEL SCIENTIFIC PAPER SESSION-BRAIN TUMOR IMAGING TECHNIQUES
O-01

Fully Automated Quantitative Scoring of VASARI Glioma Imaging Features Demonstrates High Interobserver Agreement with Expert Neuroradiologists

P Chang1, D Chow1, C Filippi1, K Cauley1, A Lignelli1
1Columbia University Medical Center, New York, NY

Purpose
Emerging techniques in quantitative neuroimaging require accurate and reproducible extraction of image features (1, 2). Within neuro-oncology, the Visually Accessible Rembrant Images (VASARI) feature set provides a standard for objective description. Widespread use however is limited by reader subjectivity and expertise (3). Thus the aim of this study is to assess the accuracy of a novel computer algorithm to automatically quantify VASARI scores in gliomas.

Materials and Methods
A total of thirty-one glioma subjects were identified from The Cancer Imaging Archive (TCIA). Three neuroradiologists scored each tumor for the following VASARI features: side of epicenter;
enhancement quality; enhancing margin thickness; volume of enhancement, nonenhancement, necrosis, and edema. These imaging features then were extracted by a fully automated computer algorithm (Figure 1). Briefly, the algorithm delineates normal anatomy by combining level set edge-based detection with content-based intensity and texture patterns. Subsequently, tumor seeds are identified by symmetry and location, which then are propagated using a region growing method with clustering constraints. Strict registration of imaging data between modalities was performed using a linear transform model. Pearson correlation coefficients (r) were calculated between each reader and the mean of the remaining two readers. Correlation coefficients also were calculated between the automated score and the mean score of all three readers. Fisher z-transformations between automated and mean reader correlations were obtained, with p-value <0.05 considered statistically significant.

Results
No significant difference was observed between correlation coefficients of the automated algorithm (r = 0.82-0.90) and readers (r = 0.75-0.97) for all imaging features except lesion size (p >0.05; table 1). The automated algorithm (r = 0.94-0.97) demonstrated significantly higher correlation coefficients than readers (r = 0.66-0.85) for lesion size characteristics (p <0.005).

Conclusions
There is high interobserver agreement in glioma VASARI scoring between the fully automated algorithm and expert neuroradiologists. This novel approach allows for quick and reproducible scoring, facilitating widespread adoption of quantitative imaging techniques in the clinical setting.
**Figure 1.** Fully Automated Segmentation and VASARI Feature Extraction: FLAIR edema (left) and contrast enhancing tumor/necrotic core (right)

![Image of brain scans](image)

**Table 1.** Interobserver agreement of VASARI tumor scoring

<table>
<thead>
<tr>
<th>VASARI Characteristic</th>
<th>Traditional review</th>
<th>Automated*</th>
<th>z-score</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side of epicenter (f2)</td>
<td>0.97</td>
<td>0.93</td>
<td>0.91</td>
<td>0.88</td>
</tr>
<tr>
<td>Enhancement quality (f4)</td>
<td>0.92</td>
<td>0.95</td>
<td>0.91</td>
<td>0.90</td>
</tr>
<tr>
<td>Proportion enhancing (f5)</td>
<td>0.89</td>
<td>0.86</td>
<td>0.91</td>
<td>0.84</td>
</tr>
<tr>
<td>Proportion nCET (f6)</td>
<td>0.85</td>
<td>0.92</td>
<td>0.92</td>
<td>0.87</td>
</tr>
<tr>
<td>Proportion necrosis (f7)</td>
<td>0.88</td>
<td>0.94</td>
<td>0.88</td>
<td>0.83</td>
</tr>
<tr>
<td>Thickness of enhancing margin (f11)</td>
<td>0.83</td>
<td>0.91</td>
<td>0.91</td>
<td>0.83</td>
</tr>
<tr>
<td>Proportion of edema (f14)</td>
<td>0.75</td>
<td>0.89</td>
<td>0.79</td>
<td>0.82</td>
</tr>
<tr>
<td>Size, long axis (f29)</td>
<td>0.75</td>
<td>0.85</td>
<td>0.66</td>
<td>0.94</td>
</tr>
<tr>
<td>Size, short axis (f30)</td>
<td>0.75</td>
<td>0.80</td>
<td>0.75</td>
<td>0.97</td>
</tr>
</tbody>
</table>

*Pearson correlation coefficient calculated between the automated score and the mean score of all three readers

*p-value for Fisher z-transformations between automated and mean reader correlations
Texture analysis for assessing of Glioblastoma heterogeneity

A Chaddad¹, M Luedi², P Zinn³, R Colen³
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Purpose
To determine glioblastoma (GBM) heterogeneity using across three phenotypes namely, necrosis (vN), active tumor/contrast enhancement (vAT) and edema/Invasion (vE), quantified using 528 texture features which extract spatial information from magnetic resonance (MR) imaging.

Materials and Methods
Texture analytics were applied on 22 GBM patients data which were obtained from the cancer genome atlas (TCGA) once institutional review board approval. Utilizing T1-weighted (T1-WI) and its corresponding fluid attenuated inversion recovery (FLAIR) by 3D Slicer tool, we rigidly registered images and segmented GBM phenotypes. A total of 528 texture features were extracted from each of GBM phenotypes. Feature selection was performed using decision structure model where the dominant feature can show in the trees. Then, nearest neighbors classifier was used to discriminate between GBM phenotypes, and leave one out cross-validation evaluated our classifier features by measuring the accuracy, sensitivity, specificity and negative predictive value (NPV) of phenotype discrimination.

Results
Texture analysis using the 528 features for phenotype discrimination showed an accuracy of over 70.93%, depending on the features selected. Haralick-based feature demonstrated highly feasible to enhance the GBM phenotypes discrimination based on selection feature (e.g., Figure).

Conclusions
Texture analysis of GBM has the potential to provide important information about GBM heterogeneity and phenotype.
Exploratory decision tree grown using Haralick feature in three groups, feature selection based on GLCM using four directions, and one pixel offset (a), two pixels offset (b), and three pixels offset (c). Features selection are the correlation, sum-average, sum-entropy, cluster shade, cluster prominence and sum-variance.

(O-03)

Validation of Intraoperative Real-Time Atlas-Based Stereotactic Neurosurgery near Eloquent Motor Areas during Tumor Resection

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Purpose
Tumor resection in eloquent areas necessitates cortical and subcortical direct electrical stimulation (DES) to reduce morbidity. We validate a brain atlas, deformable anatomic templates (DAT) for prediction of eloquent structure location for guiding DES.

Materials and Methods
In seven patients with tumor adjacent to eloquent motor areas, neuronavigation images were aligned with the DAT for intra-operative navigation. During navigation, the DES probe is tracked by the DAT system and produces calculated proximity distances (mm) to eloquent structures of interest. The DES probe's predicted proximity to eloquent motor areas during tumor resection was correlated to the electrical amplitude (mA) used for electrophysiological stimulation and the patients' diffusion tensor imaging (DTI) tractography.

Results
A DAT was connected to the neuronavigation system and used to record locations of positive
and negative DES. There were three astrocytomas, one infiltrating glioma, one glioblastoma, one ependymoma, and one oligodendroglioma. Two cases had moderate vasogenic edema (VE), one had mild VE, and four had no VE. Six patients were awake. Patients were stimulated 123 times for data collection. In terms of expected ranges stimulation ranges, DTI and DAT agreed on positive stimulation 87.1% of the time (N=101). For cases where stimulation failed, Deformable anatomic templates and DTI correctly predicted stimulation failure 72.7% and 45.4% of the time, respectively (N=22). Deformable anatomic templates and DTI agreed with each other 72.7% of the time during failure (N=22).

Conclusions
Using the DAT alongside DTI and DES adds additional information for a surgeon during tumor resection near eloquent brain areas. The DAT can predict successfully when stimulation is possible with high confidence compared to DTI. The DAT additionally can predict negative stimulation much more accurately than DTI. With this added information, surgeons can reduce morbidity during craniotomies.

O-04 10:54AM - 11:02AM
Multi-band Multi-echo EPI (M2-EPI) for Dynamic Susceptibility Contrast (DSC) Perfusion Imaging: A Feasibility Study

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Purpose
Dynamic susceptibility contrast (DSC) imaging with bolus injection of contrast injection provides important cerebral perfusion measures in the assessment of brain tumors and treatment triage of acute stroke patients (1), such as cerebral blood flow (CBF), cerebral blood volume (CBV), time to peak (Tmax). Conventional single-band single-echo EPI is limited in its sensitivity to contrast agent leakage due to breakdown of blood-brain barrier (BBB) (2), and limited slice coverage for scans with sub-second temporal resolution. In this paper, we developed a novel multi-band multi-echo EPI (M2-EPI) that could overcome these limitations. The feasibility of this sequence in DSC perfusion imaging was studied in a phantom and patients with both 12-channel and 32-channel head coils.

Materials and Methods
The M2-EPI sequence was developed on the Siemens IDEA pulse sequence development platform, and scans were performed at 3T (Tim Trio VB17, Siemens Healthcare, Erlangen). Multiband excitation pulse was implemented by modulating sinc function with exponential function. This was followed by multiple repetitions of EPI readout trains. Blipped-CAIPI was implemented to create slices shifts to minimize the multiband g-factor (3). The following parameter was used for all the scans: TR=800ms, TE=18/41/65ms, FOV=240mm, Matrix = 100x100, Slice thickness/gap = 4/1mm, multiband-factor = 3, GRAPPA factor = 3. For scans with 32-channel coil, CAIPI slice shift was 1/6 of the FOV; and a slice shift of 1/9 FOV was used for the scan with 12-channel coil since there is only very little variation of coil sensitivity in B0 direction of this coil.

Results
Both phantom and patient scans were performed with a 12-channel and a 32-channel head coil.
Figure 1A shows images from a patient with bolus injection of Multihance at 4ml/s scanned with 32-channel head coil, and the other patient scanned with 12-channel head coil injected at 4ml/s of Multihance. No obvious image aliasing can be observed with images acquired with 32-channel while images acquired with 12-channel head coil showed degenerated images quality with significant image aliasing. For patient scan with 32-channel, CBF maps can be generated successfully with no obvious artifacts (Figure 1B).

Conclusions

A multi-band multi-echo EPI (M2-EPI) is developed successfully that achieves a total of nine factor of acceleration (3 for in-plane and 3 for slice direction). The sequence performs the best with the use of a 32-channel coil with respect to a 12-channel coil. The sequence provides high temporal resolution of 800 ms with whole brain coverage. The high temporal resolution could improve the accuracy of DSC perfusion quantification, while the multiple echoes could allow more accurate quantification of perfusion parameters in the case of BBB breakdown and capacity for permeability quantification. Further study is underway to evaluate the advantage of this method in patients with neurological diseases including brain tumors.
Comparison of DCE Permeability and DSC Perfusion MRI Parametric Values in High Grade Glioma

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¹Hospital of University of Pennsylvania, Philadelphia, PA, ²University of Pennsylvania, Philadelphia, PA

Purpose
The purpose of our study was to compare hemodynamic parameters generated from dynamic contrast-enhanced (DCE) and dynamic susceptibility contrast (DSC) MRI acquisitions in patients with glioblastomas. We hypothesized that high correlation of one or more DCE parameters with rCBV derived from the DSC acquisition would permit the use of the DCE sequence alone, at a much higher resolution.

Materials and Methods
MR imaging studies were performed prior to surgery in nine glioblastoma patients (4 females, 5 males; age 53-78 years). Dynamic contrast-enhanced and DSC datasets were postprocessed using the same commercial software (nordicICE, version 2.3.14). Ktrans, Vp, Ve, Kep, rAUC (ratio of AUC in the tumor to contralateral white matter) were generated using DCE data and rCBV (ratio of CBV in tumor to contralateral white matter) from DSC data. Four regions of interest (ROIs) were drawn in the area of maximum visible Ktrans map for quantitative analysis, as well as Gd-DTPA enhanced T1-weighted images to avoid vessels and cystic or necrotic components. The ROI with maximum Ktrans value was identified and corresponding Vp, Ve, Kep, rAUC and rCBV values were recorded from the same ROI. Pearson correlation was calculated between rCBV and each DCE-MRI metric.

Results
Mean ± standard deviations for each parameter were as follows: Ktrans= 0.5 ± 0.3 minute⁻¹, Vp=22.2 ± 24.2, Ve = 37.5 ± 37.9, Kep=1.6 ± 1.8 minute⁻¹, rAUC = 22.5 ± 21.4 and rCBV = 5.1 ± 2.8. The correlation coefficients between rCBV and Ktrans, Vp, Ve, Kep, rAUC were 0.26, 0.05, 0.06, 0.33 and 0.73, respectively.

Conclusions
Of the various DCE and DSC metrics, maximum correlation was found between rCBV and rAUC. Though the results are preliminary with limited dataset, acquisition of only rAUC using DCE- MR perfusion might provide sufficient clinical information.
Purpose
It is important to capture as much physiologic information as possible when imaging brain tumors. Current clinical practice forces most physicians to choose between perfusion or permeability. In this case a full dose of contrast is used for either measurement while not collecting the other. Alternatively, one could use a partial dose for each measurement but this compromises each measurement. Here we introduce a method to collect both physiologic measures with a single full dose of contrast.

Materials and Methods
Data were collected on a Siemens Verio 3T scanner with a standard head coil and a Medrad power injector. A routine dose of contrast (0.1 mM/kg of Magnevist) was injected at 4mL/s followed by a 20ml saline flush at the same rate. Five 3D volumes with varying flip angles (3, 7, 10, 15, 20) were acquired at baseline to map the T1 for input in the Toft's model to determine permeability parameters as well as steady precontrast data. A typical dynamic susceptibility contrast (DSC) perfusion measurement was started and the signal in the brain was monitored in real time. Once the contrast bolus washed through the brain, the scanner was switched to the dynamic contrast-enhanced (DCE) 3D T1-weighted volume acquisition and run for 8 minutes.

Results
Figure 1 shows the time course data scaled so that they are visible on the same plot. Note that both the DSC and the DCE curves are captured completely to allow full analysis of both datasets using whatever software required.

Conclusions
Using the real time switching from DSC to DCE allows one to capture the full physiologic status of the brain lesion. Furthermore, having the rapid sampled perfusion measurement provides a patient specific arterial input function that can be used to improve the DCE model. This methodology would improve diagnosis, staging and treatment monitoring in brain tumors.
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\textsuperscript{1}New York-Presbyterian Hospital - Weill Cornell Medical College, New York, NY, \textsuperscript{2}Weill Cornell Medical College, New York, NY

Purpose
Permeability surface area product (PS) has been suggested as a marker for blood-brain barrier (BBB) permeability with many potential applications in clinical research as well as clinical care, however few studies have demonstrated the correlation of PS with actual BBB permeability. Our aim was to demonstrate increased permeability surface area product in a murine model with known alteration in BBB permeability.

Materials and Methods
Coronal MR imaging was performed on mice treated with mannitol (n=6) for disruption of the BBB and controls treated with saline (n=5) (1). Permeability surface area product was determined by standardized region of interest (ROI) placement and analyzed by vascular territory. Permeability surface area product was compared between saline- and mannitol-treated mice and correlated with contrast enhancement curves and immunohistologic stained sections of tripeptidyl peptidase-1 (TTP1) distribution in mice treated with mannitol or saline followed by injection of a viral vector containing the CLN2 gene, known to direct production of the enzyme TPP1.

Results
Significantly increased PS was seen in mannitol-treated mice compared to controls in the whole brain (P=0.020), MCA (P = 0.015) and mixed vascular territories (P = 0.027). These findings were correlated qualitatively with immunohistologic stained sections of TPP1 demonstrating BBB permeability to a large vector and contrast enhancement curves demonstrating BBB permeability to gadolinium.

Conclusions
Permeability surface area product is increased in situations with known disruptions of the BBB, as evidenced by large vector passage through the BBB and concordance with contrast enhancement curves, demonstrating its use as a potential biomarker for BBB permeability. Further investigations are warranted to demonstrate the correlation of PS with BBB permeability in human studies.
Role of Radial-VIBE with GRASP in Identifying the Normal Pituitary Gland from Macroadenoma: Surgical Implications

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Purpose
Trans-sphenoidal approach is the mainstay for surgical resection of macroadenoma. The neurosurgeon based on direct visualization identifies the normal pituitary gland and leaves it behind at the time of surgery, excising as much of the macroadenoma as possible. So far, imaging has not explored the potential of distinguishing the normal pituitary gland from macroadenoma. Radial-VIBE with GRASP (Golden-angle Radial Sparse Parallel MRI) allows
excellent dynamic evaluation of the pituitary gland. The purpose of our study was to assess permeability characteristics of the normal pituitary gland, and evaluate those to distinguish it from a macroadenoma.

Materials and Methods

We retrospectively reviewed nine cases of macroadenoma. All nine cases were assessed utilizing the GRASP technique. A 20-channel head/neck coil was used on a 3T Siemens Trio system. Imaging protocol included a coronal GRASP acquisition (repetition time/echo time, 6.4/2.4 milliseconds; in-plane resolution, 0.7 mm; slice thickness, 0.8 mm; 32 slices; field of view, 180 mm; flip angle 9.5 degrees; bandwidth, 391 Hz/pixel; pixel base resolution, 256; 944 spokes; acquisition time, 180 sec). Subsequently postprocessing was performed to evaluate the permeability characteristics of the normal pituitary gland and the macroadenoma. Paired-sample Wilcoxon (W) signed rank test was utilized to evaluate for any differences in their permeability characteristics. Based on these permeability characteristics, the location of the normal pituitary gland was determined and correlated to the surgeon's intra-operative notes.

Results

In all nine cases, the permeability maps, especially the Wash-in and Peak curves were significantly different ($p < 0.005$) for the normal pituitary gland and macroadenoma. Such differences in permeability characteristics enabled localizing the normal pituitary gland in a setting of macroadenoma, confirmed upon correlation with the surgeon's intra-operative notes.

Conclusions

Based upon our literature search, this is the first imaging study to demonstrate that permeability characteristics can be utilized to distinguish the normal pituitary gland from macroadenoma.
Pituitary height measured along the larger lobe correlate best with pituitary volume when compared to measurements in continuation with the stalk.

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¹UT Medical Branch, Galveston, TX, ²University of Texas Medical Branch, Galveston, TX, ³UTMB, Galveston, TX, ⁴The University of Texas Medical Branch, Galveston, TX, ⁵the University of Texas Medical School at Houston, Houston, TX, ⁶University of Texas Health Science Center-Houston, Houston, TX, ⁷The University of Texas- Houston, Houston, TX

Purpose
Assessment of pituitary function on MRI is best done through the determination of the volume of the gland, but most studies have only reported the characteristic heights of the gland in abnormalities such as physiological hypertrophy, inflammatory disease, microadenoma, etc., typically in the midsagittal plane. Evaluation of pituitary height alone may be inaccurate owing to morphological variability. We sought to assess and compare correlation between pituitary volume and height measured on sagittal and coronal planes.

Materials and Methods
Twenty-four healthy adults (average age 46 ± 4 years) were scanned between 2010 and 2013 at our institution with isovolumetric sagittal and coronal T1 sequence. The isovolumetric T1 sequences were performed with 1 mm voxel size on a 3T MR scanner (Verio, Siemens, Germany). The sagittal and coronal images were analyzed by an experienced neuroradiologist independently. Pituitary heights were measured on midsagittal and coronal images in continuation with the stalk as well as along the larger lobe on coronal plane. Volume analyses were performed using a semi-automated program (Analyze 11.0; AnalyzeDirect, Overland Park, KS).

Results
The average pituitary height measured 4.7 ± 1.5 mm (mean ± SD), 4.1 ± 1.2 and 5.3 ± 1.5 on midsagittal and coronal planes along the stalk, and on coronal plane along the larger lobe respectively. The average volume was 0.6±0.1 mL. There was a good correlation between height measured along the larger lobe and pituitary volume (r²=0.44, p=0.032). No correlation was found between pituitary volume and sagittal or coronal measurements along the stalk (r²=0.28, p=0.19 and r²=0.33, p=0.11 respectively).

Conclusions
Clinically, pituitary height measured in continuation with the stalk mostly on sagittal view is used as a surrogate for pituitary volume when screening for pituitary abnormalities. We showed that pituitary height measured along the larger lobe is a better surrogate for volume than measurements along the stalk. As our sample size was rather small, more generalizable studies are necessary to further investigate this relationship.
Purpose
Magnetization-prepared 2 rapid acquisition gradient echo (MP2RAGE) is a new T1-weighted sequence (a modification of the standard T1-weighted MPRAGE that removes the sensitivity to the B1 transmit and receive field inhomogeneities) that provides four different contrasts [first and second inversion contrast, T1 map and uniform image, (cf. Figure)]. We test their usefulness and show the normal and the abnormal findings in epileptic patients.

Materials and Methods
Retrospectively, we analyzed results of MP2RAGE obtained on a 3T MR system in 25 epileptic patients [7 women and 18 men - ages ranging from 11 months to 70 years (average age 28 years)]. Acquisition time was 8,52 minutes, 1mm3 isotropic resolution, TE 3 ms TR 5000 ms, T11 700 ms, T12 2500 ms. The signal intensity, thickness of the cortex, blurring of gray-white matter junction, morphometric findings, artifacts were evaluated in normal and abnormal areas.

Results
Normal findings are noted in six patients; dysplasia in seven, hippocampal lesions in three, migration abnormalities in three, closed lip schizencephaly in one (see Figure), hamartoma in one, fornix and mammillary body atrophy in two, DNET in one, encephalocele in one and post-traumatic lesion in one. Most commonly encountered problems were the flux artifacts in the temporo-mesial region and the suboptimal visualization hippocampal layers that were observed in all patients.

Conclusions
The different MP2RAGE contrasts provide complementary information to study cortex abnormalities which may even be sufficient for a full diagnostic evaluation. This would allow to considerably reducing the total scan time.
A Meta-Analysis of Acute Stroke Infarct Core Size Error Estimates by CT Perfusion

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Purpose
The accuracy of CT perfusion (CTP) for estimating the size of the acute stroke ischemic core infarct has been estimated using diffusion MRI as the standard reference. Most reports have utilized regression analysis to validate CTP. A more appropriate statistical test for assessing the value of a diagnostic measurement in individual patients is Bland Altman analysis. The aim of this study is to re-analyze published data using the Bland-Altman approach.

Materials and Methods
Literature search identified articles that assessed accuracy of CTP-based (CBF and CBV) estimates of ischemic core size using diffusion MRI as the reference standard, and that reported original quantitative data in graphs or tables. Data were pooled for regression and Bland-Altman analyses.

Results
Seven studies were identified (Wintermark et al. (2002). Stroke 33: 2025. Schramm et al. (2004). Stroke 35: 1652; Bivard et al. (2011). Cerebrovascular Diseases 3: 238; Bivard et al. (2011). Brain 134: 3408; Campbell et al. (2012). Stroke 43: 2648; Huiss et al. (2014). J Stroke Cerebrovasc Dis 23: 114. Schaefer et al. (2015). Stroke (in press). Core lesion volumes were reported by CT-CBV for 197 patients, and for 331 patients by CT-CBF. Pooled analysis revealed high correlation between CT-CBV and DWI infarct volumes (R2= 0.73, Slope= 0.73, P<0.0001) as well as between CT-CBF and DWI lesion volumes (R2 = 0.63, Slope= 0.85, P<0.0001).

Bland-Altman analyses revealed that the 95% confidence limits (±1.96 SD ) were +62.3 ml and -41.2 ml for CBV, and +48.7 ml and -60.7 ml for CBF.

Conclusions
Meta-analysis confirms high correlations between CTP estimates of core infarct volumes and diffusion MRI estimates of the same, but large (+/- >40 ml) 95% confidence intervals. We conclude that CTP-based estimates of infarct core are unlikely sufficiently accurate for treatment decisions on INDIVIDUAL PATIENTS when the target core volume is 70-100 ml.
Fig 1. CT-CBV vs DWI core volume

Fig 2. CT-CBF vs DWI

Fig 3. CT-CBV/DWI core volume Bland-Altman plot

Fig 4. CT-CBF/DWI Bland-Altman
Determination of CT Perfusion Thresholds for the Evaluation of Acute Ischemic Core and Penumbra Utilizing Bayesian Deconvolution Method.

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Purpose
CT perfusion (CTP) is utilized widely to evaluate the extent and location of irreversible cerebral infarction (core) and oligemic territory at risk of infarction (penumbra) in acute stroke. Bayesian probabilistic methods have been stated to be more accurate than currently utilized single value decomposition (SVD) methods but the exact hemodynamic thresholds that best predict infarct core and penumbra have not been determined. The purpose of this preliminary study is to establish the most accurate Bayesian values using clinical data.

Materials and Methods
Strict criteria were applied to retrospectively identify patients with the greatest likelihood of having predictable infarct volumes consisting of either core or core plus penumbra infarcts. Eight ideal patients with cerebrovascular occlusion who underwent CTP and vascular imaging documenting either complete recanalization with restoration of normal flow (n=5 representing core infarct) or nonrecanalization (n=3 representing core plus penumbra) were included. Varying combinations of relative cerebral blood flow (rCBF) or relative cerebral blood volume (rCBV) ± absolute/relative arterial tissue delay (aATD, rATD), the Bayesian equivalent of Time to Maximum Residue Function (Tmax), were used (Sphere, Olea Medical) to generate volumes that were co-registered with the final MR DWI infarct. Sensitivity versus 1-specificity graphs determined the optimal thresholds within our datasets.

Results
Relative CBF <40% and aATD >2 seconds achieved best overall sensitivity/specificity (70th percentile) while rCBF <30% and aATD >1 second achieved higher specificity (80th percentile) yet remained above 60th percentile for sensitivity (Figure 1). Using these parameters for core, aATD >5 seconds yielded the best overall sensitivity/specificity (60th percentile) for penumbra.

Conclusions
Literature review indicates this is the first clinical determination of the optimal Bayesian deconvolution thresholds demarcating core and penumbra in patients with acute ischemic stroke. Analogous to prior studies, a two-parameter threshold is optimal. These results allow for the clinical application of Bayesian method in acute stroke.
In Acute Stroke Imaging, Can Thresholded CT Perfusion-Derived Cerebral Blood Flow Maps Substitute for Diffusion-Weighted Imaging in Measuring the Size of the Ischemic Core?
Purpose
To assess whether thresholded cerebral blood flow (CBF) maps derived from CT perfusion imaging (CTP) can reliably substitute for diffusion-weighted imaging (DWI) in measuring the volume of the ischemic core.

Materials and Methods
Fifty-eight patients with suspected acute ischemic stroke underwent CTP and DWI within 6 hours of symptom onset. Cerebral blood flow maps were computed, and automated software measured the volumes of low CBF lesions, using absolute CBF thresholds ranging from 0 to 30 mL/100g/min in 1 mL/100g/min increments, and relative CBF thresholds ranging from 0% to 100% of the mean CBF in the contralateral hemisphere, in 2.5% increments. Diffusion-weighted imaging lesion volumes were measured by a neuroradiologist, without referring to CTP images, using a semi-automated thresholding technique with manual editing. Accuracy of each CBF threshold in predicting gold standard DWI lesion volume was assessed, using the coefficient of determination (R2) statistic for a model in which CBF lesion volumes were equivalent to DWI lesion volumes. For each patient and each threshold, the amount by which CBF underestimated DWI lesion volume was calculated.

Results
Mean DWI lesion volume was 27.0 mL. All absolute CBF thresholds yielded negative R2 values, indicating that individual patients' core lesion volumes would be more accurately predicted by discarding their imaging information, and simply predicting that every patient's core volume was equal to the sample mean of 27.0 mL. Negative R2 values also were yielded by every relative threshold except those between 2.5% and 12.5%, inclusive. The relative CBF threshold with greatest overall accuracy was 5%, with R2=0.497. However, in individual patients, the volumes of lesions with CBF<5% underestimated true DWI lesion volumes by up to 229.5 mL, and overestimated true lesion volumes by up to 50.8 mL.

Conclusions
Thresholded CTP-derived CBF maps cannot reliably substitute for DWI in measuring the volume of the ischemic core.
Purpose
Conventional CT perfusion (CTP)-based stroke imaging methods rely on applying a threshold to single parameter perfusion maps (e.g., CBV, MTT) to determine infarct outcome. However, the definition of optimal thresholds acquired by receiver operating characteristic (ROC) curve analysis is variable and not standardized. We evaluate a threshold-free method of infarct volume prediction.

Materials and Methods
In this multicentric retrospective study design, 161 first ever proximal middle cerebral artery occlusive strokes were included. Admission native and perfusion CT was performed (i.e., thrombectomy was performed and infarct lesions were segmented in follow-up imaging targeted at 48 hours after onset). Four perfusion parameters (CBV, CBF, MTT, TTD) were thresholded to predict infarct volumes for every patient. The optimal threshold was identified by ROC curve analysis (Youden's index). For threshold-free infarct prediction parameter maps were converted to voxel-wise infarct probability using a logistic regression model. The predicted infarct volume, the stochastic expected value of voxel-wise infarction, was calculated by summation of voxel-wise infarct probabilities. The performance of infarct prediction by conventional thresholding and threshold-free method was assessed by the root-mean-square error of predicted versus real infarct volume.

Results
The threshold-free model showed a significantly improved root-mean-square error for predicted infarct volume versus conventional thresholding. For CBF, CBV and TTD mean error was lower in the threshold-free model. For MTT the mean error was comparable for both methods.

Conclusions
We established a threshold-free method to interpret CT perfusion maps for infarct volume prediction. Our model showed improved precision independent of thresholding.
Correlation of Baseline CT ASPECTS with Admission Neutrophil–Lymphocyte Ratio in ICA/MCA Acute Ischemic Stroke

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Purpose
The neutrophil–lymphocyte ratio (NLR) as an inexpensive and easily available inflammatory marker, has become a useful index in various conditions such as cardiovascular diseases, neoplastic diseases, diabetes, peripheral arterial diseases, and recently acute ischemic stroke (AIS). We studied the association between the baseline Alberta Stroke Program Early Computed Tomographic Score (ASPECTS) with admission NLR in AIS patients with anterior circulation large vessel occlusion.

Materials and Methods
Consecutive AIS patients with CTA/MRA verified ICA/MCA occlusion presenting in acute setting (less than 8 hours) were studied retrospectively. Exclusion criteria included: AIS due to other vascular pathologies, patients who were hospitalized before developing stroke, receiving corticosteroids, and associated systemic or infectious diseases prior to developing stroke. Admission NLR was obtained using baseline white blood cell differential by dividing the percentage of neutrophils by the percentage of lymphocytes. ASPECTS were obtained after two blinded observers evaluated the baseline CT examinations. Subsequently, the interobserver agreement was evaluated. ASPECTS was dichotomized into >7 (favorable) and ≤7 (unfavorable). Accordingly, NLR was subclassified into high (>5), and low (≤5) groups. Patient demographics, baseline NIHSS score, pretreatment Total Health Risks in Vascular Events (THRIVE) score (1), and final clinical outcome (90 day modified Rankin Scale score) subsequently were obtained. Intraclass Correlation Coefficient (ICC) was used to evaluate interobserver agreement and Chi-square, Mann-Whitney U and student t tests were used for univariate analyses as appropriate. Correlation between ASPECTS and NLR was calculated using Pearson's correlation coefficient (r). The receiver operating characteristic (ROC) curve analysis was performed to determine the optimal cut-off NLR for discriminating favorable ASPECTS. P value of <0.05 was considered to be statistically significant.

Results
Fifty-three patients (29 F/24 M, mean age ±SD of 71.86 ± 11.63 years), were enrolled to the study. Interobserver agreement for ASPECTS was good (ICC=0.82) with no significant difference between the scores assigned by the observers (P=0.51). After dichotomizing the patients based on the ASPECTS and NLR, all groups were comparable in terms of age, sex, and THRIVE score (P>0.05). A significant inverse correlation was observed between ASPECTS and admission NLR (P=0.0023, r = -0.41). Unfavorable ASPECTS (≤7) was associated significantly with high NLR (≥5) (P=0.0006). Receiver operating characteristic curve analysis revealed that NLR of 5 or less can discriminate favorable (>7) from unfavorable (≤7) ASPECTS with the sensitivity of 80.8% and specificity of 70.4% (P=0.003, area under the curve= 0.72). Neither...
ASPECTS nor NLR was predictor of final good functional outcome (P=0.15, P=0.39, respectively).

Conclusions
In our study, baseline ASPECTS inversely correlated with admission NLR in AIS patients presenting with anterior circulation large vessel occlusion and NLR of five or less discriminated favorable from unfavorable ASPECTS.

O-17
11:10AM - 11:18AM

Logarithmic Growth of Ischemic Lesions in Major Anterior Circulation Ischemic Strokes

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1Massachusetts General Hospital, Boston, MA, 2Massachusetts General Hospital, Charlestown, MA

Purpose
To analyze the dynamics of diffusion lesion volumes within the first 48 hours after stroke onset in patients with major anterior circulation occlusions (ACOs).

Materials and Methods
Diffusion ischemic lesion volumes were measured serially in 50 patients that had MRI performed at baseline (~5 hours post ictus) and 2 or 3 additional MRI exams (~12, ~24, ~48 hours post ictus). Thirty-eight of these patients had documented major ACOs (terminal internal carotid or proximal middle cerebral artery). Average rate of lesion growth was calculated at each time interval. Functional outcomes (3-month modified Rankin Scale) were correlated to admission NIHSS, diffusion-weighted imaging (DWI) volumes and initial lesion growth rates.

Results
Diffusion-weighted imaging lesion growth in ACOs was nonlinear over 48 hours and exhibited a logarithmic pattern. The lesion growth rates were highest during earliest period (11.4 ml/hr) and declined during the 5-12 (0.8 ml/hr), 12-24 (1.9 ml/hr) and 24-48 hour (0.9 ml/hr) periods. In 23/38 patients there was little or no growth during 5-12 hour periods despite continued presence of occlusion in over half of these patients. However, 12/38 experienced >30% growth of lesion during this period, with nearly all patients having persistent occlusions. Functional outcomes correlated with baseline NIHSS and DWI lesion size, as well as initial DWI lesion growth rate, but only the latter was an independent predictor of outcomes (P=0.0001).

Conclusions
The growth of ischemic DWI lesions caused by occlusion of major anterior circulation arteries is nonlinear and typically logarithmic. The rate of growth at the earliest time period is a strong predictor of functional outcomes. There is high variability in growth rates due to site of occlusion and most likely the quality of collateral flow.
Multivariate Dynamic Prediction of Infarct as a Function of Time Interval between Stroke CT and Mechanical Recanalization Therapy

A Kemmling¹, F Flottmann², G Broocks³, J Minnerup⁴, S Langner⁵, T Niederstadt⁶, M Knauth⁷, M Psychogios⁷, B Eckert⁸, J Fiehler⁹
Purpose
Perfusion-based penumbral imaging has been shown to successfully identify stroke patients who benefit from therapy, but not from endovascular therapy specifically. Perfusion imaging-based patient selection is limited due to variability of endovascular treatment time. There is a need for prediction models that estimate tissue outcome depending on time intervals until endovascular treatment. We present a multivariate model that dynamically predicts infarct outcome with respect to treatment time.

Materials and Methods
In this multicentric retrospective study 161 first ever proximal middle cerebral artery strokes were included. Admission perfusion CT was performed, infarct lesions were segmented in follow-up imaging targeted at 48 hours after onset. For infarct prediction we trained a voxel-wise multivariate general linear model (GLM) including time to treatment as covariate. Precision of prediction using real treatment times was tested against observed infarct volume distribution. Infarct volumes with changing treatment times were calculated within the GLM.

Results
The mean infarct volume of the study cohort was 69 ml ranging from 0 to 328 ml. Infarct prediction across all ranges of final infarct sizes was robust. The overall mean predicted infarct size for treatment at admission imaging versus 10 hours after symptom onset was 51 ml versus 112 ml, respectively with a mean growth of 61 ml. Absolute growth was highest for infarct between 75 to 125 ml treated at admission, relative growth ratios were highest for infarcts between 25 to 75 ml.

Conclusions
Infarct volume with changing treatment time can be dynamically predicted within a multivariate GLM. Stroke triage could improve significantly when adjusting penumbral imaging by expected treatment time.
4D-CTA improves accuracy and confidence in acute stroke assessment

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Purpose
Intra-arterial therapy (IAT) is now a proven effective therapy for ischemic stroke caused by
proximal artery occlusion in the anterior cerebral circulation. Patient selection can be done with CTA with or without CT perfusion (CTP). Interpretation of CTA in stroke patients for intra-arterial recanalization selection takes place under time pressure, mostly outside office hours. In case of false negative CTA, additional IAT with possible clinical benefits is withheld incorrectly. Primary aim of the study is whether the use of CTP and 4D CTA derived from the perfusion data-set would increase accuracy and confidence for detection of proximal artery occlusion in stroke patients, compared to CTA alone, as interpreted by radiology residents.

Materials and Methods
Anonymized data of 25 subsequent patients, eligible for enrollment in the MR CLEAN trial for possible intra-arterial therapy, were stored on a dedicated workstation. The dataset consisted of Dual Energy CTA of head and neck (Siemens Definition Flash, Forchheim. DECTA: 80/Sn140 kVp, 310/155 mAs, CTDI 26.3 mGy, DLP 454 mGycm. 90 cc Ultravist 300 mg/ml) and CTP dataset (80 kVp, 100 mAs; 40 cc Ultravist 300 mg/ml) in 5 mm and 1 mm. Observers were radiology residents at different stages: first to fifth (last year) year residents and a fellow neuroradiology. To simulate a clinical situation, the sessions were timed (time registration). Data analysis on a dedicated workstation (SyngoVia, Siemens) was at personal preference: axial images, multiplanar reformations, maximum intensity projection or volume rendering with or without bone removal could all be used. Observers scored whether an occlusion was present on CTA. Subsequently they calculated perfusion maps and could decide to stay with their initial opinion or take a second look at the CTA. At last 4D CTA was calculated from the 1 mm source images of the CTP, before a definite decision was noted. After each step the observers rated their confidence. An expert neuroradiologists and interventional radiologist rated all scans in consensus as gold standard. Accuracy and confidence will be calculated.

Results
Preliminary evaluation indicates that adding CT perfusion increases the accuracy of the residents and their confidence. The additional interpretation of CT perfusion maps and 4D CTA lowered the number of false negative assessments on CTA. Reading time increased with reading of additional series.

Conclusions
Definite study results will be presented. Meanwhile CT perfusion interpretation and 4D CTA are added in our standard interpretation of candidates for IAT.

O-20
11:34AM - 11:42AM

A Modification of a Collaterals Scoring System for Improved stratification of Outcome in Acute Ichemic Storke

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Purpose
The status of collateral circulation has been well demonstrated to be an important predictor of outcome in ischemic stroke patients with large artery occlusion. From experience, we had noted
that there was marked heterogeneity in the outcomes in patients who had between 50 and 99% collateral circulation at presentation. We sought to improve the predictive value an existing single phase CTA collateral score by further subdividing this group into two subgroups, with the expectation that outcomes would be better stratified.

Materials and Methods

Four experienced neuroradiologists retrospectively reviewed the CT angiograms and noncontrast head CT exams of 342 patients presenting to our institution with anterior circulation acute ischemic stroke and large artery occlusion. The collateral score was modified to a five-point scale (Figure 1), and scores were dichotomized into unfavorable (0-2a) and favorable (2b-3) profiles. A logistic regression model was good and poor discharge outcome (based on mRS 0-2 and 4-6) was used. Receiver operating characteristic (ROC) analysis also was used to compare the previous collateral score and the use of ASPECTS to the modified collateral score.

Results

Patients with favorable mCS had a significantly higher odds of a good outcome (OR 9.61, 95%CI 2.78-33.2, p=0.0003). Moreover, patients with unfavorable profile mCS (0-2A) had greater odds of poor outcome at discharge (4-6), and this association was maintained when using more stringent criteria for poor outcome (mRS 5-6) (Table 2). These results persisted after adjustment for CT early ischemic changes (ASPECTS) and stroke severity (NIHSS). The modified scale was more precise than the original CS in predicting patients' clinical outcomes.

Conclusions

Further modification and substratification of existing scoring systems can improve predictive power (in this case subdividing patients with greater than 50% visible collaterals). Part of our added value as imagers is to continue to suggest and test modifications that are simple, reproducible and require minimal or no revision of widely applied imaging protocols.
**Effect of collaterals on clinical presentation, baseline imaging, complications and outcome**

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**Purpose**

We sought to evaluate the role of collateral circulation and important clinical and imaging variables, for a given recanalization status, as predictors of baseline stroke severity, total ischemic volume, hemorrhagic transformation (HT), final infarct size and clinical outcome.

**Materials and Methods**

Retrospective study of 395 patients presented to our institutions from 2009-2012. Patients were dichotomized by recanalization status (R+/R-) and subdivided further based on collateral status (C+/C-) assessed on follow-up and admission CTA respectively. Gray and white matter penumbral and core volumes were derived from thresholded and segmented CT perfusion maps. Final infarct size was assessed on follow-up CT or MRI. Uni and multivariate analyses were performed for each outcome adjusting for rt-PA status, using general linear regression for continuous variable, and logistic regression for binary variables. Only factors with p<0.10 in univariate analysis were advanced into a multivariate analysis with backward stepwise selection. Bonferroni adjusted p-value < 0.025 was considered statistically significant after controlling for multiple comparisons.

**Results**

Collateral status persisted as an independent predictor of all outcomes irrespective of recanalization status. Low clot burden score independently predicted all outcomes except for HT in R+ patients and clinical outcome in all groups. However, proximal clot location was associated significantly with clinical outcome in R- patients and HT in R+ patients.

**Conclusions**

Collateral circulation independently predicts baseline stroke severity, total ischemic volume, final infarct size and clinical outcome irrespective of recanalization status. Poor collateral status is associated with increased hemorrhagic transformation risk in R+ patients.

**O-22**

**Diffusion Lesion Reversal after Transient MCAO in Nonhuman Primate Stroke Models**

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Purpose
Though early diffusion lesion reversal (DLR) after recanalization treatment of acute ischemic stroke has been observed in clinical settings, still controversial is if diffusion-weighted imaging (DWI) lesions are truly reversible. This is to present our observation of sustained DLR after transient middle cerebral artery occlusion (MCAO)/reperfusion in nonhuman primate (NHP) models.

Materials and Methods
Seven rhesus monkeys were subjected to transient MCAO using endovascular technique to achieve focal cerebral ischemia and had been followed for 4 weeks after MCAO. Immediately after occlusion, prospective MRI scans were repeated every 10 ~ 20 minutes. Occlusion was maintained until diffusion MRI showed plateau of lesion volume (peak volume) which was calculated by real time measurement technique using ImageJ (v1.46, NIH). Early DLR was defined as the ADC-derived lesion volume difference between peak volume and volume at 3 hours after reperfusion. We defined sustained DLR as voxels of acute ADC-derived lesion at the peak that corresponded to normal-looking brain on follow-up FLAIR MRI at 4 weeks. 3D volume analysis was used for quantitative analysis of ADC-derived lesion characteristics with AFNI software package (http://afni.nimh.nih.gov/afni/), FSL software (http://www.fmrib.ox.ac.uk/fsl) and ITKsnap (http://www.itksnap.org/pmwiki/pmwiki.php).

Results
Peak volume percentages of ADC-derived hemispheric lesions (%HLVs) were ranged 4.0 ~ 21.7% (mean=10.3%). Hemispheric early DLRs were ranged 1.1 ~ 10.5% and percentages of early DLR/Peak volume 9.9 ~ 68.9% (mean=36.3±19.3%). Final %HLVs on FLAIR images at 4 weeks were between 0.9 and 11.0% (mean=4.8%). Sustained DLR was detected in all animals (9/9), and percentages of sustained DLR/Peak volume were 15.7 to 84.9% (mean=58.6±25.8%).

Conclusions
We confirmed that sustained DLR as well as early reversal is persistent in all transient focal cerebral ischemia monkey models.
Radiologic Manifestations of Acute Infectious Flaccid Paralysis in Children with Emphasis on Peripheral Nerve Involvement

M Mamlouk¹, R Griggs², B Tamrazi², P Thomas¹, J Strober¹, J Barkovich¹, C Chin¹

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Purpose
Radiologic appearances of acute flaccid paralysis (AFP) are reported to involve the spinal cord and brainstem, while peripheral nerve involvement rarely has been reported. The purpose of our study is to further characterize the specific MR imaging features of acute infectious flaccid paralysis in children, with an added emphasis of the peripheral nerve component.

Materials and Methods
Electronic medical records at two children's hospitals were reviewed for all patients younger than 18 years with symptoms of AFP and signs of infection to our tertiary referral centers from December 1, 2011 to December 1, 2014. Available clinical notes were reviewed for the presenting clinical symptoms, serologies, and electromyography data when available. MR imaging of the brain and spinal cord were reviewed. MR neurography also was reviewed when available for evaluation of the brachial plexus. Diffusion tensor imaging (DTI) and diffusion-weighted imaging (DWI) were analyzed with fractional anisotropy (FA) and apparent diffusion coefficient (ADC) values, respectively, within the spinal cord and brachial plexus.

Results
Twelve patients (6 boys, 6 girls: age range 1-12 years) were identified with AFP in one or more extremity; all presented with upper respiratory symptoms. Seven of 12 patients tested positive for enterovirus (EV), of which four were subtype D68. Two patients tested positive for acute mycoplasma pneumonia, one for rhinovirus, and one for both EV and rhinovirus. A specific infectious organism was not identified in two patients but was presumed viral based on symptoms and signs. Five of 12 patients had electromyograms that all showed severe motor neuropathy. MR imaging showed intracranial lesions in three of 12 patients with involvement of the medulla, pons, and cerebellar dentate nuclei. All 12 patients had spinal cord disease with 11 involving the cervical cord, 10 involving the thoracic cord, and none involving the lumbar cord. Cord lesions were restricted to the anterior horn cells in five patients, while eight had diffuse gray matter involvement. Peripheral nerve disease was seen in eight of 12 patients characterized by root enlargement and/or enhancement, and two patients with brachial plexus trunk involvement. One of these patients with root and truncal disease had diffuse brachial plexus disease from EV, including the divisions, cords, and branches. Enhancement within the cord or peripheral nerves was identified in eight of 12 patients. Diffusion tensor imaging was performed in one patient and showed average FA values of 0.35, 0.51, 0.40, and 0.27 in normal cord, abnormal cord, normal roots, and abnormal roots, respectively. Diffusion-weighted imaging was performed on two patients and showed ADC values of 0.00101 and 0.00065 mm2/sec in normal and abnormal cord, respectively.

Conclusions
Viral etiology was the most common cause of AFP in our patients, with the majority identified as enterovirus. MR imaging of all patients showed spinal cord gray matter involvement, restricted to ventral horns in some cases. Peripheral nerve disease was seen in the majority of patients, most commonly within the roots but also within other segments of the brachial plexus. Abnormal DTI/DWI metrics possibly reflect extracellular edema/regenerative response and may quantify disease.
Purpose

The purpose of this study was to demonstrate the feasibility of using diffusion kurtosis imaging (DKI) metrics as a potential biomarker for evaluation of pediatric spinal cords both with and without spinal cord (SC) injury (SCI) using a newly developed inner field of view (iFOV) DKI imaging sequence.

Materials and Methods

Subjects: A total of 16 subjects, 12 controls (mean age 11.2 years) and four patients (mean age 9.5 years) with cervical SCI. Imaging: The iFOV sequence was implemented on a 3.0T Siemens scanner. High resolution axial DKI images were acquired to cover the cervical SC (C1-C7). Diffusion kurtosis imaging parameters included: 30 diffusion directions, b-values = (0, 1000, 2000) s/mm², voxel size = 0.8x0.8x6mm³, axial slices = 25, TR = 5200 ms, TE = 123 ms, and averages = 1 (6 B0 images). Data analysis: Both diffusion and kurtosis tensors were estimated using a least squares approach by linearizing the kurtosis equation as outlined in (1, 2). RESTORE (3) also was implemented in the algorithm to handle outlier rejection of the tensors. The following DKI and DTI indices were extracted at each slice location along the cervical SC: fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (Dax), radial diffusivity (Drad), mean kurtosis (MK), axial kurtosis (Kax), and radial kurtosis (Krad).

Results

Statistically significant differences were seen between the controls' averaged FA (p<0.01), MK (p<0.03), and Krad (p<0.01) values compared to the patients' values (Figure 1). However, no statistical differences were seen with Kax (p=0.07). The FA values observed were comparable to values published in the current literature (4).

Conclusions

To the best of our knowledge this is the first demonstration of in vivo DKI in pediatric spinal cord: injured and noninjured. These preliminary findings are very encouraging and warrant further investigation with large populations for determining the applicability of DKI to the characterization of the spinal cord.

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Purpose
The purpose of the study was threefold: to propose a new method for drawing regions of interest (ROIs) in the cervical spinal cord; to establish normal diffusion tensor imaging (DTI) parameters for gray and white matter regions; and to determine the influence of gray matter DTI values on white matter DTI values.

Materials and Methods
The study consisted of 10 subjects (2 males, 8 females, mean age of 9.7 years) without clinical or imaging evidence of spinal cord injury or pathology. Subjects underwent two identical scans using a 3.0T Siemens Verio MR scanner (Siemens, Erlangen, Germany) with a 4-channel neck matrix and 8-channel spine matrix coils. The protocol consisted of conventional T1- and T2-weighted structural scans and axial DTI scans based on the iFoV sequence. VAT also has been
applied to reduce in-plane distortions. Manual shim volume adjustments were performed prior to data acquisition. High resolution axial DTI images were acquired to cover the entire cervical spinal cord. The imaging parameters included: 3 averages of 20 diffusion directions, 6 b0 acquisitions, \( b = 800 \text{ s/mm}^2 \), voxel size = 0.8 x 0.8 x 6 mm\(^3\), axial slices = 40, TR = 7900 ms, TE = 110 ms, and acquisition time = 8:49 min. Three ROIs were hand-drawn on each axial slice of each scan between the C1 and C7 levels (11-15 slices per subject). Whole cord ROI was drawn using the B0 and FA images. A single voxel width was avoided between the ROI margin and the cerebral spinal fluid (CSF) to avoid contamination. Slices were excluded if there was significant distortion. The whole cord ROI then was segmented and grouped into pure gray and pure white matter ROIs. Each voxel was designated as either gray matter or white matter using an anatomical atlas, B0, FA, and T2 GRE images. The DTI values then were compared within each subject and at each cord level across all 10 subjects.

**Results**

There was a statistically significant difference in the functional anisotropy (FA) and axial diffusivity (AD) values between whole cord and gray matter ROIs. Similarly, there was a significant difference when comparing gray matter FA and AD values to white matter values. White matter FA values were greater than whole cord values at every level, but were not statistically significant. For AD, white matter values were significantly greater than whole cord values. There were no significant differences between gray matter, white matter and whole cord radial diffusivity (RD) values.

**Conclusions**

Functional anisotropy and AD values are consistently higher in white matter than gray matter regardless of the cord level. Whole cord DTI ROI analysis does not accurately quantify pure white matter or pure gray matter disease that affects fractional anisotropy or axial diffusivity. These findings suggest that accurate representation of gray matter and white matter values for FA and AD requires segmentation. Furthermore, the consistent differences between gray and white matter values in FA and AD suggest that it may be possible to use an automated process to segment out the gray and white matter. Finally, if RD is the only parameter of interest, this study suggests that the whole cord analysis may yield the same results as segmented ROI analysis.
Normal development and measurements of the occipital condyle-C1 interval (CCI) in children and young adults

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Purpose
Widening or asymmetry of the occipital condyle-C1 interval (CCI) on CT has been proposed as a specific and sensitive means of detecting atlanto-occipital dislocation in the pediatric (1) and adult (2) populations with prior studies suggesting no significant difference between these populations (3). Our experience at a tertiary care children's hospital suggests that the CCI
undergoes dynamic changes during development. This study was performed to test the null hypothesis that CCI morphology and measurements do not change as a function of age. Materials and Methods
IRB-approved retrospective review was performed of subjects undergoing CT imaging of the upper cervical spine for reasons unrelated to trauma or developmental abnormality. Four equidistant measurements were obtained for each bilateral CCI on sagittal and coronal images. On sagittal images only, the medial occipital condyle notch was avoided. An average CCI for each joint was calculated. The mean absolute asymmetry between the left and right average CCI was calculated. The mean difference between unilateral sagittal and coronal average CCI was calculated and paired t-test was performed to detect significant differences based on the plane of measurement. The cohort was divided into seven age groups to calculate the mean, standard deviation (SD), and 95% CIs for average CCI in both planes. The presence of a characteristic medial occipital condyle notch in the mid joint on sagittal images was recorded and prevalence within each age group calculated.
Results
Two hundred forty-eight joints were measured in 124 subjects with an age range of 2 days to 22 years. The CCI varies substantially by age with a statistically significant relationship between CCI measurements and variance and subject age (p<0.0001, Figure 1). Average coronal measurements are larger and more variable than sagittal measurements (p<0.0001). Mean asymmetry (95% CIs) between left and right sagittal and coronal measurements are 0.218 mm (0.186, 0.249) and 0.252 mm (0.208, 0.296), respectively. The medial occipital condyle notch develops in the second year of life, is most prevalent from 12 months to 12 years, and is uncommon in older adolescents and young adults (p<0.0001).
Conclusions
The null hypothesis is rejected. The CCI increases over the first several years of life, is largest in the 2-4 year range, and then decreases through late childhood and adolescence. Average coronal measurements are larger and more variable than sagittal measurements, especially in younger patients, likely secondary to presence of the medial occipital condyle notch. These dynamic changes suggest that a single threshold value to detect atlanto-occipital dissociation may not be sensitive and specific for all age groups. Application of this normative data to documented cases of atlanto-occipital injury is needed to determine clinical utility.
<table>
<thead>
<tr>
<th>Age group</th>
<th>0-12 mos. (n=44)</th>
<th>12-24 mos. (n=36)</th>
<th>2-4 yrs. (n=34)</th>
<th>5-8 yrs. (n=38)</th>
<th>9-12 yrs. (n=32)</th>
<th>13-17 yrs. (n=38)</th>
<th>&gt;17 yrs. (n=26)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined sag avg (95% CI)</td>
<td>1.72 (1.62, 1.83)</td>
<td>2.22 (2.11, 2.34)</td>
<td>2.4 (2.18, 2.63)</td>
<td>2.21 (2.10, 2.33)</td>
<td>1.92 (1.81, 2.03)</td>
<td>1.21 (1.08, 1.34)</td>
<td>0.96 (0.89, 1.03)</td>
</tr>
<tr>
<td>Combined sag avg (95% CI)</td>
<td>2.03 (1.91, 2.14)</td>
<td>2.22 (2.08, 2.37)</td>
<td>2.57 (2.35, 2.80)</td>
<td>2.54 (2.36, 2.72)</td>
<td>2.24 (2.04, 2.45)</td>
<td>1.47 (1.26, 1.69)</td>
<td>0.92 (0.84, 0.99)</td>
</tr>
<tr>
<td>Medial occipital condyle notch prevalence</td>
<td>2.3%</td>
<td>61.0%</td>
<td>85.3%</td>
<td>84.0%</td>
<td>71.9%</td>
<td>16.0%</td>
<td>7.7%</td>
</tr>
</tbody>
</table>

![Sag OC-C1 joint (mm)](image)

**Age (months)**

![Sag OC-C1 interval (mm)](image)

**Age**

Dark boxes are +/- 1 SD from mean; thin lines are +/- 2 SD.
Significance of perioperative restricted diffusion following chiari decompression surgery

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Purpose
Selective cerebellar tonsillar reduction is a relatively common procedure performed by surface electro-cautery that can improve symptoms in patients with Chiari malformation type 1 (CM1). The purpose of this investigation is to evaluate the clinical significance of various patterns of diffusion restriction in the peri-operative period.

Materials and Methods
A total of 10 consecutive cases of tonsillar reduction performed at our institution from 2007–2014 (mean age: 25 years) with available early postoperative MRI (mean: 3.7 postoperative days) were reviewed for extent of diffusion restriction. An additional postoperative MRI that was performed after lysis of adhesions and 4th ventricular stenting, but not tonsillar cauterization, also was included. The MRI findings were compared with early postoperative neurological status.

Results
Cerebellar tonsillar diffusion restriction (mean size 11 mm) was present in 100% of cases and inferior vermian diffusion restriction (mean size 3 mm) was present in 60% of cases. The diffusion restriction was predominantly semilunar in the tonsils and more focal in the vermis. Extra-tonsillar or extra-vermian foci of diffusion restriction and signal abnormality were present in 50% of cases, involving the posterior medulla (2) and left bi-ventral lobule (3). Among these cases, 100% of the patients with posterior medulla lesions and 33% of the patients with bi-ventral lobule lesions experienced acute postoperative neurologic deficits. None of the patients without extra-tonsillar or extra-vermian diffusion restriction experienced deficits. More extensive bilateral cerebellar hemispheric foci of diffusion restriction were present in a patient with acute upper extremity weakness after a noncauterization CM1 decompression procedure.

Conclusions
Selective cerebellar tonsillar reduction by electro-cautery is a relatively common, but under-recognized procedure in the treatment of CM1. Expected early postoperative findings are characteristic and include diffusion restriction corresponding to acute ischemia confined to the inferior vermis and cerebellar tonsils. Extension beyond this zone is associated with neurologic deficits. Best practice is a familiarity with the expected imaging findings and an understanding of the potential operative complications.
Purpose
Many hypotheses have been proposed for the development of Chiari I malformation, but most consider this entity as a congenital abnormality. Most reported cases of "acquired" Chiari I malformation in the literature are secondary to herniation or intracranial hypotension. Only a few isolated reports of "idiopathic" Chiari I malformation development or resolution have been reported. We investigated the morphometric and volumetric measurements of the cerebellum and posterior fossa in a pediatric cohort of idiopathic acquired Chiari I malformations and also in two patients with idiopathic resolution of Chiari I malformation in order to shed more light on the sometimes complicated etiopathogenesis of this often controversial entity.

Materials and Methods
Eight pediatric patients were identified which previously had documented brain MRI examinations without Chiari I malformation, but subsequently had developed the abnormality. The cause for the development of Chiari I malformation was not evident based on qualitative imaging and clinical data. All patients with secondary causes of tonsillar herniation and patients with craniosynostoses were excluded. Two additional patients had Chiari I malformation which had resolved spontaneously. Volumetric measurements of the cerebellum and posterior fossa were performed by manual tracing on contiguous MRI slices at two timepoints for each patient, once when there was Chiari I malformation and once without. The trajectory of the interval growth of the cerebellum in absolute values and also relative to the growth of the posterior fossa was determined. The ratios of cerebellar to posterior fossa volumes were compared statistically. Various linear and angular measurements of the cerebellum and posterior fossa also were performed.

Results
All patients had been born full-term. In all cases of idiopathic acquired Chiari I malformation, the initial normal MRI had been obtained in the first year of life and Chiari I was diagnosed an average of 3.8 years later. The ratio of cerebellum to posterior fossa volumes had increased significantly (p<0.001) at the time of diagnosis of Chiari I malformation compared to the initial infantile MRI without Chiari I. In the subjects with spontaneous resolution of Chiari I malformation, the cerebellum to posterior fossa volume ratio had decreased.

Conclusions
In at least a subset of patients, idiopathic Chiari I malformation is an acquired condition resulting from a disproportionate volumetric growth of the cerebellum compared to the growth of the posterior fossa during or shortly after the first year of life. Rarely, disproportionate continued volumetric growth of the posterior fossa may result in resolution of previously diagnosed Chiari I malformation.

O-29
11:18AM - 11:26AM

Tonsillar Pulsatility Before and After Surgical Decompression for Children with Chiari Malformation type 1: An Application for TrueFISP Sequence

A Radmanesh¹, A Chatterjee², J Greenberg³, D Limbrick³, A Sharma²
Purpose
To assess tonsillar pulsatility before and after surgical decompression for Chiari malformation type 1 (CM-1).

Materials and Methods
IRB-approved HIPAA-compliant retrospective study was performed on 22 children with CM-1 (8 males; mean age 11.4 years) who had cardiac-gated true FISP sequence and phase contrast cerebrospinal fluid (CSF) flow imaging as parts of routine MR imaging before and after surgical decompression. The surgical techniques were recorded for each patient. Three independent radiologists with different experience levels assessed tonsillar pulsatility qualitatively (none, minimal, marked) and quantitatively (in mm), and assessed peri-tonsillar CSF flow qualitatively (none, decreased, robust). Results were analyzed using standard statistical tests. To evaluate reliability, Fleiss Kappa for multiple raters on categorical variables, and intra-class correlation for agreement in pulsatility ratings were calculated.

Results
After surgical decompression, the degree of tonsillar pulsatility appreciably decreased, both qualitatively (P values 0.0004, 0.0004, and 0.0451 for the 3 readers), and quantitatively (P values: 0.0002, 0.0002, and 0.0220). There was better agreement among the readers in quantitative assessment of tonsillar pulsatility (Kappa 0.753 – 0.834), compared to qualitative assessment of pulsatility (Kappa 0.472 – 0.496), and qualitative assessment of flow (Kappa 0.056 to 0.203). PFDD surgical technique led to larger decrease in tonsillar pulsatility, compared to PFDO.

Conclusions
Tonsillar pulsatility in CM-1 is reduced significantly after surgical decompression. Quantitative assessment of tonsillar pulsatility may be more reliable across radiologists than qualitative assessments of tonsillar pulsatility or CSF flow. Future studies are needed to address benefits of tonsillar pulsatility as a potential biomarker of surgical success in CM-1.

O-30
11:26AM - 11:34AM

Evaluation of Cervicomedullary Junction Velocity and Syringohydromyelia in Patients with Chiari One Malformation

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Purpose
The purpose of this study was to determine the relationship between the velocity of the cervicomedullary junction (CMJ) and spinal cord syringohydromyelia in patients with Chiari I malformations before and after foramen magnum decompression.

Materials and Methods
A retrospective study was conducted from September 2010 to March 2013 of pediatric patients (age ≤ 18) with clinico-radiologic diagnosis of Chiari I malformation with the following inclusion criteria: A) Patients who underwent posterior decompression of the foramen magnum and B)
Preoperative and postoperative MRIs of the brain including sagittal plane 2D phase contrast cerebrospinal fluid (CSF) flow imaging. Maximum velocity in the CMJ was obtained by placement of a freeform region of interest on the phase contrast images on Circle Cardiovascular Imaging software (Calgary, Canada). An unpaired t-test was used to determine statistical significance (p<0.05) of preoperative CMJ velocity in patients with and without syringohydromyelia, and postoperative CMJ velocity in syringohydromyelia patients with and without decrease in the size of the syringohydromyelia.

Results
A total of 23 patients were included. Syringohydromyelia was present in 12 patients preoperatively. Prior to foramen magnum decompression, the average maximum velocity of the CMJ in patients without syringohydromyelia was 0.36 cm/s compared to 0.74 cm/s in patients with syringohydromyelia (p=0.040). Following decompression of the foramen magnum, the average maximum velocity of the CMJ in patients with postoperative decrease in size of spinal cord syringohydromyelia was 0.30 cm/s compared to 0.66 cm/s in patients with stable or increasing size of the syringohydromyelia (p=0.047).

Conclusions
There is a significant difference in the maximum velocity of the cervicomedullary junction in Chiari I malformation patients with preoperative presence or absence of syringohydromyelia and in the postoperative change in syringohydromyelia.

O-31

Fissures of the Annulus Fibrosus and Anterior Spinal Artery Infarcts of the Cervical Cord in Children

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Purpose
To determine if an association exists between fissures of the annulus fibrosus and anterior spinal artery (ASA) infarcts of the cervical cord in children.

Materials and Methods
In order to establish the incidence of annular fissures in our patient population, we retrospectively reviewed the sagittal TSE T2 images from 103 consecutive cervical spine examinations (618 disc levels) performed at a large children's hospital between March and July 2014 (55 male, 48 female; ages 0.5 to 20.7 years). In order to establish the incidence of annular fissures in subjects with acute cervical myelopathy, an additional 42 examinations (252 disc levels) were obtained from the radiology database using keywords 'spinal cord infarct', 'transverse myelitis', 'acute disseminated encephalomyelitis', 'multiple sclerosis' and 'neuromyelitis optica'. Database cases were performed between April 2004 and February 2014. The combined groups yielded a total of 46 noncompressive acute cervical myelopathy examinations (23 female, 23 male; ages 0.5 to 17.3 years). Images were transferred to an independent workstation and de-identified. The groups were combined (145 cases, 870 disc levels) and presented in random order for image review. Masks were placed over the spinal cords to reduce potential bias. Following a training session, two pediatric neuroradiologists with 23
and 15 years of experience independently evaluated the C2-C3 through C7-T1 discs for posterior annular fissure and disc desiccation. Following a delay of 2 weeks, the same two readers independently reviewed the sagittal and axial TSE T2 images from the 46 acute myelopathy examinations. For this review, masks were placed over the vertebrae and discs to reduce potential bias. Patients were classified as ASA infarct or not ASA infarct based on imaging characteristics described in published reports. Differences were resolved by consensus and diffusion imaging, when available. The frequency of findings, percent agreement and odds ratios were calculated.

Results
Thirteen of 870 discs were excluded due to segmentation anomaly or susceptibility artifact. Posterior annular fissures (any type) were identified by one or both examiners in 60 of 857 discs (7.0%). Seven (7) cervical ASA infarcts were identified by consensus. According to examiner A, 7.2% of noninfarct subjects had at least one convincing annular fissure as opposed to 71.4% of infarct subjects [OR=32.0, 95% CI (4.3, 354.1), p < 0.001]. According to examiner B, 2.9% of noninfarct subjects had at least one convincing annular fissure as opposed to 42.9% of infarct subjects [OR= 25.1, 95% CI (2.6, 204.4), p = 0.002]. In contrast, no significant difference in incidence of annular fissures was seen between noninfarct myelopathy and nonmyelopathy subjects. Percent agreement was 83.9% for disc desiccation and 94.5% for annular fissure.

Conclusions
There is an association between annular fissures and ASA infarcts of the cervical cord in children. Such an association may be due to fibrocartilaginous disc embolism and reveal the pathway by which nuclear material enters the spinal vasculature.

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<thead>
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O-32

Effect of spinal cord viscoelasticity on its response to CSF pressure waves: a computational study
Purpose
In theory, syringomyelia develops in Chiari I patients because cerebrospinal fluid (CSF) flow has a mechanical effect on the spinal cord. Computational fluid dynamics and solid mechanics provide tools to investigate the effect of CSF flow on the spinal cord. Many computational studies of the spinal cord employ models that deform as a linearly elastic tissue. This assumption disregards the high fluid component of the spinal cord tissue, in particular the viscoelastic properties of the spinal cord. Due to the small deformations during a cardiac cycle, linear models are appropriate, but it is not clear whether elastic or viscoelastic models should be used. In this study, we measure the viscoelastic effect in the spinal cord on its reaction to CSF pressure dynamics.

Materials and Methods
We created a 3D model of the spinal cord from high resolution DTI images of a sheep spinal cord. The model was ascribed stiffnesses, viscosity and compressibility parameters extrapolated from reported values in the literature (Model 1). Deformation of the model was induced by a pressure wave determined by measurements of the pressure exerted by the CSF flow on the spinal cord in a Chiari I patient, moved at 1 Hz and at 2 cm/sec along the model. The deformation of each point in the spinal cord model was calculated using a numerical approximation of the Standard Linear Solid equations; these equations describe viscoelastic behavior under small deformations. Additional models were created in which the viscosity (Model 2) and compressibility (Model 3) parameters were varied, and also a purely elastic model with comparable stiffness and compressibility (Model 4). All simulations were performed via a verified solver using the finite element library FEniCS. The displacement of individual points in the model were plotted as a function of time and the displacement patterns for each model were inspected and compared.

Results
The passage of the CSF pressure wave produced complex patterns of tissue displacement varying with position in the model and time in the cycle. Tissue displacements in the cord were similar in magnitude and behavior for the viscoelastic and elastic models. The effects of pressure on the cord model lagged in the viscoelastic model compared to the elastic model (Figure 1), (Figure 2). Peak displacements in the viscoelastic model varied minimally from one cycle to another. Displacements varied in magnitude with the viscosity coefficient assigned to the spinal cord (Figure 3). Displacements varied in magnitude and qualitative behavior with the compressibility coefficient assigned to the spinal cord (Figure 4).

Conclusions
Accurate simulations of spinal cord displacements secondary to the CSF pressure waves requires the inclusion of spinal cord viscosity and compressibility.
Adaptive Neuro-Fuzzy Inference System for Detection of Ghost Artifact in Diffusion Tensor Imaging of the Spinal Cord

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Purpose
Diffusion tensor imaging (DTI) is very sensitive to phase shifts occurring during long echo train acquisition. This causes ghosting in the resultant images. The purpose of this study is to evaluate the validity and reliability of an automatic postprocessing method for identifying and segmenting spinal cord regions from ghost regions in b0 DTI images.

Materials and Methods
Diffusion tensor imaging data from 12 subjects (7 healthy and 5 spinal cord injury patients) with a mean age of 11.18 years were acquired using an inner field of view (iFOV) echo planar DTI pulse sequence implemented on a 3.0T Siemens Verio MR scanner. The imaging parameters included: Diffusion direction = 20; number of b0 scans=6; field of view size=250mm, TR=7900ms, TE=110ms, slice thickness=6mm, flip angle=90° and number of averages=3. The ghost detection method consists of three stages, namely, segmentation, feature extraction and classification. Ten statistical features were selected using Mutual Information (MI) method from...
21 predefined statistical features and classified into the true cord or ghost cord using Adaptive Neuro-Fuzzy Interface System (ANFIS) (Table 1).

Results
The experiments were carried on 50 b0 images of DTI data which consist of ghost artifacts. One hundred regions including 50 true cords and 50 ghost cords were detected using the morphological segmentation method by sensitivity, specificity and accuracy of 0.99, 0.98 and 0.98, respectively. The results obtained from the classifier showed a sensitivity of 0.91, specificity of 0.79, and accuracy of 0.84 which assures that the proposed method would be viable for use in clinical practice for the detection of ghost in DTI images. Figure 2 represents the output of ANFIS classifier tested on 25 images included 10 ghost cords (with target class of 2) and 15 true cords (with target class of 1). Outputs higher than 1.5 were considered as ghost cord and less than 1.5 were considered as true cord.

Conclusions
In conclusion, an automatic method to detect and segment spinal cord regions from ghost regions in DTI scans was implemented and tested. Such techniques are extremely valuable for accurate detection characterization and interpretation of the DTI metrics in normal and spinal cord injury patients.

<table>
<thead>
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<th>Calculated from co-occurrence matrix</th>
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(Filename: TCT_O-33_q41_converted.jpg)

Figure 1. (a) Axial b0 image of a control subject at spinal cord level of C6-C7, (b) segmented region anterior and (d) cord located in the posterior region of the image.
High-resolution Flat-panel CT for the Evaluation of a Manubrium of the Malleus Fracture

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Purpose
Isolated fracture of the manubrium of the malleus is a rare condition, classically presenting with sudden hearing loss after digital manipulation of the external auditory canal (EAC). The diagnosis is typically clinical, based on otomicroscopy, audiometry, tympanometry and laser-

Figure 2. The output of ANFIS classifier tested on 25 image

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Doppler vibrometry (1). A fracture may not be evident through an intact tympanic membrane (TM). We describe the use of flat-panel CT (FPCT) with higher resolution secondary reconstructions in the evaluation of a suspected fracture of the manubrium of the malleus.

Materials and Methods
A 61-year-old woman with no significant past medical history presented with left-sided hearing loss after placing her finger inside the EAC. She heard a "pop" upon removal and experienced immediate decreased hearing, tinnitus, and otalgia. Otomicroscopy demonstrated an intact TM with an area of central atelectasis that was hypermobile with auto-insufflation. A collimated 20-second FPCT (DynaCT, Siemens, Erlangen, Germany) of the temporal bones was performed using a flat-panel angiography system (Axiom Artis Zee, Siemens) with the following parameters: 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). Higher resolution secondary reconstructions were created using a manually generated volume of interest (VOI) to include only the ossicles, 512 x 512 matrix, Hounsfield units (HU) kernel type, and sharp image characteristic. Intra-operatively, the manubrium fracture was visualized, reduced, and stabilized with hydroxylapatite (HA) bone cement (OtoMimix, Gyrus AMCI, Southborough, MA). An underlay graft of perichondrium reinforced the surrounding tympanic membrane. Postoperatively, audiometry showed closure of the air-bone gap at all tested frequencies except 4 kHz, where it improved to 20 dB HL.

Results
Secondary reconstructions using a smaller VOI created higher resolution images with a slice thickness of 0.03 mm. These images showed a discontinuity of the manubrium of the left malleus consistent with a fracture. The remaining ossicles were intact. Figure 1. Flat panel CT and intra-operative images. Coronal oblique MPR images demonstrate an intact right manubrium (A) but a fracture of the manubrium of the left malleus (B). Intra-operative images confirm the fracture (C), which was repaired (D) with HA bone cement.

Conclusions
Fractures of the manubrium of the malleus typically are diagnosed by otologic examination. Flat panel CT with secondary reconstructions is a novel imaging technique that provides higher resolution images and should be considered for interrogating temporal bone pathology whose radiographic diagnosis requires the ability to depict fine bony detail, including rare entities such as manubrium of the malleus fractures.
Central Nervous System Involvement in Degos Disease

S Ellika¹, A Bhatia², T Feygin², E Schwartz³

Purpose
Malignant atrophic papulosis (Degos disease), is a rare dermatological disorder. Pathologically it is a small vessel angiopathy targeting the skin, gastrointestinal tract (GI), and central nervous system (CNS). Gastrointestinal tract or CNS involvement portends a poor prognosis and high mortality. Neuroradiologic reports of this condition are rare. We report a child with CNS and GI involvement who presented with progressive clinical deterioration and meningovascular pattern at cerebral imaging.

Materials and Methods
A previously healthy 4-year-old male presented to an outside hospital with fever and headaches. His clinical course has included infarctions in the brain and spinal cord, subdural hematoma, and perforated gastric ulcers.

Results
Brain MRI at presentation revealed a right subdural fluid collection and abnormal leptomeningeal enhancement, concerning for an infectious process. Follow-up brain MRI 2 weeks later showed increased leptomeningeal enhancement with new infarctions in the right frontal lobe and the right subdural hematoma. Intracranial CTA then showed irregularity of branches of the circle of Willis, compatible with vasculitis. Follow-up brain MRIs demonstrated development of new hemorrhagic infarctions in the right side watershed territories, diffuse leptomeningeal enhancement, bilateral subdural collections, dural enhancement and vessel wall enhancement. Spinal MRI demonstrated infarctions in the thoracic spinal cord. Brain biopsy was nonspecific, showing chronic vasculopathy with intraluminal fibrin thrombi in microvasculature and some vasculitic changes. Typical skin lesions of Degos disease then were recognized and the diagnosis was confirmed with skin biopsy.

Conclusions
Multifocal intestinal, cerebral, and cutaneous ischemic lesions in the setting of vasculitis should raise the concern for Degos disease. The rash is usually the first recognizable symptom in Degos disease, but other symptoms may precede the skin manifestations, posing difficulties in diagnosis.

Transient Optic Neuropathy after Intrathecal Methotrexate

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E-02
10:35AM - 10:40AM

E-03
10:40AM - 10:45AM
Purpose
Methotrexate (MTX) is an indispensable antimetabolite for the treatment of oncological and immunological disorders in all age groups. It can be administered intravenously as well as intrathecally and may be used alone or in combination with other drugs. Leukoencephalopathy is a well known side effect of MTX, especially in conjunction with intrathecal administration. Rare complications of intrathecal methotrexate include transverse myelopathy and optic neuropathy, likely representing a form of acute demyelination. We report the MR imaging findings in a case of transient optic neuropathy following intrathecal methotrexate, with complete clinical and radiologic resolution on follow up.

Materials and Methods
A 7-year-old boy with relapsed acute lymphoblastic leukemia had received multiple cycles of intrathecal methotrexate. Three days after receiving intrathecal methotrexate (fourth cycle) for known central nervous system involvement, he presented with right sided periocular pain and reduced vision. The left eye was unremarkable. The patient had a marked color deficit and a relative afferent pupil defect on the right. Ophthalmoscopic examination and ultrasonography revealed normal optic discs. MR imaging of the brain and orbits subsequently performed showed new signal changes, thickening, and enhancement of the right optic nerve. Given the recent history of intrathecal MTX, the radiologic possibility of transient drug-induced optic neuropathy was kept over leukemic involvement, and follow up was recommended. Patient was started on steroids. After 3-5 days there was marked improvement in vision in the right eye. Follow-up MR examination showed near complete resolution of signal changes and enhancement of the right optic nerve. The radiologic impression of transient methotrexate-induced optic-neuropathy thus was confirmed.

Results
Postcontrast images through the orbits show thickening and enhancement of the right optic nerve.

Conclusions
Toxic optic neuropathy from methotrexate is rare, but given the large numbers of patients on long term therapy, methotrexate-induced optic neuropathy needs to be considered in the differential diagnosis of visual loss in such patients.
A Rare but Rapidly Destructive Case of Autoimmune Labyrinthitis Associated with Ulcerative Colitis

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Purpose
To study the imaging features of a rare but rapidly destructive autoimmune labyrinthitis associated with ulcerative colitis (UC).

Materials and Methods
A 16-year-old male with a history of ulcerative colitis presented with an acute onset left greater than right sensorineural hearing loss, dizziness, and vertigo. The UC was incompletely controlled at the time with increased fecal frequency and urgency. Extensive infectious work up was negative. Autoimmune serology was nonspecific with only atypical ANCA positivity. Audiogram revealed moderate right, profound left hearing loss. A combination of high dose IV methylprednisolone and intratympanic steroid injections improved hearing only on the right side. He was discharged with oral prednisone and Remicade infusion every 4 weeks for control of both the UC and suspected autoimmune hearing loss. He eventually required hearing aids in both ears.

Results
On the initial MRI, avid enhancement of the left cochlea, vestibule, and semicircular canal as well as the left vestibular nerve in the fundus was noted. The signal characteristics of the peri/endolymph also was slightly less hyperintense than the CSF. Slight left facial nerve enhancement was seen additionally. On the right, lesser degree of enhancement was noted in the cochlea and vestibular nerve. The morphology of the inner ear structures was intact. A follow-up MRI 1 year later showed obliteration of the left posterior semicircular canal with decrease in caliber of the left horizontal and superior semicircular canals. Slight decrease in caliber of the right horizontal semi-circular canal also was seen.

Conclusions
In conclusion, we show a rare case of autoimmune labyrinthitis which evolved to labyrinthine destruction in a patient with ulcerative colitis. As no definitive serologic, immunological or functional tests exist for diagnosis of autoimmune labyrinthitis, understanding the expected evolution of imaging features in this rare disease will be helpful for early diagnosis and treatment.
Enhancement of the L>R Cochlea & Semicircular Canals

T2 FLAIR

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Unusual Presentation of Granulomatous Amebic Meningoencephalitis with Leptomeningeal and Cranial Nerve Enhancement: A Case Report

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\textsuperscript{1}Ramathibodi Hospital, Bangkok, Thailand, \textsuperscript{2}Ramathibodi Hospital, Mahidol University, Bangkok, Thailand, \textsuperscript{3}Indiana University, Indianapolis, IN
Purpose
To demonstrate an unusual presentation of granulomatous amebic meningoencephalitis (GAM) as leptomeningeal and cranial nerve enhancement with multistage infarctions.

Materials and Methods
A 5-year-old previously healthy boy presented with right upper and lower extremity tonic-clonic seizure and subsequently developed gradually progressive right hemiparesis over 1 month.

Results
Initial MRI of the brain demonstrated multifocal parenchymal abnormalities: a mass-like lesion with cortical restricted diffusion, gyriform enhancement, and mild vasogenic edema in the right anterior frontal lobe; cortical restricted diffusion, intrinsic T1-shortening indicative of laminar necrosis, gyriform enhancement, and surrounding vasogenic edema in the left pre/postcentral gyri; small ring-enhancing lesion without significant vasogenic edema or diffusion restriction in the right occipital lobe; small nonenhancing T2-hyperintense lesion in the right thalamus suggestive of an old lacunar infarct. Abnormal leptomeningeal enhancement was identified in the interpeduncular, quadrigeminal and preoptic cisterns as well as abnormal contrast enhancement of cranial nerves III and V-VIII bilaterally. The imaging pattern supported an infectious etiology, presumably granulomatous, and he was treated medically for potential tuberculosis meningitis. A 2-week follow-up MRI brain performed due to clinical deterioration demonstrated progressive diffuse leptomeningeal and cranial nerve enhancement, and progression of parenchymal findings including multiple abscess formation. A right frontal craniotomy was performed with surgical drainage of the right frontal lesion. Greenish pus with focal brain necrosis and granulomatous response was encountered, and Balamuthia mandrillaris was identified on pathology. Currently, patient is still in comatose status.

Conclusions
Balamuthia mandrillaris is a rare CNS pathogen that causes GAM. Most of the reported cases present with solitary or multiple enhancing lesion with hemorrhagic necrosis, formation of abscesses, focal or gyriform enhancement or nodular enhancement along the ventricular surface. No previous reports have documented the presence of focal leptomeningeal and cranial nerve enhancement in GAM. This feature may be an additional finding of GAM.
E-06

Look at This Headache! Focusing on Ophthalmoplegic Migraine.

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Purpose
Ophthalmoplegic migraine is a rare disorder of uncertain etiology, commonly first presenting in children with recurrent episodes of headache and cranial nerve III, IV, or VI palsy. Imaging and spinal fluid testing are helpful to exclude other causes, including Tolosa-Hunt syndrome, aneurysms, neoplasia, myasthenia gravis, and inflammation. Early diagnosis may be promoted through increased awareness of this rare entity, and understanding the importance of contrast-enhanced MRI with attention to the brainstem in evaluation of this disorder. We present a case with classic imaging findings of ophthalmoplegic migraine.

Materials and Methods
A 4-year-old female presented with headache, dizziness, emesis and diplopia, with a negative noncontrast brain MRI. One day later, a brain MRA and contrasted brain MRI with attention to the brainstem was obtained for clinical findings of right eye ptosis and partial adduction palsy, revealing abnormal nodular enhancement of the right cisternal segment of CNIII. Lumbar puncture and labs were negative for autoimmune disorders and malignancy. The patient was discharged with follow-up brain MRI scheduled in 4 months.

Results
1.5T T1-weighted (TE 10/TR 444) 3mm slice thickness imaging through the brainstem shows abnormal thickening and enhancement of the cisternal segment of right CNIII with notable nodular thickening at the root entry zone (see image).

Conclusions
Our case highlights classic imaging findings of ophthalmoplegic migraine in a patient with CNIII palsy and headache. Abnormal enhancement and thickening of cranial nerves III, IV, or VI commonly is seen, often with nodular thickening at the root entry zone as in our case. Enhancement and thickening often decreases on follow-up imaging. Use of thin-slice postcontrast and heavily T2-weighted cisternographic MR sequences through the brainstem are helpful in evaluating for subtle cranial nerve abnormalities.
Imaging Findings of Enterovirus D68

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¹BC Children's Hospital, Vancouver, British Columbia

Purpose
1. To review the clinical presentation of patients infected with enterovirus D68. 2. To demonstrate the imaging findings on magnetic resonance imaging (MRI) in patients with confirmed enterovirus D68.

Materials and Methods
Enterovirus D68 has been linked to a cluster of infections in children across the United States and Canada in the summer and fall of 2014. The children typically presented with a viral prodrome of fever and respiratory illness progressing to asymmetric limb paralysis and severe respiratory distress. All of the confirmed cases at our institution demonstrated similar findings of increased T2 signal and expansion, predominantly in the cervical cord gray matter, involving both the anterior and posterior horns. Currently, there are no published images of the MRI findings in patients affected by this virus. We present a series of five cases of enterovirus D68 that highlight the imaging features on MRI.

Results
The common imaging feature of enterovirus D68 on spinal MRI is increased T2 signal and expansion of the cervical cord gray matter in an asymmetric distribution. Additional features seen in some patients included increased T2 signal within the brainstem, increased T2 signal in the conus gray matter and ventral nerve root enhancement.

Conclusions
Enterovirus D68 has had a recent outbreak in North America, with classic and devastating clinical manifestations including limb paralysis and respiratory failure. Imaging of the spine with MRI can support the diagnosis of acute flaccid myelitis with its characteristic involvement of the gray matter of the cervical cord, including both the anterior and posterior horns. Unfortunately at this time current therapeutic measures have failed at restoring function and supportive care has been recommended.

MR imaging of a case of combined central and peripheral demyelination with anti-neurofascin antibody

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Purpose
Demyelinating disease can affect the central and peripheral nervous system simultaneously. Anti-neurofascin antibody is known to frequently present in patients with combined central and peripheral demyelination (CCPD). We present magnetic resonance imaging (MRI) findings of a rare case of CCPD with anti-neurofascin antibody.

Materials and Methods
A previously healthy 16-year-old boy was evaluated because of a 2-year history of repeated falls, reduced vision and decline in academic performance. Neurological examination showed only mild gait disturbance. Examination of the cerebrospinal fluid (CSF) revealed elevation of protein level and antineurofascin antibody. Electromyography (EMG) revealed peripheral neuropathy (polyneuropathy). Brain and spine MRI revealed white matter disease and peripheral neuropathy. From these findings, a diagnosis of CCPD with antineurofascin antibody was made.

Results
Brain MRI revealed scattered lesions of restricted diffusion and T2 elongation in the periventricular and deep white matter. Cerebellar dentate nuclei also were involved. There was no contrast enhancement in these lesions. These white matter lesions showed interval progression on follow-up MRI studies. Spine MRI revealed enlargement of cervical and lumbosacral nerve roots. MR neurography showed thickening of the brachial and lumbosacral plexus. There was no abnormal signal in the spinal cord.

Conclusions
Brain MRI and MR neurography well demonstrated central and peripheral nervous lesions in a case of CCPD with anti-neurofascin antibody.
Diencephalic-Mesencephalic Junction Dysplasia

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Purpose
To describe imaging features and phenotypic expression of a case of suspected diencephalic-mesencephalic dysplasia, and to discuss potential developmental embryology and genetic etiologies, compared to other causes of midbrain–hindbrain malformations.

Materials and Methods
A 17-year-old female with history of congenital developmental delay and cerebral palsy secondary to in utero isotretinoin exposure presented for evaluation following documented caregiver abuse. Computed tomography (CT) of the head without contrast was performed in the ED, with subsequent neurosurgery consultation and MRI of the brain without contrast.

Results
Computed tomography head showed enlargement of the lateral and third ventricles with a normal sized fourth ventricle, suggestive of aqueductal stenosis. An enlarged midbrain can be seen. MR imaging of the brain confirmed hydrocephalus with enlargement of lateral and third ventricles and with a normal sized fourth ventricle with periventricular T2 prolongation from transependymal fluid migration. There is enlargement of the midbrain with a "thumb" sign on the sagittal view. In addition, there is hypoplasia of the inferior vermis.

Conclusions
Diencephalic-mesencephalic junction dysplasia is an extremely rare form of developmental dysplasia with severe phenotypical expression and was first described in Egyptian families by Zaki et al. in 2012. While the history of isotretinoin exposure is confounding, midbrain abnormalities have not been described with this toxic exposure in utero.
Fetal MRI and Prenatal Ultrasound diagnosis of Syntelencephaly with Post Natal MRI Correlation

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¹Beaumont Health System, Royal Oak, MI, ²Beaumont Health System, ROyal Oak, MI, ³Beaumont Health System, Royal Oak, MI

Purpose
Syntelencephaly, also referred to as the interhemispheric variant of holoprosencephaly, is a
distinct entity separate from the more common types of holoprosencephaly. We present and discuss the prenatal imaging features in a baby diagnosed by MRI and Ultrasound. Embryology relevant to the entity is reviewed briefly.

Materials and Methods
Routine prenatal ultrasound imaging performed on a 24-year-old G2P1 mother, with a history of Type I diabetes, detected concerning findings intracranially that led to a diagnostic fetal MRI. A baby girl was delivered at 37 weeks and 5 days. Postnatal imaging also was performed.

Results
Fetal MRI and ultrasound showed fusion of the posterior superior frontal and anterior parietal lobes in the midline. The genu, anterior body and splenium of corpus callosum were present. However, the posterior half of the body of the corpus callosum was absent along with absence of the septum pellucidum. Imaging findings of holoprosencephaly including fusion of inferior frontal lobes were notably absent. The mother underwent counseling and decided on pursuing pregnancy. Postnatal MRI performed at 3 days confirmed the prenatal imaging diagnosis.

Conclusions
Syntelencephaly is both embryologically and radiographically a distinct entity. Specific imaging features can be seen on prenatal imaging facilitating early diagnosis and assisting in maternal counseling.
Association of Hypothalamic Hamartomas and Periventricular Nodular Heterotopia

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¹UCLA, Los Angeles, CA, ²David Geffen School of Medicine at UCLA, Los Angeles, CA

Purpose
To describe a previously unreported association of hypothalamic hamartomas with periventricular nodular heterotopia (PVNH) in five patients with seizures.

Materials and Methods
Case 1: A 19-year-old male presented with intractable epilepsy beginning at age 10. Complex partial seizures are precipitated by an aura of lightheadedness and blurred vision. EEG suggests left posterior quadrant epileptogenicity with corresponding depth electrode results. MR imaging shows focal PVNH about the left occipital horn and a 6 mm hypothalamic hamartoma, as visualized in the provided figure. 2: A 35-year-old female presents with complex partial seizures beginning at age 9 with occasional secondary generalization. EEG suggests epileptogenicity in the left frontotemporal region. MR imaging shows bilateral temporo-occipital PVNH and a 6 mm hypothalamic hamartoma. 3: A 34-year-old female presents with medically intractable complex partial seizures beginning at age 16. EEG suggests epileptogenicity in the frontotemporal region. MR imaging demonstrates an 8 mm hypothalamic hamartoma and left greater than right focal periatrial PVNH. 4: A 19-year-old female presents with abdominal pain and fatigue with a history of seizures beginning at 13 months, developmental delay, and lupus nephritis. MR imaging demonstrates right lateral ventricle PVNH, a 4 mm hypothalamic hamartoma, and partial agenesis of the corpus callosum. 5: A 34-year-old male presents with complex partial seizures beginning at age 31. EEG suggests right temporo-occipital epileptogenicity. MR imaging demonstrates right occipital PVNH and a 5 mm hypothalamic hamartoma.

Results
Coronal T2-weighted image from case 1 shows a 6 mm central hypothalamic hamartoma. Coronal MPRAGE T1-weighted image from case 1 shows three foci of heterotopic gray matter about the left occipital horn.

Conclusions
Periventricular nodular heterotopia is a relatively common migrational anomaly, which can be associated with seizures. Hypothalamic hamartomas are relatively rare lesions that can be seen with precocious puberty and/or seizures. Prior studies suggest that the association of hypothalamic hamartoma with malformations of cortical development is rare. All five of the cases demonstrated subcentimeter hypothalamic hamartomas. Technological improvements in imaging, as well as dedicated coronal imaging in seizure protocols, potentially may improve detection of small hypothalamic hamartomas. This raises the possibility of a more significant association between hypothalamic hamartomas and PVNH, and suggests that continued research and attention to the hypothalamus may be helpful in the future.
Ipsilateral cerebellar diaschisis (ICD) with intractable seizures after gunshot wound to the head in an infant.

T Teo¹, A Capizzano², L Ponto³, Y Menda⁴, M Graham⁵, T Moritani³
¹University of Iowa Hospital & Clinics, Iowa city, IA, ²University of Iowa Hospitals and Clinics, Iowa City, IA, ³University of Iowa Hospital & Clinics, Iowa City, IA, ⁴University of Iowa, Iowa City, IA, ⁵University of Iowa Hospitals & Clinics, Iowacity, IA

Purpose
To present a case of ipsilateral cerebellar diaschisis (ICD) in an infant with post-traumatic epilepsy using F18-Fluorodeoxyglucose (FDG) positron emission tomography (PET) imaging.

Materials and Methods
A 3.7-year-old female suffered a gunshot wound (GSW) to her right cerebral hemisphere resulting in left hemiparesis. Two years post-traumatic brain injury (TBI), she was diagnosed
with seizures that became medically intractable within 18 months after onset. EEG suggested an epileptic focus located deep within the right frontal lobe. Brain CT showed large right frontoparietal encephalomalacia. Interictal FDG PET demonstrated right frontoparietal cortical defect and hypometabolism in the right cerebellar hemisphere consistent with ipsilateral cerebellar diaschisis.

Results
Figure A, B: Axial CT shows right frontoparietal encephalomalacia with hemispheric atrophy. Figure C, D: Interictal FDG PET images show right frontoparietal cortical defect and ipsilateral decreased cerebellar metabolism.

Conclusions
The term ICD was coined by Hamano et al in 1993 (1). Patients with injuries to the frontal or parietal lobes before age 4 show ipsilateral cerebellar hypometabolism, as opposed to crossed cerebellar diaschisis (CCD) seen in older patients. The different laterality of the cerebellar hypometabolism in ICD is speculated to result from the immaturity of the crossed corticopontocerebellar tract in the developing brain, with a significant role of the earlier myelinating direct inferior cerebellar peduncle fibers instead (1). An in-house retrospective review of epilepsy patients imaged between 2007 and 2014 found a total of 11 cases of CCD and one case of ICD. In our patient, head injury induced impaired cerebellar metabolism by damaging the efferent fibers at the level of the right frontal cortex that explain the left hemiparesis and seizures. Furthermore, on follow-up PET, the ICD findings were less apparent, suggesting reversibility of the remote cerebellar metabolic changes. Given frequent seizure refractoriness leading to surgical evaluation including PET, familiarity with CCD and the less common ICD is warranted.
Pediatric Primary Leptomeningeal PNET presenting with Psychiatric Symptoms and Deceiving MR Imaging

S Shah¹, U Tariq¹, O Bronov¹, J Smith¹
¹Geisinger Health System, Danville, PA

Purpose
To review a complicated case of primary leptomeningeal primitive neuroectodermal tumor (PNET) in a pediatric patient presenting with misleading clinical symptoms and to illustrate deceiving imaging findings including "pseudo-T2" appearance on postcontrast T1 imaging.

Materials and Methods
We present the case of a 10-year-old male who had a history including 6 weeks of mood changes and behavior problems which had been referred to psychiatric care. Somatic complaints developed and included diffuse pain, headache, photophobia, and phonophobia. A generalized seizure prompted presentation to our tertiary care center. Physical examination revealed papilledema and bilateral lower extremity paralysis. Cerebrospinal fluid analysis demonstrated elevated protein. Following imaging, biopsy of the arachnoid matter was performed after L5 laminectomy which showed PNET with glial differentiation, WHO grade IV. The patient was started on chemotherapy along with radiation therapy. Although more recent imaging shows partial remission, the patient has severe residual treatment-related changes including arachnoiditis.

Results
Computed tomography (CT) scan of the head showed symmetric ventriculomegaly suggestive of communicating hydrocephalus. Head magnetic resonance imaging (MRI) showed smooth diffuse leptomeningeal enhancement throughout bilateral sylvian fissures in T1 sequences with contrast. Spine MRI revealed diffuse and homogeneous leptomeningeal enhancement of the subarachnoid space on T1 sequences with contrast with a very deceiving "pseudo-T2" appearance. Significant interval decrease in burden of leptomeningeal enhancement was seen postchemotherapy. However, the presence of severe arachnoiditis remains evident.

Conclusions
Primary leptomeningeal PNET is a rare tumor with little reliable peer-reviewed literature available. Here we present a challenging case of pediatric diffuse primary leptomeningeal PNET.
Atypical Teratoid/Rhabdoid Tumor (ATRT) Arising from the 3rd Cranial Nerve in Infants: A Clinical-Radiological Entity?

C Oh¹, B Orr², B Bernardi³, M Garré⁴, A Rossi⁴, L Figà-Talianca³, G Robinson², Z Patay²
Purpose
In this work, we describe three cases of atypical teratoid/rhabdoid tumors (ATRTs) arising from the 3rd cranial nerve in infancy, all of which demonstrate strikingly similar clinical and radiologic findings. We use these cases to define a unique clinical-radiological constellation, which could help establish an earlier, confident diagnosis of ATRT in this particular location and lead to earlier initiation of therapy.

Materials and Methods
Our case series consists of three infants treated in three different pediatric hospitals, each of which presented within the first 6 months of life with isolated oculomotor palsy. All of the patients underwent several MRI studies of the brain during the course of their disease and demonstrated strikingly similar imaging findings. Open surgical biopsy and partial resection was performed on all three cases, leading to histopathologic diagnoses of ATRT. All of the participants underwent treatment with combination chemotherapeutic regimens based on protocols within their respective institutions. One of the patients underwent proton beam radiotherapy. Despite treatment, disease progression occurred rapidly, and all of the patients died within 10 months. Mean survival time after presentation was 7.5 months, with a range of 4.5 to 10 months.

Results
The imaging findings were nearly identical in each case. At presentation, all of the masses were small, measuring 4-6 mm in diameter, predominantly solid, and located at the anterior aspect of one of the cerebral peduncles near the origin of the 3rd cranial nerve. The masses demonstrated the following: variable but near iso-intensity on T1-weighted images, relative hypointensity on T2-weighted images, marked contrast enhancement, and intrinsic diffusion restriction. As the tumors grew in size, T2-hyperintense cystic changes developed, consistent with areas of spontaneous or therapy-induced necrosis. Overall, the imaging findings of the tumor itself are consistent with those found in ATRT in other, more common, CNS locations. However, the specific location and small size at presentation in our cases is unique and represents a highly suggestive imaging "gestalt".

Conclusions
Atypical teratoid/rhabdoid tumors commonly are misdiagnosed initially, further exacerbating the dismal prognosis of the disease. Therefore, early, accurate diagnosis of this disease is critical. Awareness of the highly consistent and characteristic clinical and imaging pattern we have described here should contribute to such improvements in diagnosis. In an infant (typically < 6 months of age) presenting with isolated unilateral oculomotor nerve palsy, a small enhancing tumor arising from the CN III adjacent to the midbrain that exhibits hypointensity on T2-weighted images and restricted water diffusion should be considered to be strongly suggestive of ATRT. Malignant peripheral nerve sheath tumor (MPNST), though exceedingly rare (especially in infants and absent history of neurofibromatosis), may appear similar and may have a better prognosis; underscoring the need for immediate biopsy, with excision if and when feasible.
Sonographic and MRI Findings of Neurocutaneous Melanosis

Y Chen¹, J Woodley-Cook¹, M Sgro², A Bharatha³
¹University of Toronto, Toronto, Ontario, ²St. Michael's Hospital, Toronto, Ontario, ³St. Michael's Hospital, Toronto, ON

Purpose

Neurocutaneous melanosis (NCM) is a rare nonfamilial phakomatosis with approximately 100 cases reported in the literature. Patients usually have normal neurologic examination at birth, but can present with hydrocephalus, seizures and cranial nerve dysfunction (1). Diagnostic criteria include a large nevi (> 20 cm) or multiple (>3) congenital melanocytic nevi, plus the presence of

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Sex</th>
<th>Age at diagnosis</th>
<th>Initial ophthalmologic signs at presentation</th>
<th>Side of lesion</th>
<th>Size of the lesion at diagnosis (largest diameter, mm)</th>
<th>Clinical events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>5.5 mo</td>
<td>Ptosis, Exotropia, Dysconjugate gaze</td>
<td>R</td>
<td>6</td>
<td>Local tumor recurrence leptomeni dissemination</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>25 d</td>
<td>Ptosis</td>
<td>L</td>
<td>4</td>
<td>Local tumor recurrence leptomeni dissemination</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>5 mo</td>
<td>Ptosis, Non-reactive mydriasis</td>
<td>R</td>
<td>6</td>
<td>Local tumor recurrence leptomeni dissemination</td>
</tr>
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benign central nervous system melanosis or malignant central nervous system melanoma (1). We present a case of NCM in a newborn male diagnosed with ultrasound and MRI, and conduct a literature review of its clinical and imaging findings.

Materials and Methods
Transcalp ultrasound performed on the day of birth demonstrated a few small echogenic foci in the left thalamus and left choroidal fissure, without mass effect (B). Further evaluation with MRI confirmed the presence of those foci, as well as demonstrated additional foci of T1 hyperintensity in bilateral thalami, mesial temporal white matter, inferior basal ganglia, and left cerebellar hemisphere (C). The lesions appeared hypointense on both T2-weighted and susceptibility-weighted images. There was no evidence of leptomeningeal enhancement. Given the presence of the giant nevi, the provisional diagnosis of NCM was established. The patient had a 3-month follow-up MRI, which demonstrated stable lesions (D).

Results
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Conclusions
Our case elegantly demonstrates the sonographic features of intracranial melanosis. Although the diagnosis of NCM is not definitive on ultrasound, it is important for radiologists to recognize its sonographic appearance and be alerted to the potential diagnosis given an appropriate clinical history. MR imaging is the modality of choice in the diagnosis and characterization of intracranial melanosis, however remains insensitive in differentiating between benign and malignant types. Features suggestive of malignancy include enlarging lesion size, parenchymal invasion, and intralesional necrosis and hemorrhage (2).
Iatrogenic Pediatric Spinal Epidermoid Cyst. Definite Role of DWI in Preoperative Diagnosis. Case Report

P Cornejo\textsuperscript{1}, M Klysik\textsuperscript{2}, J Curran\textsuperscript{3}

\textsuperscript{1}Phoenix Children's Hospital, Phoenix, AZ, \textsuperscript{2}Barrow Neurological Institute, Phoenix, AZ, \textsuperscript{3}Phoenix Children's Hospital, Phoenix, AZ

Purpose
Our case demonstrates the importance of diffusion-weighted imaging in the differential diagnosis of intraspinal masses in pediatric patients.

Materials and Methods
A 5-year-old, previously healthy male presented to routine consultation for several months of progressive low back pain with no associated neurological deficits. Upon further investigation, the patient had two lumbar punctures as an infant, part of a fever workup.

Results
Total MRI of the spine without contrast was performed. Images demonstrate a well circumscribed, ovoid, intradural lesion at the level of L3-L4 which is mostly hyperintense on T2
with a thin-rim of T2 hypointensity and iso-hypointense on T1. The lesion exhibits intrinsic diffusion restriction and thin-marginal enhancement. The descending nerve roots are displaced peripherally by this lesion. Imaging findings and clinical history are consistent with an intraspinal epidermoid cyst.

Conclusions
Spinal epidermoid cysts can be congenital, or more frequently, iatrogenic lesions formed by unintended inclusion of skin debris during lumbar puncture or other spinal surgical interventions. Diffusion-weighted imaging of the spine is essential in the pre-operative differentiation of epidermoid from arachnoid cyst.
Idiopathic Spinal Cord Herniation in a Child: Diagnostic Value of 3-Dimensional Turbo Spin Echo with Variable Flip Angle MRI Sequence (T2-SPACE)

M Ferris¹, J Mah², M Benour², V Moorjani², M Albayram²
¹University of Calgary, Calgary, Alberta, ²Alberta Children's Hospital, Calgary, Alberta

Purpose
Idiopathic spinal cord herniation is a very rare disorder in children (1). We present the imaging findings of a pediatric patient with idiopathic spinal cord herniation that was well demonstrated using a 3-dimensional turbo spin echo with variable flip angle sequence (T2-SPACE) using a 1.5T MRI (Avanto, Siemens, Erlangen, Germany) without using CT myelogram or other invasive technique.

Materials and Methods
A 17-year-old, previously healthy male presented with progressively worsening right leg weakness and right foot drop over 4 months. He denied any history of pain or bowel or bladder dysfunction. Physical examination revealed right lower extremity motor and sensory deficits characterized by distal muscle paresis including foot drop, hyperreflexia, clonus, altered temperature and decreased vibration sense. There was no prior history of spinal intervention, surgery or significant trauma. Based on MR imaging, a diagnosis of spinal cord herniation was made. Due to the patient's progressive myelopathy, surgical treatment was recommended. Four days later, the patient underwent T4-5 laminoplasty, which revealed a strangulated herniated spinal cord segment corresponding to imaging findings. The dural defect was extended in order to safely reduce the spinal cord hernia. Visual inspection of the spinal cord following reduction revealed three focal areas of gliosis. The dural defect was repaired using a dural patch. In the immediate postoperative period, the patient had increased bilateral lower extremity paresis. Repeat MR imaging performed on the second postoperative day demonstrated cord expansion and edema at T4-5. A short course of oral corticosteroids and a physiotherapy regime were initiated. The patient showed gradual improvement until the time of discharge, 9 days postoperatively.

Results
Multisequence, multiplanar MR imaging of the entire spine including a 3-dimensional T2-weighted sampling perfection with application optimized contrast using different flip angle evolutions (3D-T2 SPACE) sequence was performed on a 1.5T magnet. Imaging demonstrated focal right ventrolateral extradural herniation of the spinal cord through a suspected dural defect at the T4-5 level (Figure 1A-B). Sagittal imaging demonstrated a c-shaped kink in the spinal cord, cord thinning and increased T2 signal intensity of the displaced cord consistent with edema (Figure 2). There was marked enlargement of the dorsal subarachnoid space at the same level (Figure 1A). A large epidural fluid collection extending from C6 to T8 was present, most likely a cerebrospinal fluid (CSF) leak from the dural defect. No abnormal cord enhancement, susceptibility artifact or restricted diffusion was demonstrated. There was no associated osseous or intervertebral disc pathology.
Conclusions
Idiopathic spinal cord herniation, although rare, must be considered in the differential diagnosis of myelopathy in a child. TSE T2-weighted 3-dimensional MRI sequences, such as 3D-T2 SPACE provide effective noninvasive thin section images in a single volumetric data set with good spatial resolution to permit definitive diagnosis of the spinal cord herniation.

Figure 1A. 3D-T2 SPACE axial 3T MR image superior to the cord herniation demonstrates a large dorsal subarachnoid space (white arrows) and eccentric right ventrolateral displacement of the spinal cord (white arrowhead). Note the CSF-intensity epidural fluid collection (*).

Figure 1B. 3D-T2 SPACE axial 3T MR image at the level of the cord herniation demonstrates extradural spinal cord (white arrow).

Figure 2. 3D-T2 SPACE sagittal 3T MR image at the level of the cord herniation demonstrates a c-shaped kink in the spinal cord with focal spinal cord thinning and increased signal intensity consistent with edema (white arrows).

(Filename: TCT_E-17_Slide1.jpg)

Monday
12:15PM - 1:15PM
Sheraton Chicago Hotel & Towers, Hall A - River Exposition - Level 1

Exhibits Tour (CME)
Monday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)
04A - ASHNR: CANCER IS THE ANSWER: PATIENT CENTERED HEAD AND NECK CANCER IMAGING

04A-1

1:15PM - 1:35PM

Laryngeal Cancer: Distinguishing Candidates for Speech Conversation

Stambuk, H.
Memorial Sloan-Kettering Cancer Center
New York, NY

04A-2

1:35PM - 1:55PM

Important Imaging Issues in Head and Neck Cancer

Morales, R.
University of Maryland Medical Systems
Baltimore, MD

04A-3

1:55PM - 2:25PM

Creating Outcome Driven and Patient Centered H&N Cancer Services

Weber, R.
The University of Texas MD Anderson Cancer Center
Houston, TX

04A-4

2:25PM - 2:45PM

PET-CT: Appropriate Utilization in Your Head and Neck Practice

Anzai, Y.
University of Utah
Salt Lake City, UT

Monday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)

04B - ASPNR: BACK TO THE FUTURE: FETAL MR IMAGING IN 2015

04B-1

1:15PM - 1:25PM

Pediatric Neuroradiology in Europe: Past, and Future
04B-2  1:25PM - 1:45PM
Fetal MRI of the Brain: How Identification of Prenatal Brain Abnormalities Guides Pre-, Peri-, and Postnatal Management

Girard, N.
APHM Timone
Marseille

04B-3  1:45PM - 2:05PM
Fetal MRI of the Spine: Increasing our Understanding of Congenital Spine Abnormalities and Developing Prenatal Therapies

Glenn, O.
Univ. California San Francisco
San Francisco, CA

04B-4  2:05PM - 2:25PM
Fetal DTI: Insights into Microstructural Connectivity of the Developing Brain and Neuroplasticity Remodeling in Prenatal Malformations

Prayer, D.
Department of Biomedical Imaging and Image-guided Therapy, Medical University of Vienna
Vienna, Austria

04B-5  2:25PM - 2:45PM
Quantitative Fetal MRI: Advanced Neuroimaging Tools to Predict Postnatal Outcome

Limperopoulos, C.
Children's National Medical Center
Washington, DC
Monday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

04C - YOUNG PROFESSIONAL II: ADVANCED IMAGING: STARTING YOUR OWN SERVICE

04C-1

Vessel Wall Imaging

DeMarco, J.
Michigan State University
East Lansing, MI

1:15PM - 1:40PM

04C-2

fMRI & Perfusion MRI

Dehkharghani, S.
Emory University Hospital
Atlanta, GA

1:40PM - 2:05PM

04C-3

Interventional Spine Service: Beyond LP's & Myelos

Doshi, A.
Mount Sinai Hospital
New York, NY

2:05PM - 2:30PM

04C-4

Discussion

2:30PM - 2:45PM

Monday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)
04D - GENERAL: SPOTTY SCIENCE: EVERYTHING YOU NEED TO KNOW ABOUT ICH AND THE "SPOT SIGN"

04D-1

Intracranial Hemorrhage: Clinical Perspective – Scope of the Problem

Flaherty, M.
UC Neuroscience Institute
Cincinnati, OH

04D-2

CTA Spot Sign: Boot Camp

Aviv, R.
Sunnybrook and Women's College HSC
Toronto, ON

04D-3

Clinical and Imaging Models of ICH Expansion Prediction

Huynh, T.
University of Toronto
Toronto, ON

04D-4

Current ICH Studies Utilizing “Spot Sign”- A Review

Flaherty, M.
UC Neuroscience Institute
Cincinnati, OH

04D-5

Future Directions in Evaluating Intracranial Hemorrhage

Chakraborty, S.
University of Ottawa
Ottawa, Ontario
Purpose
We have sometimes encountered dynamic susceptibility contrast-enhanced (DSC) perfusion MR imaging with signal loss and geometric distortion in post-treatment glioblastoma. To compare the diagnostic accuracy and reproducibility of diffusion-weighted imaging (DWI) and dynamic contrast-enhanced (DCE) perfusion MR imaging when applied to the post-treatment glioblastoma with noninterpretable DSC perfusion MR imaging.

Materials and Methods
Thirty-nine post-treatment glioblastoma patients with noninterpretable DSC perfusion MR imagings who had undergone both DWI and DCE perfusion MR imaging were enrolled in this study. The histogram cutoffs of DCE imaging and DWI were calculated. The area under the receiver operating characteristic curve (AUC) and leave-one-out cross-validation for distinguishing tumor recurrence from treatment-related change and inter-reader agreement were assessed.

Results
There were three main causes of noninterpretable DSC perfusion MR imaging, and which included treatment-related hemorrhage (n=26), skull base location (n=8), and too small size (n=5). For determination of tumor recurrence or treatment-related change, DCE perfusion MR imaging showed a significantly higher AUC than DWI in patients with noninterpretable DSC imaging (AUC: 0.80 versus 0.57 for reader 1 and 0.79 versus 0.51 for reader 2). Leave-one-out cross validation was done for DCE imaging (AUC: 0.77 for reader 1, 0.74 for reader 2, accuracy: 69.2% for both readers). Inter-reader agreement for DCE perfusion MR imaging was higher than that for DWI (intraclass correlation coefficient: 0.97 versus 0.87).

Conclusions
DCE perfusion MR imaging showed a higher diagnostic accuracy and reproducibility than DWI for distinguishing tumor recurrence from treatment-related change in post-treatment glioblastoma when DSC perfusion MR imaging is not interpretable.
DSC MR Perfusion Imaging may Identify Incipient Progression or Suspected Recurrence of Post-treatment GBM: Preliminary Study

J Collins¹, S McCann¹, D Kromrey¹, D Ginat¹, S Lee¹
¹The University of Chicago, Chicago, IL

Purpose
To evaluate the diagnostic value of dynamic susceptibility contrast (DSC) MR perfusion imaging in post-treatment glioblastoma (GBM) patients for the detection of incipient progression before it becomes evident on conventional MR images.

Materials and Methods
Dynamic susceptibility contrast MR perfusion studies of 12 post-treatment tumor progression patients were reviewed retrospectively. Inclusion criteria were: 1) pathologically proven GBM patients; 2) a follow-up MRI including DSC MR perfusion study showing no evidence of tumor progression on conventional MR images (MRI before Tumor Progression: MR-bTP); and 3) a subsequent follow-up MRI showing tumor progression on conventional MR images (MRI with Tumor Progression: MR-wTP). For patients with confirmed progression, the last exam showing no evidence of tumor progression was used for postprocessing with a commercially available software package (Olea Sphere®, Olea Medical, La Ciotat, France). Visual assessments of perfusion maps as well as region of interest (ROI) measurements of both the tumor progression area and a reference area (generally the contralateral normal appearing region) were performed. Tumor progression reference area region of interest ratios were calculated for rCBV, leakage corrected rCBV, rCBF, and K2 maps.

Results
The median interval between MR-wTP and MR-bTP was 2 months (average 2.42 month, range: less than a month ~ 5 month). In nine patients (9/12=75%), visual assessment and ROI ratio assessment showed matching increased perfusion values in the area which later progressed on the MR-wTP. Median ROI ratios of rCBV, corrected rCBV, rCBF and K2 were 1.34, 1.45, 1.35,
and 1.47, respectively. In three patients, there were no visual perfusion abnormalities and no elevated ROI ratios in the area which later progressed. With visual assessment, all positive corrected rCBV regions also were identified on the noncorrected rCBV map. The ROI ratio between rCBV and corrected rCBV did not show a statistically significant difference (p>0.05, paired t-test).

Conclusions
In post-treatment GBM, follow-up MR perfusion imaging may provide valuable information to help identify areas of incipient progression or recurrence before these become evident on conventional sequences. However, the corrected rCBV maps do not seem to increase detectability of incipient tumor progression when compared to noncorrected rCBV maps.

O-36
Tofts Model-Corrected Leakage Correction of Relative Cerebral Blood Volume (rCBV) Maps for Single-Echo Gradient Echo Dynamic Susceptibility Contrast (DSC)-MRI Acquisitions

B Ellingson¹, K Leu², T Cloughesy¹
¹University of California Los Angeles, Los Angeles, CA, ²UCLA, Los Angeles, CA

Purpose
Contrast agent extravasation through a disrupted blood-brain barrier leads to inaccurate estimation of relative cerebral blood volume (rCBV). Boxerman et al. (method I) proposed a method to correct for this phenomenon. In this study, we present a method (method II) to correct for extravasation that incorporates the Tofts model² and validate the findings with dynamic contrast-enhanced (DCE) MRI, whose signal arises from the leakage of contrast agent.

Materials and Methods
Twenty-five anonymized, histologically proven glioblastomas had dynamic susceptibility contrast (DSC) MRI and DCE MRI acquisitions from the same scan session. Both method I and method II involve least squares fitting to the terms K1, a term reflective of rCBV magnitude, and K2, a term that reflects the extent of contrast agent leakage. The difference between method I and method II is the incorporation of Kep, which reflects the backflow of contrast agent from the tissue to the blood plasma.

Results
Modeling of rCBV involves extracting two terms: the "true" rCBV and the leakage term associated with extravasation into tissue. Figure 1 demonstrates that the leakage term better reflects the DCE MRI curve, whose signal is similarly derived from contrast agent extravasation. Furthermore, the rCBV is underestimated by method I. Overall, in all 49 tumors, the average percentage difference in rCBV between method I and method II was 19.2%.

Conclusions
Our model (method II) better reflects the underlying biology of contrast agent leakage, as evidenced by its closer approximation of the DCE MRI curve.
Relationship of Subventricular Zone with Tumor Blood Volume, Tumor Genomics and Patient Survival in Glioblastomas: A TCGA Glioma Phenotype Research Group Project

B Griffith¹, L Poisson¹, L Bangiyev², J Huse³, R Jain⁴
¹Henry Ford Health System, Detroit, MI, ²Stony Brook University Medical Center, Stony Brook, NY, ³Memorial Sloan Kettering Cancer Center, New York, NY, ⁴NYU Langone Medical Center, New York, NY

Purpose
To determine whether location of glioblastoma (GBM) relative to the subventricular zone (SVZ) is associated with patient survival and how it correlates with genomic/molecular expression, as well as with tumor blood volume.

Materials and Methods
Patients with untreated GBM, molecular information assayed by The Cancer Genome Atlas (TCGA) and presurgical imaging collected by The Cancer Imaging Archive (TCIA) were included (n=203). Tumor locations were classified to location in both the SVZ and cortex (Group I, n=92), SVZ only (Group II, n=18), cortex only (Group III, n=86), or neither SVZ nor cortex (Group IV, n=7). Molecular analysis included t-test screening of differential expression and functional analysis by Ingenuity Pathway Analysis. DSC T2* MR perfusion data were available for 45 patients and rCBV of the contrast enhancing lesion (CEL) and nonenhancing lesion (NEL) was evaluated.

Results
Subventricular zone GBM patients have shorter OS (median 0.81 years, 95% CI (0.64, 0.99)) compared to those with only cortex involvement [median 1.28 years, 95% CI (1.16, 1.63), log-rank p=0.0030]. When evaluating rCBV CEL, there was no statistically significant difference between various groups. When evaluating rCBV NEL, there is evidence of a difference in mean rCBV NEL-max between the groups (p=0.0502). Genes within canonical (e.g., RAC, ERK/MAPK, JAK/STAT) and immune (e.g., TNF) signaling pathways show increased activity in Group II tumors relative to Group III. Though classic stem cell markers (e.g., CD133) are not differential, networks of overexpressed genes suggest a developmental role with emphasis on histone modification (e.g., HOXB genes and HIST3H3).

Conclusions
Glioblastomas involving the SVZ have worse overall survival and also increased rCBV NEL as compared to those without SVZ involvement. Our study suggests that these observed differences in vascular phenotype and survival may, in part, be driven by molecular differences between SVZ-originating and cortex-originating GBMs.

Prospective Clinical Evaluation of Perfusion Weighted MRI for Diagnosis of Pseudoprogression in Glioblastoma

O-38

1:47PM - 1:55PM
Purpose
Current treatment for glioblastoma (GBM) includes surgical resection followed by combined radiation therapy with temozolomide chemotherapy (RT TMZ). Disease management is complicated by failure of conventional MRI to distinguish early tumor progression (EP) from treatment effects termed pseudoprogression (PP). Multiple published studies using perfusion MRI with relative cerebral blood volume (rCBV) calculation have attempted to distinguish EP/PP with inconsistent results. Published retrospective analysis by Kong et al (2011) evaluated rCBV and O-6-methylguanine-DNA methyltransferase promoter (MGMT) methylation status. Pseudoprogression was more common with MGMT methylation (MGMT+), and rCBV failed to distinguish EP/PP in MGMT+ subjects. We initiated a prospective study to validate clinical use of DSC perfusion in GBM subjects with new lesions in the immediate postradiation period.

Materials and Methods
A prospective study was performed on subjects with histology proven primary GBM following gross total resection and RT TMZ. Following IRB approved protocol, 25 subjects were screened prospectively for inclusion, with criteria including development of new focal enhancing lesions within 3 months of completing RT-TMZ. Nine subjects met inclusion criteria and underwent additional perfusion MRI using dynamic susceptibility contrast enhanced (DSC) T2*-weighted technique with gadobutrol intravenous injection. Imaging was performed on a 3T scanner (Siemens Medical Solutions Trio) with calculation of CBV images on the scanner console. Region of interest analysis was performed to calculate rCBV with comparison to normal appearing white matter in the contralateral hemisphere. The subjects were followed clinically and with MRI to determine EP/PP. All subjects were followed to tumor progression, or >6 months of stable MRI without recurrence. MGMT methylation status was determined from GBM tissue samples.

Results
Three subjects showed EP and six subjects showed PP. Relative CBV values in EP ranged between 3.0-5.0. The range of rCBV values for PP was between 0.3 and 4.0. Six subjects were MGMT-. Relative CBV cutoff value of 2.0 correctly differentiated EP from PP for all of these subjects. Three subjects were MGMT+. All MGMT+ subjects had elevated rCBV on perfusion MRI scans in the range of 2.4-3.0. None of the MGMT+ subjects showed tumor progression within 3 months of completing RT-TMZ. Elevated rCBV did not accurately predict EP in MGMT+ subjects.

Conclusions
The current prospective study is consistent with published retrospective analysis which showed no significant difference in rCBV values between the EP and PP groups for MGMT+ subjects. Data are limited by the number of MGMT+ subjects enrolled to date. Caution is advised in the interpretation of DSC perfusion in the immediate post-treatment setting in subjects who are MGMT+, as they frequently have PP. These preliminary results indicate rCBV calculation from DSC perfusion may not be accurate in differentiating EP from PP in the immediate post-treatment period.
IVIM Perfusion Fraction is Prognostic for Survival in Brain Glioma

M Cerny¹, M Roux¹, P Maeder¹, A Hottinger¹, R Meuli¹, C Federau¹

¹CHUV, Lausanne University Hospital, Lausanne, Switzerland

Purpose

IVIM MR perfusion imaging is a noninvasive (i.e., without contrast injection) method to measure local microvascular perfusion (1), and was shown to be of value to differentiate high and low grade gliomas (2). While currently standardly used dynamic susceptibility contrast-enhanced perfusion imaging has been shown to be predictive of survival in brain glioma (3), a similar study with IVIM is lacking. Therefore, the aim of this study was to determine whether the IVIM perfusion parameters were predictive for survival in our patient group with brain glioma.

Materials and Methods

The 27 patients, who were presented in (2), [16 high-grade tumors (all pathologically proven), 11 with low-grade tumors (5 pathologically proven, 6 based on radiological criteria)] were considered for this study. Our database was searched for survival or date of death. Exclusions criteria were death unrelated with the brain glioma and missing follow-up data. The patients were put in one of two groups, death or alive at the time of study. The results of the IVIM parameters obtained in the region of interest plotted in (2), which were drawn in the region of the tumor with maximal IVIM perfusion fraction, were reused. Pearson's correlation coefficients (4) were calculated between the IVIM perfusion parameters and minimal survival, which was defined as time interval between IVIM measurement and death or, if the patient was alive, the study date. Statistical significance was assessed using one-tailed Student's t-test, and was set to p < 0.05.

Results

Twenty-five of 27 patients were included in this study. Two patients were excluded: the first because no follow-up data were available, the second because the patient died following intraoperative complications. Eleven patients were deceased at the time of study (558.5 ± 339.8 days in average after IVIM imaging), and 14 were alive (930.5 ± 290.7 days average follow-up). The deceased group had a statistically significant higher perfusion fraction f (12.8 ± 3.3% vs 9.1 ± 3.0%, p = 0.003) and pseudo-diffusion coefficient D* (13.5 ± 5.2 vs 8.3 ± 3.8 10^-3 mm²/s, p = 0.004) compared to the nondeceased group (Table 1), with a fair to good negative correlation of -0.557 (Figure 1) and a weak correlation of -0.348 respectively.

Conclusions

In this initial study, IVIM perfusion fraction f and, to a lesser extend, pseudo-diffusion coefficient D* were prognostic for survival in patients with brain glioma.

<table>
<thead>
<tr>
<th></th>
<th>f [%]</th>
<th>D* [10^-3mm²s^-1]</th>
<th>fD* [10^-3mm²s^-1]</th>
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</thead>
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<tr>
<td>Dead</td>
<td>12.8 ± 3.3</td>
<td>13.5 ± 5.2</td>
<td>1.2 ± 0.7</td>
</tr>
<tr>
<td>Alive</td>
<td>9.1 ± 3.0</td>
<td>8.3 ± 3.8</td>
<td>1.3 ± 0.3</td>
</tr>
<tr>
<td>p-value</td>
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<td>0.004</td>
<td>0.36</td>
</tr>
<tr>
<td>Corr. Coeff.</td>
<td>-0.557</td>
<td>-0.348</td>
<td>0.158</td>
</tr>
</tbody>
</table>
Pre-treatment rCBV is a potential predictive imaging biomarker of bevacizumab efficacy in recurrent glioblastoma

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Purpose
To analyze the relevance of dynamic susceptibility-weighted contrast-enhanced MRI (DSC MRI) derived relative cerebral blood volume (rCBV) analysis for predicting response to bevacizumab in patients with recurrent glioblastoma (rGB).

Materials and Methods
A total of 127 patients diagnosed with rGB receiving either bevacizumab (71 patients, BEV-cohort) or alkylating chemotherapy (56 patients, non-BEV-cohort) underwent conventional-anatomical MRI and DSC MRI at baseline and at first follow up after treatment initiation. The mean rCBV of the contrast-enhancing tumor (cT1), as well as cT1 and FLAIR volumes at both time-points were correlated with progression-free and overall survival (PFS, OS) using Cox proportional hazard models, cross-validated logistic regression models, and the log-rank test.

Results
Baseline rCBV was associated with both PFS [hazard ratio (HR) = 1.3; p < 0.01] and OS (HR = 1.3; p < 0.01) in the BEV-cohort and predicted 6-month PFS in 82% and 12-month OS in 79% of patients, whereas it was not associated with PFS (HR = 1.0; p = 0.70) or OS (HR = 1.0; p = 0.47) in the non-BEV-cohort. Corresponding median OS and PFS rates in patients with less (greater) than the median baseline rCBV were 11.8 (6.6) and 5.8 (2.8) months in the BEV-cohort (p < 0.01, respectively), as compared to 8.0 (5.9) and 2.6 (2.6) months in the non-BEV-cohort (p = 0.11 and 0.65). cT1 and FLAIR-volumes at first follow up were significant predictors of 6-month
PFS and 12-month OS in the BEV-cohort but not in the non-BEV-cohort. Corresponding volumes at baseline were not significant in any cohort.

Conclusions
Pretreatment rCBV is a potential predictive imaging biomarker in bevacizumab-treated, but not alkylating chemotherapy-treated rGB, which is superior to volumetric analysis of conventional-anatomic MRI and predicts 6-month PFS and 12-month OS in 80% of bevacizumab-treated patients.

**O-41**

**Impact of software modeling on the accuracy of perfusion MRI in glioma.**

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¹Mayo Clinic in Arizona, Phoenix, AZ, ²Mayo Clinic, Rochester, Rochester, MN, ³Barrow Neurological Institute, Phoenix, AZ, ⁴Mayo Clinic, Rochester, MN, ⁵University of California Los Angeles, Los Angeles, CA, ⁶Barrows Neurological Institute, Saint Joseph's Hospital and Medical Center, Phoenix, AZ

Purpose
To determine whether changing the implementation of software modeling will impact the accuracy of relative cerebral blood volume (rCBV) metrics on T2*-weighted dynamic susceptibility-weighted contrast-enhanced (DSC) MRI at 3T field strength when omitting preload dose (PLD) or comparing with histologic benchmarks.

Materials and Methods
This HIPAA-compliant study included 52 glioma patients undergoing DSC-MRI. Thirty-seven patients underwent both non-PLD and PLD-corrected DSC acquisitions, with 15 patients undergoing PLD-corrected acquisitions only. For each acquisition, we generated two sets of rCBV metrics using two separate, widely published, FDA-approved commercial software packages (IB Neuro, nordicICE). We calculated 4 rCBV metrics within tumor volumes: mean rCBV, mode rCBV, percentage of voxels with rCBV > 1.75 (%>1.75), and percentage of voxels with rCBV > 1.0 (fractional tumor burden or FTB). We determined Pearson (r) and Spearman (ρ) correlations between non-PLD- and PLD-corrected metrics. In a subset of recurrent glioblastoma patients (n=25), we determined receiver operator characteristic (ROC) areas-under-curve (AUC) for FTB accuracy to predict the tissue diagnosis of tumor recurrence versus post-treatment effect. We also determined correlations between rCBV and microvessel area (MVA) from stereotactic biopsies (n=29) in 12 patients.

Results
Using IB Neuro, rCBV metrics correlated highly between non-PLD- and PLD-corrected conditions for FTB (r=0.96, ρ=0.94), %>1.75 (r=0.93, ρ=0.91), mean (r=0.87, ρ=0.86) and mode (r=0.78, ρ=0.76). These correlations dropped substantially using nordicICE. Fractional tumor burden performed significantly better when using IB Neuro (AUC=0.85) compared to nordicICE (AUC=0.67) (p<0.01). The highest rCBV-MVA correlations required PLD and IB Neuro modeling (r=0.64, ρ=0.58, p=0.001).
Conclusions
Different implementations of modeling correction can influence the accuracy of rCBV and its correlation with tissue benchmarks.

Usefulness of Dynamic Contrast Enhanced (DCE), Dynamic Susceptibility Contrast (DSC) and Diffusion Weighted (DW) MRI in Differentiating Tumor Progression from Treatment Related Changes in High Grade Gliomas.

N Zakhari¹, T Nguyen¹, A Boivin², G Jansen³, J Woulfe³, G Cron³, R Thornhill³
¹The Ottawa Hospital, University of Ottawa, Ottawa, Ontario, ²University of Ottawa, Ottawa, Ontario, ³The Ottawa Hospital, Ottawa, Ontario

Purpose
The appearance of a new enhancing lesion after surgery and chemoradiation for high grade glioma presents a common diagnostic dilemma (1- 4). We evaluated the diagnostic accuracy of DCE, DSC and DW MR for differentiating tumor progression from post-treatment changes.

Materials and Methods
This prospective study included 33 consecutive patients with high grade glioma who developed a new enhancing lesion on post-treatment MR. The patients were classified as tumor progression or nonprogression based on histopathological analysis or clinical/imaging follow-up. Each patient underwent a 3T MR examination including dynamic contrast-enhanced (DCE), dynamic susceptibility contrast (DSC) and diffusion-weighted (DW) sequences. Ktrans, AUC, Vp, CBV, corrected CBV and ADC maps were generated using a commercial software (Olea Sphere 1, Olea Medical). Region of interest (ROI) was placed over the largest enhancing component on a selected representative section for histogram analysis and over the perceived hot spots for each parametric map. The peak height position and the maximum value were recorded for the histogram analysis. Differences between the two patient groups were assessed via Mann-Whitney U test. Receiver operating characteristic (ROC) curve analysis was performed.

Results
There were 29 patients with progression and four patients with post-treatment changes with a total of 35 lesions. The progression group had significantly higher Ktrans values on hot spot (median (IQR) 0.765 (0.48 - 1.4) versus 0.235 (0.075 - 0.55); (p = 0.0231) and histogram analysis (p = 0.0422) and higher AUC values (p = 0.0543). Vp, CBV, corrected CBV and ADC maps showed no significant differences between the two groups (p>0.05). The ROC area under the curve (Figure dynamic contrast-enhanced (1) ) was highest for Ktrans (0.854; p=0.0039). Ktrans cutoff value > 0.32 showed sensitivity 93.3% and specificity 75% for progression detection.

Conclusions
Dynamic contrast-enhanced (DCE) MR derived Ktrans using hot spot or histogram analysis might be a useful parameter in differentiating between tumor progression and nonprogression. Cerebral blood volume (CBV) and ADC values did not show significant differences between the two groups.
Fig. 1 ROC curves of $K_{\text{trans}}$, AUC and corrected $K_{\text{trans}}$. 
Perfusion and Permeability MRI Biomarkers for Enhancing and Nonenhancing Components Predict Patient Survival in Newly Diagnosed Glioblastoma

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¹Biomedical Research Institute of Girona (IDIBGI), Hospital Dr Josep Trueta, Girona, Girona, ²Department of Computer Science, Applied Mathematics and Statistics, University of Girona, Girona, Girona, ³Philips Healthcare Ibérica, Madrid, Madrid, ⁴Catalan Institute of Oncology (ICO), Hospital Cancer Registry, Hospital Universitari Dr Josep Trueta, Girona, Girona, ⁵Department of Radiology, University of Manitoba, Winnipeg, Manitoba, ⁶NYU Langone Medical Center, New York, NY

Purpose
Accurate prognosis of newly diagnosed glioblastoma would improve patient management. Although growing evidence suggests that advanced MR imaging techniques, such as dynamic susceptibility contrast (DSC) perfusion-weighted imaging (PWI) and diffusion-weighted imaging (DWI) may speculate on patient's survival, the fact is that MR imaging biomarkers' role prognosis in newly diagnosed glioblastoma remains unclear. Therefore, we retrospectively determined the usefulness of DSC, permeability maps, DWI parameters, and extensive battery of qualitative findings for contrast-enhancing lesion (CEL) and surrounding non-CEL in predicting newly diagnosed glioblastoma survival.

Materials and Methods
Before treatment, 33 consecutive patients (22 men; mean age, 63 years) with histologically proven glioblastoma underwent 1.5T MRI (anatomical, first-pass DSC, and postcontrast T1-weighted sequences). We obtained volumes of interest for cerebral blood volume ratio, cerebral blood flow ratio, mean transit time (MTT), time-to-maximum, time-to-peak, permeability constant (k2), and ADC in CEL, NCEL, and contralateral tissue using Olea Sphere V.2.0 software (Olea Medical, La Ciotat, France). We used a recently proposed set of controlled MRI features called VASARI [Visually Accessable REMBRANDT ([Repository for Molecular Brain Neoplasia Data) Images]. Therefore, the following 26 MRI descriptors were used: major axis length, minor axis length, tumor location, side of lesion center, eloquent brain, enhancement quality, proportion enhancing, proportion NCET, proportion necrosis, cysts, multifocal or multicentric, T1/FLAIR ratio, thickness of CEL margin, definition of the CEL margin, definition of the NCEL margin, proportion of edema, edema crosses midline, hemorrhage, DWI characteristics, pial invasion, ependymal invasion, cortical involvement, deep WM invasion, NCET tumor crosses midline, CEL crosses midline, satellites, and calvarial remodeling. Patients were classified by survival: 6 months. Surgery, radiotherapy and chemotherapy was considered complete treatment.

Results
Twenty patients (60.6%) survived <6 months. Eleven (33.3%) underwent complete treatment. Survival groups differed in treatment (P=0.037), MTT-CEL (4.6±1.5 versus 5.5±1.2mL; P=0.043), k2-CEL (-30.22±90.12 versus -113.21±94.69; P=0.018), k2-NCEL (-20.22±34.06
versus -59.74±58.72; P=0.041), for 6 months survival, respectively. k2-CEL best predicted survival at 6 months (AUC=0.738, 57.1% sensitivity, 83.3% specificity, 72.7% positive predictive value, 71.4% negative predictive value). k2-CEL and treatment yielded the best combined prediction of survival at 6 months (AUC=0.83, 64.3% sensitivity, 88.9% specificity, 81.8% positive predictive value, 76.8% negative predictive value).

Conclusions
Preliminary data suggest PWI and permeability parameters might predict survival in newly diagnosed glioblastoma. More specifically, MTT-CEL, k2-CEL, and k2-NCEL seem useful advanced MRI survival biomarkers.

O-44

Correlation between DSC- and DCE-derived Parameters and Mean Vascular Density and Area in Patients with Newly Diagnosed Astrocytomas

T Nguyen¹, K Perdrizet¹, C Torres¹, G Cron¹, R Thornhill¹, K Bezzina², J Woulfe¹, G Jansen¹, S Chakraborty¹
¹The Ottawa Hospital, Ottawa, Ontario, ²University of Ottawa, Ottawa, Ontario

Purpose
Relative cerebral blood volume (rCBV) is a semiquantitative measurement obtained from dynamic susceptibility contrast (DSC) MR imaging and has been reported as a potential biomarker of angiogenesis in patients with gliomas. Dynamic contrast-enhanced (DCE) MRI using a phase-derived vascular input function (VIF) and bookend T1 mapping can provide an absolute measure of plasma volume (Vp). In this study, we determined if there is a correlation between DCE and DSC-derived parameters and mean vascular density (MVD) and area (MVA) obtained from immunohistochemistry.

Materials and Methods
This prospective study included patients with new pathological diagnosis of astrocytoma. A pre-operative MRI was performed at 3T which included two injections of 5 ccs gadobutrol for DCE and DSC MRI. During DCE MRI, both magnitude and phase images were acquired to estimate Vp_Φ (calculated from a phase-derived VIF and bookend T1 measurements) as well as Vp_SI (calculated from a magnitude-derived VIF without T1 measurements). Relative cerebral blood volume (rCBV) was obtained from DSC MRI using a gradient-echo EPI sequence. Four regions of interest (ROIs) were placed over the solid part of the tumor and the highest value ("hot spot") among the ROIs was recorded. One additional "large" ROI was placed over the solid component of the tumor for the slice where the tumor was largest. Histopathological grading was determined using the 2007 WHO criteria. Immunohistochemical staining of endothelial cells with CD34 antibody was performed. Following digitalization of slides under 20X magnification, MVD and MVA were calculated for three ROIs (0.5-2.5 mm2) within the tumor using image processing software. The highest value for MVD and MVA was recorded. Mann-Whitney U test was performed to determine differences according to grade. Spearman correlation was performed to determine relationship between imaging and histopathological parameters.

Results
There were 38 patients with astrocytomas (7 grade two, 8 grade three, 23 grade four). No statistically significant difference was found for imaging and histopathological parameters.
between grade 2 and 3 (Table 1). $V_p_\Phi$ and $V_p_{SI}$ from "hot spot" and "large" ROIs, as well as rCBV from "hot spot" ROIs, were significantly lower for grade 3 versus grade 4 ($P<0.05$). MVA was significantly lower for grade 3 compared to grade 4. Mean vascular density was not significantly different between grade 3 and grade 4. There was a slightly higher correlation between MVA and $V_p_\Phi$ for "large" ROIs (correlation coefficient (CC) = 0.64) than between MVA and $V_p_{SI}$ (CC=0.52) or rCBV (CC=0.27). There was a weaker correlation between MVD and $V_p_\Phi$ derived from "large" ROIs (CC=0.39), MVD and $V_p_{SI}$(CC=0.31), and MVD and rCBV (CC=0.11).

Conclusions

In astrocytomas, using DCE MRI with a phase-derived VIF, there was a stronger correlation between mean vascular area and Vp than with rCBV obtained from DSC MRI.
<table>
<thead>
<tr>
<th>Parameter</th>
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<th>Grade 3 (n=8)</th>
<th>Grade 4</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>95% CI</td>
<td>Median</td>
</tr>
<tr>
<td>MVA (%)</td>
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<td>0.47-2.95</td>
<td>1.90</td>
</tr>
<tr>
<td>MVD (/&gt;mm²)</td>
<td>98.1</td>
<td>46.4-259</td>
<td>192</td>
</tr>
<tr>
<td>rCBV hot spot</td>
<td>3.31</td>
<td>1.25-20.4</td>
<td>6.34</td>
</tr>
<tr>
<td>rCBV large ROI</td>
<td>2.75</td>
<td>1.21-7.10</td>
<td>3.15</td>
</tr>
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<td>Vp_Φ (%) hot spot</td>
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<td>0.0099-4.5</td>
<td>1.52</td>
</tr>
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<td>0.0022-1.66</td>
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</tr>
<tr>
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Monday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Michigan AB (Level 2)

04F - ADVANCED IMAGING: STRUCTURAL NEUROIMAGING
BIOMARKERS OF PSYCHIATRIC DISORDER (PART I)
04F-1
1:15PM - 1:55PM

**Structural & Functional Neuroimaging Predictors of Antidepressant Response**

Parsey, R.
SUNY at Stonybrook
Stony Brook, NY

04F-2

1:45PM - 2:15PM

**Neurodevelopmental Abnormalities in Childhood Onset Psychotic Disorders**

Gogtay, N.
National Institute of Mental Health
Bethesda, MD

04F-3

2:15PM - 2:45PM

**Neuroanatomical Correlates of Mood Disorders**

Soares, J.
University of Texas Medical School
Houston, TX

Monday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Superior AB (Level 2)

04G-NEUROGASTRONOMY

04G-1

1:15PM - 1:35PM

**Taste and Smell - A Primer for Neuroradiologists**

Castillo, M.
University of North Carolina School of Medicine
Chapel Hill, NC

04G-2

1:35PM - 2:25PM

**Smell and Flavor-Central Mechanisms**
Imaging features for differentiating malignant from benign solitary fibrous tumors in the head and neck

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Purpose
To evaluate CT and MR images to determine the imaging features which differentiate malignant solitary fibrous tumors (SFTs) from benign SFTs in the head and neck.

Materials and Methods
We recruited 19 patients with pathologically confirmed SFTs from November 2001 to July 2014, after excluding two patients without CT or MR images. Based on the postoperative pathology reports and the follow-up data, we divided these patients into benign and malignant SFTs groups. Two board-certificated neuroradiologists reviewed the CT and MR images regarding the location, size, shape, margin, internal architecture, involvement of adjacent structures, and enhancement pattern of the SFTs. The results were tested statistically between the two patient groups.

Results
There were 14 benign and five malignant SFTs in 11 male and eight female patients with a mean age of 49.2 years. The mean follow-up duration was 4.8 years (range: 0.2 – 13.5 years). The SFT locations were the orbit (n=6), paranasal sinuses/nasal cavity (n=4), subcutaneous fat (n=3), masticator space (n=3), larynx (n=1), parotid gland (n=1), and carotid space (n=1), respectively.
Statistics revealed that malignant SFTs had a significantly larger tumor size (P=0.01) and frequent involvement of adjacent structures (P=0.02) compared to benign SFTs. There were no significant differences in the shape, margin, internal architecture or enhancement pattern in the two groups (P>0.05).

Conclusions
Solitary fibrous tumors in head and neck have nonspecific imaging features. However, when SFTs are suspicious on imaging studies or preoperative biopsy, the possibility of malignancy should be considered with larger size tumors and involvement of adjacent structures.
Figure legend MR images of 5.5-cm anteroposterior size, malignant, solitary, fibrous tumor of the parotid gland in a 59-year-old man (case 17). The initial axial T2- (A) and T1- (B) weighted images demonstrate a well-defined, lobulated mass in the left parotid and parapharyngeal spaces. The mass shows heterogeneous hyperintensity on T2-weighted imaging. An axial, contrast-enhanced, T1-weighted image (C) obtained 11 years after excision of the mass demonstrated a recurrent mass with marked enhancement at the surgical bed, and which was re-excised. During the postoperative surveillance, an enhancing mass of the left side of the pituitary gland and the left cavernous sinus was depicted on coronal, contrast-enhanced T1-weighted imaging (D). The mass was confirmed as metastasis of the malignant SFT by trans-sphenoidal surgery, as demonstrated by its high cellularity, frequent mitoses (> 4 in 10 high-power fields), and cellular pleomorphism seen on the histologic examination (E; hematoxylin-eosin, original magnification x 200). The tumor cells show immunopositivity for CD34 by immunohistochemistry (F, original magnification x 200).
Differentiating malignant cervical lymphadenopathy (LAP) from benign reactive lymph nodes (LN) in PET/CT of patients with primary head/neck cancer

S Payabvash¹, Z Cayci¹, K Meric¹
¹University of Minnesota, Minneapolis, MN

Purpose
To determine the imaging characteristics of cervical lymph nodes (LN) with biopsy-proven malignant metastasis on PET/CT scans in patients with primary head/neck cancer.

Materials and Methods
The clinical and imaging findings of all patients with primary head/neck cancer who underwent PET/CT in our center from 12/2005 to 6/2013 were reviewed. All patients whose cervical LN were evaluated with excisional biopsy were included in this study. The maximum length and maximum standardized uptake value (SUV) of corresponding LN were determined. The receiver operating characteristic (ROC) analysis was performed to determine the accuracy of each imaging tool in prediction of malignant metastasis.

Results
A total of 45 patients were included in our study. The main primary head/neck cancers were: squamous cell carcinoma (n=19), thyroid papillary/follicular cancer (n=8), lymphoma (n=6), and melanoma (n=3). The average patients' age at the time of scan was 57±15 years. Excisional LN biopsy was positive for metastasis in 25/45 patients. Stepwise binary logistic regression analysis showed that both cervical LN length (p=0.013) and maximum SUV (p=0.006) are independent predictors of malignant LAP. For differentiating malignant LAP from benign reactive prominent LN, the ROC analysis showed an area under the curve (AUC) of 0.822 (p<0.001), and 0.878 (p<0.001) for cervical LN length, and maximum SUV, respectively. A cervical LN length >11.5 mm had 80% sensitivity and 75% specificity in differentiating malignant cervical LAP; and a maximum SUV >5.1 had 80% sensitivity and 100% specificity in differentiating malignant LAP.

Conclusions
Maximum SUV and cervical LN length are independent predictors of malignant cervical LAP in head/neck cancer patients. An SUV value above 5.1 is 100% specific for differentiating a malignant cervical LAP from benign reactive LN. PET/CT can provide a reliable and noninvasive tool for staging, prognostication and treatment planning of patients with primary head/neck cancer.
Purpose
We performed this study to identify superior cervical sympathetic ganglia (SCSGs) and describe their characteristic MR appearance using 3T MRI.

Materials and Methods
This prospective study recruited 53 consecutive patients without history of head and neck irradiation. Using criteria based on literature review, both sides of the neck were evaluated to identify definite (fulfilling all criteria) and probable [fulfilling all criteria except relative location to internal carotid artery (ICA) or longus capitis muscle] SCSGs. Signal characteristics of all SCSGs also were evaluated. The relative location of probable SCSGs to ICA and longus capitis muscle, and the presence of intraganglionic linear hypointensity in SCSGs, were evaluated independently by two radiologists. Interrater and intrarater agreements were quantified using weighted kappa.

Results
Ninety-one neck sites in 53 patients were evaluated after exclusion of 15 neck sites with pathology. Definite SCSGs were identified medial to ICA and lateral to longus capitis muscle at 66 (73%) sites, and probable SCSGs were identified at 25 (27%) sites. Probable SCSGs were located anterior to longus capitis muscle (n = 16), lateral to ICA (n = 6), and posterior to ICA (n = 3). Intraganglionic linear hypointensity, which was identified histologically as a venule, was identified in 82 (90%) SCSGs. Interrater and intrarater agreements were excellent (range, 0.749–1.000). Conclusion: 3T MRI identified normal SCSGs medial to ICA and lateral to longus capitis muscle at 73% of neck sites. The remaining SCSGs had variation in their location relative to ICA or longus capitis muscle. Intraganglionic linear hypointensity was a characteristic feature of SCSGs.

Conclusions
3T MRI visualized 73% of SCSGs as vertically-oriented fusiform or ovoid-shaped T2-hyperintense strongly enhanced structures located medial to the ICA and lateral to the longus capitis muscle between the C2 and C4 vertebrae. The location of the remaining 27% of SCSGs was anterior to the longus capitis muscle, lateral to the ICA, or posterior to the ICA. Intraganglionic linear hypointensity was seen in 90% of cases and could be helpful to differentiate normal SCSGs from retropharyngeal lymphadenopathy.
Table 1. Location of definite and probable SCSGs.

<table>
<thead>
<tr>
<th></th>
<th>Definite SCSG</th>
<th>Probable SCSG</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICA/LCM</td>
<td>Medial/Lateral</td>
<td>Medial/Anterior</td>
</tr>
<tr>
<td>Number (%)</td>
<td>66 (73)</td>
<td>16 (18)</td>
</tr>
<tr>
<td>Interrater agreement</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Intrarater agreement</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

LCM = longus capitis muscle; NA = not applicable; SCSG = superior cervical sympathetic ganglion.

Table 2. Visibility of intraganglionic linear hypointensity on each MR sequence

<table>
<thead>
<tr>
<th></th>
<th>CE</th>
<th>FS</th>
<th>T1WI</th>
<th>T2WI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible intraganglionic linear hypointensity, number (%)</td>
<td>Definite SCSG</td>
<td>Probable SCSG</td>
<td>All SCSG</td>
<td>Definite SCSG</td>
</tr>
<tr>
<td></td>
<td>60 (91)</td>
<td>23 (92)</td>
<td>82 (90)</td>
<td>58 (88)</td>
</tr>
<tr>
<td>Interrater agreement</td>
<td>0.915</td>
<td>0.779</td>
<td>0.877</td>
<td>0.858</td>
</tr>
<tr>
<td>Intrarater agreement</td>
<td>1.000</td>
<td>0.779</td>
<td>0.935</td>
<td>0.839</td>
</tr>
</tbody>
</table>

CE = contrast-enhanced; FS = fat-suppressed; SCSG = superior cervical sympathetic ganglion.
CT and MRI Characteristics of Benign Versus Malignant Incidental Parotid Masses.

M Bashir\textsuperscript{1}, C Britt\textsuperscript{1}, G Hartig\textsuperscript{2}, L Gentry\textsuperscript{3}, T Kennedy\textsuperscript{3}

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Purpose
Parotid gland masses account for 70-85\% of all salivary gland tumors, with a rate of malignancy approaching 15-20\%. The parotid mass found incidentally on imaging presents a common problem for the radiologist. Currently, there is no treatment algorithm for managing incidentally found parotid masses. The purpose of this study is to evaluate the CT and MR imaging characteristics of incidentally-found parotid masses in order to identify high-risk features that may aid in guiding appropriate management for these lesions.

Materials and Methods
This IRB-approved retrospective study thus far has evaluated CT and MR imaging (25 and 21,
respectively) of randomized patients between 2007 and 2013 with incidental parotid gland masses who underwent surgery. Two interpreting radiologists were blinded to the pathology results. The evaluated CT imaging characteristics of the parotid masses included contrast-enhancement, size, location within the gland, density, margins, and calcifications. The evaluated MR imaging characteristics included size, location, T1 and T2 signal intensity. Diffusion characteristics and FDG imaging was included where available. Data analysis was performed using Fisher-Freeman-Halton exact test p values as to whether or not there is a difference between the benign and malignant groups.

Results

Of the different CT and MRI characteristics evaluated, the presence of irregular margins proved to be the most useful in distinguishing benign from malignant pathology, which approached statistical significance. Pathology for the malignant lesions included mucoepidermoid and acinic cell carcinomas. The majority of benign masses were pleomorphic adenomas and Warthin tumors. The degree of enhancement, size, location, or individual MR signal characteristics were not independently useful in distinguishing benign from malignant pathology.

Conclusions

The presence of irregular margins of an incidentally found parotid mass is the most useful feature in helping to distinguish benign from malignant pathology.
Multi-parametric advanced MR imaging (IVIM, DCE-MR, 2D and 3D tumor metrics) as a predictive tool of treatment response in HPV positive oropharyngeal squamous cell carcinoma patients

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Purpose
Human papilloma virus (HPV) positive tumors carry a better prognosis than HPV negative ones. Although HPV positivity is proven to be independent of other known prognostic factors including age and TNM staging, yet treatment failure has been recorded. In our study we used Intra Voxel Incoherent Motion, dynamic contrast-enhanced magnetic resonance perfusion imaging (DCE MRI) and 2D, 3D volumetric parameters to find out which is the best predictor of treatment response in HPV positive oropharyngeal squamous carcinoma.

Materials and Methods
Patients with pathologically proven HPV positive oropharyngeal SCC were included in this study under an IRB-approved protocol with signed study-specific informed consent forms as a part of prospective ongoing clinical trial. All patients underwent two MRI studies, baseline scan within 1 week before treatment and midtreatment scan. According to response to treatment, patients then were categorized into two groups; complete responders (CR) in whom the primary has completely disappeared and partial responders (PR) where there was still a residual tumoral tissue. All morphological image analyses and segmentation were done using 3D Slicer 4.3.1 (slicer.org) and reviewed in consensus by two neuroradiologists. Multiple quantitative imaging features were identified including IVIM (D, D*, and f), MR perfusion (K-trans, Vp, Ve, and Kep) as well as 2D and 3D volumes of the primary tumor at the first time point.

Results
Median of the time between the two MRIs was 25 days. Based on the second MRI, 75% of patients had complete response to treatment. Mann-Whitney U Exact test was used to compare baseline variables between patient with complete and partial response to therapy. Kep mean and K-trans mean significantly higher in patients who showed partial response to treatment. Logistic regression analysis was performed to determine the association between each of the perfusion parameters and response to treatment. Higher K-trans had a significant association with partial response to treatment.

Conclusions
Treatment response in HPV positive oropharyngeal squamous cell carcinoma patients can be predicted reliably through different advanced MRI parameters.
Purpose

Human papillomavirus-related oropharyngeal carcinoma (HPV+ OPC) exhibits distinct clinical features compared to HPV-unrelated (HPV-) OPC. Emerging evidence suggests there also may be radiologic differences between these two diseases. The purpose of this study is to compare the radiologic characteristics between HPV+ and HPV- OPCs.

Materials and Methods

A retrospective review of OPC patients treated between 2008 and 2012 at our institution was conducted. HPV status was ascertained by p16 staining. Pretreatment CT or MRI examinations were reviewed by an experienced neuroradiologist blinded to HPV status. Cases with unknown HPV status or surgical procedures prior to imaging were excluded. Clinical and radiological characteristics of primary tumors and involved lymph nodes (LN) were compared between HPV+ and HPV- OPC.

Results

A total of 682 patients (488 HPV+ and 194 HPV-) were included. Compared to the HPV-, a greater proportion of HPV+ OPCs arose in the tonsillar complex or tongue base (97% versus 70%, P<0.001). HPV+ primary tumors also were more likely to be exophytic (74% versus 62%, P=0.011) and smaller in maximum anterior-posterior (2.4 cm versus 2.7 cm, P=0.006) and medial-lateral (2.5 cm versus 2.7 cm, P=0.017) dimensions. In contrast, HPV- primary tumors exhibited more necrosis (18% versus 9%, P=0.006) and ulceration (21% versus 10%, P=0.001). HPV+ OPCs were more likely to have LN metastasis (89% versus 69%, P<0.001). A higher intranodal cystic appearance was observed in the HPV+ (45% versus 33%, P=0.016).

Conclusions

This relatively large cohort study demonstrates that HPV+ OPCs generally have smaller exophytic primaries with well defined borders from the tonsils or tongue base. HPV+ OPCs also have a greater tendency to demonstrate LN involvement with a marginally higher propensity for a cystic appearance. In contrast, HPV- OPCs more often demonstrate necrosis, ulceration, and stage N0 disease. These differences may help to further differentiate HPV+ and HPV- OPCs.

O-52

4:11PM - 4:19PM


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¹The Johns Hopkins University School of Medicine, Baltimore, MD, ²The Johns Hopkins Bloomberg School of Public Health, Baltimore, MD

Purpose

To evaluate the relative accuracy of contrast-enhanced time-resolved angiography with interleaved stochastic trajectories versus conventional contrast-enhanced MRI following

Materials and Methods
We retrospectively reviewed time-resolved angiography with interleaved stochastic trajectories versus conventional contrast-enhanced MRI of children with diagnosis of soft tissue vascular anomalies in the head and neck referred for MRI between 2008 and 2011. Forty-seven children (0-18 years) were evaluated. Two pediatric neuroradiologists evaluated time-resolved MRA and conventional MRI in two different sessions (30 days apart). Blood-pool endovascular MR contrast agent Gadofosveset trisodium (Ablavar) was used.

Results
Our cohort had the following diagnoses: infantile hemangioma (n=6), VM (n=23), LM (n=16), AVM (n=2). Time-resolved MRA alone accurately classified 38/47 (81%) and conventional MRI 26/27 (89%), respectively. While time-resolved MRA alone is slightly superior to conventional MRI alone for diagnosis of infantile hemangioma, conventional MRI is slightly better for diagnosis of venous and LMs. Neither time-resolved MRA nor conventional MRI was sufficient for accurate diagnosis of AVM in this cohort. Conventional MRI combined with time-resolved MRA accurately classified 44/47 cases (94%).

Conclusions
Time-resolved MRA using Ablavar can accurately classify soft tissue vascular anomalies in the head and neck in children. The addition of time-resolved MRA to existing conventional MRI protocols provides hemodynamic information, assisting the diagnosis of vascular anomalies in the pediatric population at one third of the dose of other MRI contrast agents.

<table>
<thead>
<tr>
<th>Final Diagnosis</th>
<th>Number (N=47)</th>
<th>TWIST</th>
<th>CE-MRI</th>
<th>Time-Resolved MRA vs CE-MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>IH</td>
<td>6</td>
<td>5 (83)</td>
<td>4 (67)</td>
<td>40%</td>
</tr>
<tr>
<td>LM</td>
<td>16</td>
<td>11 (69)</td>
<td>15 (94)</td>
<td>30%</td>
</tr>
<tr>
<td>VM</td>
<td>23</td>
<td>22 (96)</td>
<td>23 (100)</td>
<td>20%</td>
</tr>
<tr>
<td>AVM</td>
<td>2</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>45%</td>
</tr>
</tbody>
</table>
Star VIBE Outperforms TSE for Post Contrast MR Imaging of the Neck

D Chen¹, I Corcuera-Solano¹, P Pawha¹, L Tanenbaum¹
¹Mount Sinai Medical Center, New York, NY

Purpose
MR imaging of the neck, particularly after contrast administration, is highly susceptible to somatic motion, respiratory and swallowing artifact. Modified radial imaging schemes (BLADE, PROPELLER) have been shown to be highly resistant to these artifacts but to date have not been available for high resolution fat suppressed 3D T1-weighted imaging techniques that have traditionally required breath holding. Star VIBE (Siemens, Erlangen, Germany) is a 3D RF spoiled GRE sequence using a stack of stars modified radial acquisition that has been effective in reducing motion artifact in abdominal imaging in patients who have difficulty with prolonged breath holds, such as children and the critically ill. Alternatively, Star VIBE can be used to obtain high spatial resolution, thin slice studies in scan times that exceed breath holding limits. We added postcontrast high resolution Star VIBE head and neck imaging to our protocols and performed this retrospective review to assess image quality, motion resistance and added value in routine MR imaging of the neck.

Materials and Methods
Thin slice, high resolution Star VIBE was performed in addition to the standard regimen in all patients receiving outpatient gadolinium-enhanced MRI examinations of the neck. Two experienced head and neck radiologists performed a retrospective review of 30 consecutive patients imaged on either a Siemens MAGNETOM Skyra 3T or Aera 1.5T scanner. A qualitative comparison for artifact, contrast resolution and, when appropriate, lesion conspicuity was performed with respect to the standard TSE gadolinium-enhanced T1 fat-suppressed sequence.

Results
There was a significant reduction in motion-related artifact over Cartesian TSE comparison images while providing thin slice, high spatial resolution images with excellent T1 contrast.

Conclusions
Star VIBE is effective in reducing motion artifact in neck imaging, produces high quality, high resolution MR images of the neck, and should be considered for routine use.

Spectrum of Magnetic Resonance Findings of Head and Neck Structural Anomalies in CHARGE Syndrome

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Purpose
The article aims to retrospectively review major head and neck structural anomalies seen on imaging in CHARGE patients for whom magnetic resonance imaging was performed.
Materials and Methods
Retrospective review of the radiology database from 2006 to 2014 yielded 10 patients for whom CHARGE syndrome was strongly suspected or diagnosed clinically and imaging was ordered for further evaluation of the inner ear structures, specifically for cochlear nerve deficiency. Magnetic resonance imaging (MRI) studies were performed for all 10 patients, and a temporal bone CT for one patient. The images were reviewed by two board certified neuroradiologists with certificates of added qualification. Middle and inner ear findings as well as additional findings in the orbits, brain, skull base, and upper airway supporting the diagnosis of CHARGE syndrome were evaluated and categorized.

Results
Bilateral vestibular dysmorphism was present in all 10 patients. Underpartitioning of the cochlea was present in nine of 10 patients. In the eight patients with high resolution fluid-weighted images, the Cochlear apertures were absent bilaterally in three of 10 patients and unilaterally in two of 10 patients, with equivocal finding in two patients. Cochlear nerves were absent bilaterally in seven of 10 patients and unilaterally in one of 10 patients, with equivocal finding in two of 10 patients. Semicircular canals were absent bilaterally in seven of 10 patients and hypoplastic in two of 10 patients. Diminutive caliber of the internal auditory canals was noted in seven of 10 patients. Colobomas were noted in four of 10 patients. Choanal atresia was present in two of 10 patients and cleft lip or palate was noted in three of 10 patients. Also noted were developmental anomalies at the craniovertebral junction, which included "J"-shaped sella and dorsal angulation of the clivus, seen in eight of 10 patients. Additional findings included buphthalmos, pontine or brainstem hypoplasia, ventriculomegaly, absent or hypoplastic parotid glands, mastoid effusions, absent vestibulocochlear nerve, enlarged vestibular aqueduct, deficient posterior nasal septum, and small caliber of skull base vessels.

Conclusions
The findings of this case series highlight and further validate previously described CHARGE syndrome related imaging findings in the orbits, middle and inner ear structures, upper airway, and central nervous system. Despite earlier studies demonstrating abnormal development of the basiocciput in CHARGE patients, "J" shaped sella and dorsal angulation of the clivus have not been described previously in association with CHARGE syndrome. These two findings were found to be prevalent in our study population. Cochlear nerve deficiency was seen in the majority of our patient population and has significant implication in treatment with cochlear implantation. With this information, interpreting neuroradiologists will be more familiar with CHARGE syndrome related structural anomalies in the head and neck and able to optimize protocols in imaging of CHARGE patients.
A Novel Automated Fiber Clustering Algorithm for DTI-Based Fiber Tracking in Surgical Neuro-Oncology

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University of Pennsylvania, Philadelphia, PA

Purpose
Limitations to diffusion tensor imaging fiber tracking (DTI FT) of white matter bundles for neurosurgical planning include edema and tract displacement or infiltration/interruption, intra-/inter-user and inter-institutional variability, and long processing time for manual tract creation. The purpose of this work is to develop a robust fiber clustering algorithm using connectivity profiles of fibers to improve tract visualization in the presence of pathology, facilitate automatic extraction of tracts, and provide reproducibility.

Materials and Methods
Two 3T datasets were used: (1) nine normals (DTI parameters including b=1000 s/mm², spin echo EPI diffusion encoding in 64 directions, TR/TE 14.8s/111ms, 2mm isotropic voxels); and (2) 10 patients with brain neoplasm (DTI parameters similar except diffusion encoding in 30 directions, TR/TE 5s/86ms, 1.7x1.7.x 3mm³ voxels). For automated tract extraction, a fiber bundle atlas was generated by clustering the combined set of fibers from normals. Fibers of a new subject were clustered adaptively by employing the atlas as a prior model. This resulted in automated correspondence across fiber bundles of different subjects adapted to the same atlas such that selected tracts could be generated automatically. Reliability of extracted tracts in both groups was assessed by voxel-wise comparison with manual reconstructions by experts, agreement quantified by Cohen's kappa.

Results
Test-retest comparisons in three normals showed better intra-rater (E-Intra) than inter-rater agreement (E1 versus E2) for arcuate, inferior longitudinal, and inferior frontal occipital fasciculus (AF, ILF, and IFOF). Automated clustering showed overall better agreement (C versus E) than inter-rater agreement for both groups (Table). There was noticeable variation between expert derived tracts, but reasonable agreement for most cases including brain tumors. Automatic tractography was promising compared to manual tractography, though errors are still apparent (Figure).

Conclusions
Tractography using an automated adaptive clustering algorithm is reproducible and can generate reliable fiber tracts compared to experts. This can be implemented as a robust first pass analysis.
<table>
<thead>
<tr>
<th>Bundle</th>
<th>C vs. E (0.05)</th>
<th>E1 vs. E2 (0.08)</th>
<th>E-Intra (0.14)</th>
<th>C vs. E (0.21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFOF</td>
<td>0.66</td>
<td>0.61</td>
<td>0.61</td>
<td>0.49</td>
</tr>
<tr>
<td>ILF</td>
<td>0.62</td>
<td>0.67</td>
<td>0.69</td>
<td>0.59</td>
</tr>
<tr>
<td>AF</td>
<td>0.64</td>
<td>0.46</td>
<td>0.78</td>
<td>0.46</td>
</tr>
</tbody>
</table>
Combined Functional and Metabolic Assessment of Brain Tumors using Hybrid MR-PET Imaging

B Sacconi\textsuperscript{1}, R Raad\textsuperscript{2}, J Lee\textsuperscript{2}, H Fine\textsuperscript{2}, J Golfinos\textsuperscript{2}, G Fatterpekar\textsuperscript{3}, F Boada\textsuperscript{2}, K Friedman\textsuperscript{2}, J Babb\textsuperscript{4}, R Jain\textsuperscript{3}

\textsuperscript{1}Sapienza, University of Rome, Policlinico Umberto I, Rome, Italy, \textsuperscript{2}NYU School of Medicine, New York, NY, \textsuperscript{3}NYU Langone Medical Center, New York, NY, \textsuperscript{4}NYU Langone Medical Center, New York, NY

Purpose
To retrospectively analyze functional MR perfusion (PWI) and FDG-uptake data obtained from hybrid MR PET imaging in patients with brain tumors. We assessed the diagnostic accuracy of concurrently acquired rCBV and FDG uptake in differentiating low and high grade gliomas and also differentiating tumor progression from treatment/radiation induced necrosis in previously treated patients.

Materials and Methods
Twenty patients (Group-A: nine patients with 16 treatment naïve tumors; Group-B: 11 with 18 treated tumors) underwent hybrid MR PET, using an integrated PET/3TMR system (Biograph mMR; Siemens Healthcare). Two readers blinded to patient data were asked to predict the histologic grade (Group A) and the likelihood of tumor recurrence versus radiation necrosis (Group B) based solely on mean/maximum rCBV and early mean/maximum FDG-uptake values; final diagnoses were cross-referenced to histopathology results when available (7 patients, 12 lesions) or clinical and imaging follow-up (8 patients, 17 lesions). Evaluation of diagnostic accuracy, cut off analysis for both techniques and correlation between rCBV and FDG-uptake values were performed.

Results
Diagnostic accuracy using PWI was 90\% and 94.1\% in Group A (p=0.056) and Group B (p=0.033), compared with 40\% and 55.6\% with FDG PET (Table 1a). Mean rCBVmean were 2.17 for high-grade tumors and 1.37 for low-grade tumors (p=0.031), 2.45 for recurrent tumors and 1.14 for treatment/radiation induced effects (p=0.001). Mean SUVmean values were 5.08 for high-grade tumors and 3.99 for low-grade tumors (p=0.025), 6.17 for recurrent tumors and 3.76 for treatment/radiation induced effects (p=0.007). Mean rCBVmax were 3.80 for high-grade tumors and 2.54 for low-grade tumors (p=0.042), 3.99 for recurrent tumors and 2.92 for treatment/radiation induced effects (p=0.165). Mean SUVmax values were 7.71 for high-grade tumors and 5.13 for low-grade tumors (p=0.012), 8.51 for recurrent tumors and 5.16 for treatment/radiation induced effects (p=0.001). Higher overall diagnostic accuracy was demonstrated by using mean rCBV (p<0.001; AUC 0.89) and FDG-uptake values (p=0.05; AUC 0.80). Best overall sensitivity and specificity for differentiating high grade/tumor recurrence and low grade/radiation necrosis were obtained using mean rCBV of 1.74 and FDG-uptake of 4.0 as cut off values, respectively (100\%,74\% and 75\%,89.7\%) (Table 1b). Poor correlation was demonstrated between mean rCBV and FDG-uptake values, either in treatment naïve lesions (r = 0.09; p = 0.754), post-treatment lesions (r = 0.44; p = 0.069) or in the entire patient population (r =
No significant correlation was observed between max rCBV and SUV values, in Group A \((r = 0.22; \ p = 0.403)\), Group B \((r = 0.02; \ p = 0.942)\) or in the entire patient population \((r = 0.13; \ p = 0.482)\) (Table 1c).

**Conclusions**

Perfusion-weighted imaging (PWI) demonstrated better diagnostic accuracy in both differentiating high from low-grade tumors and recurrent tumor from radiation necrosis, especially by using a mean rCBV of 1.74 as cut off value. Poor correlation between FDG PET parameters and PWI parameters was observed.

**Tab. 1a** Diagnostic accuracy of PWI and PET

| Measure | Treatment Naïve | | Treated | | | | |
|---------|----------------|------|---------|------|---------|------|
|         | Accuracy       | Lower| Upper   | Accuracy| Lower   | Upp |
| PWI     | 96.0% (9/10)   | 48.4%| 98.9%   | 94.1% (16/17) | 64.4% | 99.3 |
| PET     | 40.0% (4/10)   | 6.5% | 86.5%   | 55.6% (10/18) | 28.2% | 79.9 |
| P Value | 0.056          |      |         | 0.033  |         |

**Tab. 1b** Criterion observed to maximize the average of sensitivity and specificity

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Max rCBV</th>
<th>Mean rCBV</th>
<th>Max FDG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>Specificity</td>
<td>31%</td>
<td>74%</td>
<td>89.5%</td>
</tr>
</tbody>
</table>

**Tab. 1c** Pearson correlation and corresponding p value for the association of max rCBV and n with FDG uptake within each subject group and for the sample as a whole

<table>
<thead>
<tr>
<th>Group</th>
<th>Parameter</th>
<th>Max rCBV</th>
<th>Mean rCBV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Correlation</td>
<td>P Value</td>
</tr>
<tr>
<td>Naive</td>
<td>FDG uptake</td>
<td>0.22</td>
<td>0.403</td>
</tr>
<tr>
<td>Treated</td>
<td>FDG uptake</td>
<td>0.02</td>
<td>0.942</td>
</tr>
<tr>
<td>All Patients</td>
<td>FDG uptake</td>
<td>0.13</td>
<td>0.482</td>
</tr>
</tbody>
</table>

(Filename: TCT_O-56_Tab.jpg)

**O-57**

Comprehensive Metabolic Mapping of Human Gliomas Using Hybrid Amide Proton Transfer MR Imaging, MR-Spectroscopy and PET Imaging

S Bisdas¹, P Martirosian¹, N Schwenzer¹, M Skardelly¹, U Klose¹, H Schmidt¹

¹Eberhard Karls University, Tübingen, Germany
Purpose
Amide proton transfer (APT) MR imaging detects amide protons of endogenous mobile proteins and peptides in tissue. We sought to investigate the feasibility and the added value of in vivo APT MRI combined with MR spectroscopy (MRS) and positron emission tomography (PET) for the comprehensive metabolic mapping of gliomas.

Materials and Methods
Fourteen patients with newly diagnosed gliomas (WHO grade 2-4) were recruited prospectively and underwent simultaneous MR PET imaging, including proton MRS (echo time: 135 ms) and 11C-methionine on a 3T whole-body clinical MR PET scanner. The APT effect was quantified using the magnetization transfer ratio (MTR) asymmetry at 3.5 ppm. The APT images were coregistered with MRS-choline and 11C-methionine maps and qualitative spatial analysis of the tumor extent in each modality as well as quantitative analysis of the tumor metabolic activity in each imaging technique (APT, MRS, PET) were conducted. The signal of the MRS metabolic activity in tumor was normalized to the contralateral normal appearing white matter (NAWM). The corresponding activity in APT and PET was calculated as relative enhancement compared to NAWM, too. The acquired metabolic maps and the normalized ratios of the tumor metabolic activity in hot-spots were statistically compared and correlated to the histopathological grading.

Results
Six of the examined gliomas were low-grade (WHO grade 2), seven gliomas were high-grade (3 subjects with WHO grade 3 and four subjects with WHO grade 4 tumors). The histopathologic examination in one patient revealed only inflammatory changes. The choline MRS images showed hot-spots in all cases except of the inflammation. The MRS hot-spot had a significant (>70%) spatial overlap with the APT images in all but two cases with WHO grade 4 tumor, where the overlap was <50%. The APT signal in the inflammation as well as in two patients with low-grade gliomas was not enhanced compared to the NAWM. However, two patients with low-grade tumors demonstrated significant APT and PET enhancement. The PET images did not demonstrate any hot-spot in nearly all cases with low-grade gliomas and in two cases with WHO grade 3 glioma. The normalized choline ratio in high- and low-grade tumors was 2.7±0.4 and 1.5±0.3, respectively. The relative enhancement in APT was 60±13% and 10±25% for high- and low-grade gliomas, respectively. Finally, the PET relative enhancement was 50±18% and 7±23% for high- and low-grade gliomas, respectively. In total, the imaging findings in MRS, APT, and PET were concordant for almost all high-grade gliomas showing a remarkable interchangeability between the techniques. The MRS and APT techniques in combination provided in all cases of low-grade gliomas adequate image contrast that enabled biopsy of the metabolic hot-spots.

Conclusions
Our initial results show that the implementation of APT, MRS and PET on hybrid MR-PET imaging is feasible for comprehensive metabolic mapping with the potential to increase the diagnostic accuracy and aid in staging and surgical planning for patients with brain tumors.
Localization and Activation of Wernicke’s Area Is More Effective Using Sentence Completion Task Compared to Word Generation and Category Naming Tasks in Functional MRI

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¹MD Anderson Cancer Center, Houston, TX, ²Department of Radiology, Temple University, Philadelphia, PA, ³Temple University, Philadelphia, PA, ⁴Baylor College of Medicine, Houston, TX

Purpose
Task selection is one of the pivotal steps for successful localization and activation of speech areas using functional MRI (fMRI). Multiple tasks are available, which can be used for activation of Broca's area. However, localization of Wernicke's area using fMRI is difficult. Here, we compare the results of three different activation tasks, sentence completion (SC), word generation (WG) and category naming (CAT) for localization of Wernicke's area.

Materials and Methods
Eleven healthy volunteers (6 males and 5 females) were recruited for this study, which was approved by Institutional review board. All subjects were right handed with age range from 22 to 55 years. Subjects were trained on each task prior to scanning. Scans were done on a GE 3.0T machine with a 32-channel head coil. All experiments were block design. For SC, subjects were presented with an incomplete sentence which they had to complete. On WG and CAT, subjects were asked to generate words that either start with the letter of the alphabet shown on the screen or are related to the category that was displayed. During rest, subjects were presented with a gibberish sentence during the first task and a picture of a hand on the second and third tasks. Functional MRI was acquired using EPI sequences; for SC, TR was 2 seconds while for WG and
CAT, TR was 4 seconds. Preprocessing, individual, group and region of interest (ROI) analysis were done using SPM8 software.

Results
Multiple uncorrected P-values of cluster probability were used, ranging from 0.05 to 0.001. Region of interest (ROI) analysis of Wernicke's spatial co-ordinate revealed no activation in CAT and WG across different P-values. However, for Sentence Completion task with a cluster probability of an uncorrected P-value (<0.001), activation in Wernicke's area was detected with a T-value of 4.45. On individual analysis, during SC nine out of 11 (82%) subjects show activity in Wernicke's spatial co-ordinates, compared to only two (18%) and three (27%) subjects with activity in the same co-ordinates in WG and CAT, respectively.

Conclusions
Sentence completion task is a more effective task in localizing Wernicke's areas compared to Word generation and Category naming tasks.
SPM results: \{Comparison data\(t\)-test 1\}\SPM
Height threshold \(T = 4.143701 \{p<0.001 \text{ (unc.)}\}\)
Extent threshold \(k = 5 \text{ voxels}\)

Statistics: search volume: 6.0 mm sphere at [-56, -32, 8]

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(Filename: TCT_O-58_Wernicke.jpg)
Middle Frontal Gyrus fMRI Activation as a Surrogate Indicator of Hemispheric Dominance for Language in Brain Tumor Patients

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Purpose
Functional MRI (fMRI) is used increasingly to assess language laterality in pre-operative brain tumor patients. However, the accuracy of fMRI is nuanced as neurovascular decoupling in high grade gliomas can lead to false negatives and errors in lateralization. The current study investigated whether the middle frontal gyrus (MFG), a verbal working memory area, could be used as a surrogate marker of language hemispheric dominance.

Materials and Methods
Fifty 100% right handed patients with left sided brain tumors (19 low and 31 high grade gliomas) performed verb generation, phonemic fluency, and/or semantic fluency BOLD fMRI. Data analyzed using Matlab and AFNI. Language laterality index (LI) was determined in the MFG and Broca's area (BA). LI=(L−R)/(L+R). Middle frontal gyrus LI was compared to BA LI across tasks, tumor grades, and distance from BA.

Results
The differences in language lateralization between high and low grade tumors was not significant in BA (p = 0.32), but significant in the MFG (p = 0.05). Tumors in BA have more widely distributed LIs in both low grade tumors (SDBA=0.56, SDMFG=0.36) and high grade tumors (SDBA=.55, SDMFG=.44) than in MFG, regardless of the distance of the tumor from Broca's Area. The average fMRI voxel activation number of MFG exceeded the BA (208.2 vs 153.7). Middle frontal gyrus predicted language laterality significantly better than BA in cases where tumors were located far from BA (p=0.61 for BA, p=0.04 for MFG). ANOVA of individual fMRI tasks did not show significant differences in the ability to lateralize language in either BA (p=0.24) or MFG (p=0.37).

Conclusions
The MFG is a better predictor of hemispheric dominance for language than BA in some cases and is equivalent in others. Middle frontal gyrus activation may be an adjunct measure in the clinical determination of language laterality in pre-operative fMRI scans in brain tumor patients.

O-60
3:55PM - 4:03PM

Neurite Density and Diffusion Kurtosis Characterization of Brain Tumors with Compressed Sensing (CS) Acceleration of Diffusion Spectrum Imaging (DSI)

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Purpose
Diffusion kurtosis imaging (DKI) and neurite orientation dispersion and density imaging
(NODDI) are newly proposed methods for white matter characterization. We report preliminary results from compressed sensing (CS) accelerated diffusion spectrum imaging (CS DSI) in brain tumor patients.

Materials and Methods

Compressed sensing (CS) DSI was acquired in 15 patients with intracranial tumors (mean, 47.4 years) at 3T using a single-shot EPI acquisition (FOV=24 cm, 128×128 matrix, thickness=3mm, TR=4-5s, TE=107-116ms) with R=4-5 acceleration (b=6,000-10,000s/mm², 102-127 directions). Data were fitted for kurtosis (limited to b<3000 s/mm²) and NODDI without CS reconstruction. Selected Kurtosis metrics (Kmax=maximum apparent kurtosis coefficient, KOrthogonal=orthogonal and Kparallel=parallel kurtosis) and NODDI metrics (ICVF=volume fraction occupied by cylindrical neurite structures, ODI=orientation dispersion index, ISO=isotropic) were selected for analysis after semi-automatic segmentation of tumor from the ADC maps and ICVF maps.

Results

In all subjects, tumors were visualized clearly on ADC, KMax, KOrthogonal and ICVF maps. Apparent diffusion coefficient and ISO maps were best at distinguishing tumor from CSF (p<.0001). Percentage standard deviation of ISO CSF (4%) was one third that for ADC CSF (13%). The %SD was larger for ISO-tumor (79%) than ADC tumor (32%). FA, KMax and KOrthogonal distinguished tumor from normal tissue (p<.0001). In both tumor and normal tissue, %SD was smaller for KMax and KOrthogonal than the standard maps (T2, ADC, FA). In normal tissue, %SD was larger for NODDI tumor maps and NODDI-ODI and ISO maps than the standard maps.

Conclusions

Accelerated CS DSI is helpful to overcome long scan times required for multiple b-values and direction acquisition, and enable Kurtosis and NODDI modeling. This may improve tumor segmentation from normal tissue and CSF. The larger spread of NODDI values in tumors may provide added information for tumor classification. This preliminary work motivates further analysis of tumor sub-classes, and machine-learning methods to improve tumor segmentation and classification.
$K_{\text{max}}$ (A), $K_{\text{orthogonal}}$ (B), ICVF (C) and ODI (D) maps in a single subject show demarcation of the glioma (arrow), peritumoral abnormality (double arrow) and normal brain.
Presurgical mapping of ventral sensorimotor network using resting-state functional MRI: comparison with task-based functional MRI

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The Johns Hopkins Hospital, Baltimore, MD, Johns Hopkins Medical Institution, Baltimore, MD, Johns Hopkins Hospital, Baltimore, MD, Johns Hopkins Medicine, Baltimore, MD

Purpose
Task-based functional MRI (tb-fMRI) is used widely as a tool for presurgical brain mapping. Resting-state functional fMRI (rs-fMRI) has shown some promise in identifying dorsal sensorimotor networks; the ventral sensorimotor network (VSMN) has been studied less. The goal of this study is to assess the utility of rs-fMRI in identification of the VSMN and compare rs-fMRI to tb-fMRI in a cohort of brain tumor patients.

Materials and Methods
Thirty-one patients referred for presurgical fMRI brain mapping were identified who had undergone both tongue motor activation tasks as well as rs-fMRI. Following standard preprocessing for tb-fMRI and rs-fMRI, general linear model (GLM) analysis of the tongue motor tasks, and independent component analysis (ICA) of rs-fMRI was performed with target components of 20, 30, 40, and 50. Candidate VSMNs were identified manually. Due to variable strength of GLM activation and ICA correlations for each subject, the relevant maps were normalized to percent maximum signal, and thresholded at multiple levels. Dice coefficients were calculated for each threshold between tb-fMRI and rs-fMRI.

Results
A VSMN was identified in 70% of the patients (22/31). Tb-fMRI/rs-fMRI concordance was highest with 50 ICA components, with Dice value of 0.31. Dice coefficients decreased with number of target ICA components. Figure illustrates the Dice coefficient matrix for rs-fMRI (x axis) versus tb-fMRI (y axis) at varying thresholds.

Conclusions
In the majority of patients, a VSMN can be identified that shows high concordance with tb-fMRI, better with higher ICA target components. Factors affecting lack of ability to identify the VSMN in rs-fMRI warrant further investigation.
Quantitative Evaluation and Novel Visual Assessment of MR Diffusion Tensor Imaging and Perfusion Weighted Imaging in Differentiating Tumefactive Demyelinating Lesions from High-Grade Glioma

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Purpose
Accurate differential diagnosis tumefactive demyelinating lesions (TDLs) and high grade gliomas (HGGs) is very important to avoid unnecessary surgical procedures. However, it is sometimes difficult on conventional MR imaging alone. Previous studies revealed that MR diffusion tensor imaging (DTI) and dynamic susceptibility contrast MR perfusion imaging (DSC MR PWI) showed potential advance in differentiating between TDLs and HGGs. The aim of this study is to use quantitative values of maximal relative blood volume (rCBV) ratio derived from MR-PWI, trace apparent diffusion coefficient (trace ADC) and fractional anisotropy (FA) from DTI in this differential diagnosis. A novel program superimposing the voxels with ADC value lower than 0.55 and FA value higher than 0.215 (1,2), which are reported with active tumor component, is applied for visual assessment between TDLs and HGGs.

Materials and Methods
Twenty cases with TDLs diagnosed through laboratory tests, clinical outcome and follow-up imaging and 20 patients with pathology confirmed HGGs were reviewed. The mean values of maximal rCBV ratio, ADC and FA in the enhancing lesions were measured and compared between TDLs and HGGs with a nonparameter Mann-Whitney test and ROC analysis. In addition, we developed a voxel-based superimpose program which could superimpose the voxels with ADC value lower than 0.55 and FA value higher than 0.21, in the delineated enhancing lesions with different colors. The distribution patterns of voxels with low ADC value and high FA value were assessed visually by two experienced neuroradiologists.

Results
The mean FA value of the enhanced TDLs (0.193±0.07) was higher than the mean FA value of the enhanced HGGs (0.131±0.03), p <0.0001. There was no significant difference of mean trace ADC value between two groups (1.048±0.17 in TDLs and 1.12±0.23 in HGGs separately). The mean value of maximal rCBV ratio in TDLs (1.48±0.28) was significantly lower than HGGs (5.75±1.72), p <0.0001, Figure 1. The receiver operating characteristic (ROC) analysis showed that maximal rCBV ratio and mean FA value were the best imaging biomarker in differentiating between TDLs and HGGs, (area under curve value was 0.89 and 0.913 separately). All (20/20) HGGs presented voxels with concurrent low ADC value and high FA , this pattern was only detected in 2/20 TDLs(Figure 2).

Conclusions
Combined quantitative diffusion and perfusion abnormality information, MR DTI and PWI are useful in differentiating between TDLs and HGGs. Our visual superimposing program not only provides novel assessment in aiding quick clinical differential diagnosis, but also demonstrates specific patterns of microstructure change in TDLs and HGGs.
Resting-state Functional MR Imaging in an Intraoperative MR Setting: Proof of Feasibility and Correlation to the Clinical Outcome

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¹Eberhard Karls University, Tübingen, Germany

Purpose
To prove feasibility of resting-state functional MRI (RS fMRI) in an intra-operative MR setting and to correlate findings with the pre- and postoperative clinical condition of patients undergoing tumor resection.

Materials and Methods
Twenty patients underwent intra-operative MRI-guided resection of lesions in or directly adjacent to the central region and/or the pyramidal tract. Intra-operative RS fMRI was performed pre- and intra-operatively and was correlated with patients' clinical condition as well as with intra-operative monitoring (IOM) results after recording the motor and sensory evoked potentials. Independent component analysis (ICA) was used to postprocess the RS-fMRI data concerning the sensorimotor networks. Main anatomical localizations of the ICA peak activations were: the left or the right precentral gyrus for IC7 (Brodmann area 6); the left central gyrus for IC23 (Brodmann area 4); the right precentral gyrus for IC24 (Brodmann area 4). The mean z-scores were analyzed statistically by Analysis of Variance and Pearson's correlation coefficient tests.

Figure 1: The TDLs show lower value of rCBV ratio than HGGs. Figure 2: 2a is a HGG case, and 2b is a case of TDLs. The voxels with ADC value lower than 0.55 are labeled with red color, voxels with FA value higher than 0.215 are labeled with blue, and the voxels with concurrent lower ADC value and higher FA value are labeled with yellow. The HGG case shows a yellow mass within the enhancing tumor, and the enhanced TDL lesion doesn't present. The HGG case shows a yellow mass within the enhancing tumor, and the enhanced TDL lesion doesn't present yellow voxels.
Results
Intraoperative RS MRI in anesthetized patients proved to be feasible and analysis revealed no significant differences in preoperative z-scores between the sensorimotor areas ipsi and contralateral to the tumor. Significant decrease of z-scores (P<0.01) was shown in patients with postoperative neurological deficits. The ipsilateral intra-operative z-score had a significant negative correlation with the degree of paresis immediately after the operation (r=-0.67, P=0.0001) (short term paresis) and after the discharge from the hospital (r=-0.65, P=0.0001) (midterm paresis). Receiver operating characteristic (ROC) curve analysis demonstrated moderate prognostic value of the intraoperative z-score (AUC: 0.84) for the midterm paresis score. The contralateral to tumor z-scores (pre- and intra-operative ones) were not significantly correlated to the short and midterm clinical findings.

Conclusions
The use of intra-operative RS fMRI with ICA is feasible and the results may correlate with clinical parameters demonstrating a significant negative correlation between the intensity of the intra-operative RS fMRI signal and the postoperative neurologic changes.

Purpose
Isocitrate dehydrogenase (IDH) mutations, which occur in up to 80% of brain gliomas, confer a gain of function with the novel production of the oncometabolite 2-hydroxyglutarate (2HG) from alpha ketoglutarate. 2HG can have important prognostic information for patients with gliomas and may be a useful biomarker that can be followed to evaluate treatment response. The purpose...
of this study is to examine the utility and feasibility of incorporating routine 2HG proton magnetic resonance spectroscopy (MRS) into a busy clinical neuro-oncology practice.

Materials and Methods
Thirty-eight patients with nontreated gliomas (aside from biopsy) were evaluated with 2HG MRS. Twenty-five of 38 (66%) patients had IDH mutant tumors and 13/38 (34%) had wild type tumors. Of the 38 tumors included, 20 were low grade, 13 were anaplastic, and five were glioblastoma. The median patient age was 41.5 years. Patients were evaluated on a 3T scanner (750/750W GE). Single-voxel spectroscopy was acquired with a PRESS sequence with varying TE (TE1/TE2=26/71ms) and analyzed with LCModel using a simplified Hamiltonian basis set.

Results
Ten of the IDH mutant gliomas demonstrated positive MRS for a sensitivity of 10/25 (40%). No wild type tumors were declared 2HG positive after accounting for Cramer Rao bound error limits for a specificity of 13/13 (100%). Out of the 2HG positive mutant IDH tumors, the 2HG concentration was a median of 2.1 mM (range, 0.7-12.6).

Conclusions
MR spectroscopy is a highly specific method for detection of IDH mutant tumors in brain gliomas. Further research is necessary to improve the sensitivity of current techniques, which may be limited by tumor volume or small concentrations of 2HG in IDH mutant tumors.

![mIDH Low Grade Astrocytoma](TCT_O-64_ASNRfigure.jpg)

O-65

**Task-free mapping of eloquent cortex using fMRI at ultrahigh field strength (7T) MRI: Comparison to task-based fMRI**

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Purpose

Resting-state functional connectivity MRI (rs fcMRI) identifies networks of functionally connected brain regions based on temporal correlations in spontaneous low frequency (0.01-0.1 Hz) fluctuations of their resting-state BOLD signals. It does not require active subject participation and is a promising noninvasive alternative to traditional task-based fMRI (tb fMRI) for evaluation of brain function. Studies optimizing rs fMRI for the identification of eloquent cortex have been performed mainly at clinical-strength (3T) systems. Recently, ultrahigh field 7T MRI systems have been installed in many clinical centers. Advantages for BOLD fMRI mapping at 7T (increased sensitivity to the BOLD effect, increased functional contrast-to-noise ratio and possibly strengthened measures of rs fcMRI connectivity) co-exist with limitations related to thermal noise, physiological noise, susceptibility-related signal loss and B1 field inhomogeneity. This study investigates brain mapping using rs fcMRI compared to tb fMRI. Specifically, we compare rs fcMRI maps of motor networks to tb fMRI maps of motor activation at 7T in healthy subjects.

Materials and Methods

IRB approved study. Six healthy subjects underwent rs fcMRI and tb fMRI to localize the hand-motor area using a 7T MRI system (Siemens Healthcare, Erlangen, Germany) with a 32-channel head coil. Resting-state time series (no stimulus, subjects fixated on a cross hair) were obtained using a single-shot gradient-echo EPI sequence (TR/TE/flip angle=5000ms/20ms/90 degrees, 103 measurements). Task-based fMRI was obtained using a hand-motor task (TR/TE=5000ms/20ms, 45 measurements). The spatial correspondence between rs fcMRI and tb fMRI was assessed.

Results

Using rs fcMRI, it was possible to map the motor cortex in healthy subjects. The motor regions localized based on rs fcMRI matched to the regions defined by actual movement tasks.

Conclusions

This study demonstrates the feasibility of using ultrahigh field strength (7T) MRI to map clinically relevant functional anatomy in healthy subjects using a task-free paradigm. The greatest impact will be for presurgical mapping in patients who cannot tolerate traditional tb fMRI, such as young children and patients with developmental delay.

O-507

4:43PM - 4:51PM

Melanoma Brain Metastases: Correlation of Imaging Features with Genomic Markers and Patient Survival

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Purpose

To identify MR imaging features of melanoma brain metastases (MBM) that correlate with genetic profile of the metastases and patient survival.

Materials and Methods

From the patients enrolled in Interdisciplinary Melanoma Cooperative Group at our institution, we identified 182 patients with newly diagnosed MBM from 2001-2013. Patients who had MRI brain within 30 days of diagnosis and who previously had not received treatment for MBM were
included in our study. We retrospectively reviewed MR images for 98 patients. The following features were evaluated: number of lesions, size of the largest lesion, number of lesions larger than 1 cm, presence or absence of melanin/hemorrhage, edema, central necrosis, and enhancement pattern. Genomic data from primary melanoma lesion with respect to BRAF mutation was obtained. Details of treatment were recorded. Patient survival was calculated from the date of first diagnosis to the date of death or last follow up.

Results
The imaging findings in this cohort of patients are summarized in Table 1. A strong correlation was found between size of the largest lesion and the percent of lesions with size >1 cm (0.55) and the lesions that are clearly hemorrhagic (0.43). There was also a strong correlation of percent of lesions with size > 1 cm (0.40) with lesions that contained melanin (0.66) and lesions that were clearly hemorrhagic (0.35). Analysis of imaging parameters and BRAF status revealed that these imaging parameters are independent of the BRAF mutation status. The median survival (9.1 months) of subjects with single lesion was significantly higher than the median survival (4.9 months) of subjects with more than one lesion (p=0.002). Patients with two to 18 lesions had significantly longer survival (5.6 months) than with >18 lesions (2 months) (p<0.001). Other imaging parameters such as lesion size, number of lesions with edema and hemorrhage were not related significantly to survival. Among patients with multiple lesions, BRAF inhibitor treatment was found to be the most significant prognostic factor (p=0.002).

Conclusions
With rapid advances in management options available for MBM, identification of imaging phenotype that correlates with genotype and survival will play a critical role. In our study, we found that the number of lesions at diagnosis had statistically significant correlation with survival. Among patients with multiple lesions, BRAF inhibitor treatment was found to be the most significant prognostic factor. Lesion size, presence of melanin, hemorrhage or edema did not affect prognosis significantly. The imaging features analyzed in our study did not show significant correlation with BRAF mutation status.
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(Filename: TCT_O-507_Table1.JPG)
Pneumorhachis of the Thoracolumbar Spine Secondary to E. coli Infection with Few Initial Findings of an Infectious Process

B Hoffman¹, S Imbesi², J Chen³

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Purpose
To describe an uncommon etiology of pneumorhachis secondary to an E. coli spinal infection with few initial MRI findings of an infectious process.

Materials and Methods
A 78-year-old male presented with acute coffee-ground emesis, abdominal pain and 5 days of progressive acute on chronic low back pain. Initial neurologic examination was essentially unremarkable, except for mild bilateral hip flexor weakness. Initial imaging demonstrated multifocal lower spine pneumorhachis without epidural abscess or convincing evidence of discitis-osteomyelitis, but possible findings suggestive of a subsequently confirmed meningitis. By day 12, E. coli epidural abscesses and discitis-osteomyelitis developed at every site of pneumorhachis.

Results
Initial CT of the abdomen and pelvis demonstrated a change over 2 months in configuration and quantity of previous disc gas, new pneumorhachis without air-fluid levels nor clear etiology and a small amount of gas extending into the right psoas muscle. Same day MRI also depicted pneumorhachis but no epidural abscess or convincing discitis-osteomyelitis and questionable abnormal signal and enhancement in the thecal sac. Next day, MRI showed definite abnormal signal and enhancement within the cerebrospinal fluid (CSF) and leptomeninges. Day 12 MRI finally exhibited development of epidural abscesses at essentially every previous level of epidural and disc gas and adjacent discitis-osteomyelitis and infectious facet disease. Areas of previous psoas intramuscular gas also became abscesses. Leptomeningeal enhancement persisted.

Conclusions
Pneumorhachis has a variety of etiologies, typically noninfectious processes, and is usually associated with air in other compartments of the body, such as pneumocephalus, pneumothorax, pneumomediastinum, pneumopericardium or subcutaneous emphysema (1). Disc gas may change dynamically on serial imaging (2) and also typically is considered noninfectious (3). Our case represents an unusual combination of pneumorhachis and disc gas from an infectious etiology with few early findings to initially imply infection.
Injection of n-Butyl Cyanoacrylate and Epidural Fibrin Sealant for the Treatment of Spontaneous Intracranial Hypotension Secondary to a Sacral Perineural Root Sleeve Cyst

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¹Rutgers-Robert Wood Johnson Medical School, New Brunswick, NJ

Purpose
Spontaneous intracranial hypotension (SIH) is a commonly initially misdiagnosed condition which is now becoming increasingly recognized as a cause of daily persistent positional
headaches. Studies have demonstrated the effectiveness of injection of an autologous blood patch and/or percutaneous CT-guided placement of fibrin sealant for cerebrospinal fluid (CSF) leaks. The purpose of this excerpt is to present a novel use of n-Butyl cyanoacrylate (n-BCA) in the management of intractable CSF leak-related headaches using a representative case of a patient with SIH secondary to a sacral perineural root sleeve cyst who failed injection of autologous blood patches and CT-guided placement of fibrin sealant.

Materials and Methods
The patient is a 46-year-old female who presented with intermittent postural headaches since 2012 and was diagnosed with SIH. A CT myelogram showed an enlarged right peri-S1 nerve root sleeve cyst. Since 2012, she underwent a total of five separate epidural autologous blood patch injections and one CT-guided epidural fibrin sealant injection into the cyst with persistent recurrence of her headache within days. The case was discussed in Neurosurgery/Neurointerventional Radiology conference. We discussed placement of a lumbar drain to divert CSF flow and combined CT-guided epidural injection of fibrin sealant and a sclerosing agent such as n-BCA into the cyst. This was reviewed with the patient and she consented. Initially, a lumbar drain was placed and a lumbar myelogram showed reaccumulation of the right peri-S1 nerve root sleeve cyst which communicated with the thecal sac and corresponded to the patient's CSF leak. Next, an 11-gauge bone biopsy needle was inserted through the right lamina into the epidural space adjacent to the cyst and fibrin sealant was injected. A 22-gauge needle then was inserted coaxially through the 11-gauge guide needle and into the collapsed cyst. Thirty-three percent n-BCA glue was injected to create local adhesions and close the CSF leak. The patient tolerated the entire procedure well. She reported immediate resolution of her postural headache and returned 1 month later with persistent resolution of her symptoms.

Results
A) CT demonstrated reaccumulation of a dilated right para-S1 nerve root sleeve cyst (red arrow) which communicated with the thecal sac and corresponded to the patient's known CSF leak, B) Insertion of an 11-gauge bone biopsy needle through the right lamina into the right epidural space adjacent to the cyst (blue arrow), C) Obliteration of the cyst with epidural fibrin sealant (green arrow), D) Postprocedural CT showed appropriate positioning of the n-BCA into the collapsed cyst (orange arrow).

Conclusions
We describe a novel treatment modality which proved effective despite multiple treatment failures with the gold standard treatment options (epidural autologous blood patch injection and CT-guided epidural fibrin sealant injection) in a case of a patient with intractable positional headaches secondary to a spinal CSF leak. Based on these results, our team will surely add n-BCA to its arsenal when primary treatment options do not result in symptom relief.
Peripheral Mononeuropathy of the Median Nerve caused by Neurolymphomatosis

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Purpose
Peripheral neurolymphomatosis is a rare phenomenon, primarily affecting individuals with a history of non-Hodgkin lymphoma which infiltrates the brachial/sacral plexus or extremity peripheral nerves causing plexopathy or neuropathy. It is essential to promptly and efficiently recognize the diagnostic radiologic appearance of this entity as the clinical management and success of therapeutic treatments are time dependent. The purpose of this exhibit is to demonstrate the MR, PET/CT and sonographic appearance of peripheral neurolymphomatosis to familiarize the neuroradiologist with this diagnosis.

Materials and Methods
A 59-year-old female presented to her oncologist with a 3-month history of progressive worsening of recurrent tingling and burning sensation along the palmar aspect of her left first, second and third fingers. During the same time period she noted an enlarging soft tissue mass in the volar aspect of the distal left forearm and wrist. Physical examination at the time of presentation was notable for decreased light touch and pinprick sensation in these regions with no loss of proprioception or weakness. Her past medical history was significant for Mantle cell lymphoma diagnosed 8 years prior and had been in remission both clinically and from an imaging perspective for more than 7 years. Imaging evaluation with PET/CT, MR and ultrasound was diagnostic for peripheral neurolymphomatosis of a long segment of the distal left median nerve. A subsequent ultrasound-guided biopsy confirmed the pathologic diagnosis.

Results
Initial PET/CT demonstrated an FDG-avid soft tissue mass in the volar aspect of the distal left forearm. Low dose CT could not distinguish the degree of local invasion or involvement of adjacent neuromuscular structures, so further imaging was recommended. Additionally, there were multiple hypermetabolic marrow, hilar and retroperitoneal lymph nodes consistent with active lymphoma. A targeted ultrasound of the volar distal left forearm revealed a 5 centimeter segment of a fusiform thickening and expansion of the distal left median nerve with extensive circumferential hypoechoic soft tissue. Evaluation with color doppler showed increased vascularity of the soft tissue and thickened segment of the nerve. Spectral doppler waveforms confirmed the vascularity. Subsequent MR for further characterization confirmed a fusiform enlargement of the median nerve with a homogenous T2 hyperintense, T1 isointense to adjacent muscle enhancing soft tissue mass surrounding and insinuating into the substance of the nerve with separation of the thickened nerve fascicles.

Conclusions
The diagnosis of lymphocytic infiltration of peripheral nerves relies on PET/CT largely because the presentation of extra nodal disease is variable. Accurate and timely diagnosis is essential to the successful treatment with chemotherapy or radiation to salvage nerve function. MR imaging is invaluable in differentiating from postradiation/chemotherapy neuropathy, Guillain-Barre or
primary nerve malignancies. Ultrasound is a useful adjunct to further characterize the extent of the lesion or to guide biopsy.

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E-21  
Tenosynovial Giant Cell Tumor of the Posterior Arch of C1  

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Purpose
To present a rare case of C1 tenosynovial giant cell tumor with multimodality imaging and pathologic correlation.

Materials and Methods
A 61-year-old female with a focal C1 abnormality on PET/CT in the setting of positive thyroglobulin and negative radioiodine imaging concerning for dedifferentiated thyroid cancer. Further imaging and CT-guided biopsy ensued. Histologic findings were compatible with giant cell tumor of the tendon sheath. This case was specifically atypical in that an origin was not delineated to a specific facet joint or the C1-occipital condyle joint suggesting possible bursal origin. Despite deferral of surgical resection, our patient remains asymptomatic 15 months from initial diagnosis.

Results
Fluorodeoxyglucose (FDG) PET/CT identified a hypermetabolic mass (SUVmax 12.4) involving the posterior to arch of C1. MR imaging better localized this 1.4 cm T2 hypointense, enhancing mass posterior to the left C1 arch with focal anterior intraosseous extension. Computed tomography (CT) revealed nonaggressive dehiscence of the posterior vertebral arch adjacent to the mass.

Conclusions
Axial tenosynovial giant cell tumors (ATGCT) fall under the category of locally aggressive monoarticular synovial tumors affecting joints, bursa, and tendon sheaths typically of the appendicular skeleton. Axial tenosynovial giant cell tumors are rare with distribution reported in the cervical>thoracic>lumbar spine. However a literature review found only four reported cases in the upper cervical spine (C1-C3), only one other at the C1 level. Knowledge of the multimodality imaging appearance can raise suspicion for this rare entity. The MR appearance is variable including an enhancing mass with low/intermediate signal on all noncontrast sequences, +/-T2 hypointensity/GRE blooming. On CT osseous erosion, sclerotic margins, and absence of calcification may be seen. Fluorodeoxyglucose PET/CT activity has been described in extra-axial GCTS as intense as that of high grade sarcomas. Clinically ATGCT varies based on the size and location from asymptomatic to radiculopathy. Gross total resection has been recommended with low rates of local recurrence. Follow-up imaging has been described additionally for at least 2 years.
perfusion. A PubMed search demonstrated this to be the first report to evaluate an intramedullary spinal cord mass using PET/MR.

Materials and Methods
Patient is a 65-year-old male with a history of filum terminale ependymoma (Grade 1) status post subtotal resections in 2004 and 2005, followed by 46.8 Gy external beam radiotherapy completed in August 2005. The patient began experiencing subjective weakness in his legs that progressively worsened between February and October 2014. Positron emission tomography MR of the thoracic spine was obtained to evaluate for possible recurrent ependymoma versus postradiation changes. Positron emission tomography MR revealed a hypermetabolic enhancing lesion involving the bilateral, predominantly posterior, cord that increased in size since the patient's prior MRI in 2012 (Figure). pMRI (not shown) time-concentration curve demonstrated rapid enhancement with slowly ascending enhancing plateau, high vascular permeability (KTRANS), and high relative cerebral blood volume (rCBV), all worrisome for recurrent tumor. Patient currently is pending follow-up clinical evaluation, with surgical intervention tentatively scheduled for January 2015.

Results
Current MRI images (Figure, top right) demonstrate interval increase in size of the intramedullary cord lesion compared to prior MRI in 2012 (Figure, top left), now measuring 8 mm x 11 mm x 37 mm in the anterior-posterior, transverse, and craniocaudal dimensions respectively, versus 6 mm x 9 mm x 25 mm in the same dimensions on prior exam. MR attenuated-corrected PET images without (MR-AC PET; Figure, bottom left) and with MR fusion (MR-AC PET fused; Figure, bottom right) demonstrate increased intramedullary cord tracer activity at the site of the treated ependymoma, all suspicious for recurrent tumor.

Conclusions
We previously reported that PET/MR may be useful for differentiation of radiation change from progressive disease in patients treated for intra-axial glioma and CNS metastasis, which has significant clinical ramifications requiring divergent treatment (1). This single, first reported case description of PET/MR characterization of an intramedullary spinal cord lesion suggests PET/MR may prove similarly useful for post-treatment evaluation of spinal cord neoplasms.
E-23 3:40PM - 3:45PM

A Rare Cause of Communicating Hydrocephalus: Thoracic Schwannoma

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Purpose
Hydrocephalus secondary to the presence of a spinal tumor is an infrequent phenomenon. We discuss the clinical presentation and radiologic findings in a case of a hydrocephalus associated to a spinal schwannoma.

Materials and Methods
We report the case of a 68-year-old female patient that presented in our center with rapid progressive alteration of the mental status and poor gait. The patient had a previous history of breast cancer and did not have other chronic diseases.

Results
A head CT scan was performed, revealing significant dilatation of the ventricular system. This finding was confirmed on a MRI of the brain; no intracranial enhancing lesions were observed suggesting brain metastasis. A lumbar puncture then was performed demonstrating hyperproteinorrachia (1.84g/l) but no neoplastic cell. The MRI of the spine revealed three intradural extramedullary well defined lesions, with increased signal intensity in T2-weighted images and hypointensity in T1-weighted images, and uniform enhancement following contrast injection. One of the lesions at T12 was 27 mm in height and it was responsible for severe cord compression. These lesions were compatible with the diagnosis of multiple spinal schwannomas.

Conclusions
Schwannomas are benign slow growing tumors that usually present with progressive symptoms. The elevation of cerebrospinal fluid (CSF) protein related to the presence of a schwannoma can increase the viscosity of the CSF, and consequently lead to a decrease in the resorption of the CSF. In case of hydrocephalus of unclear origin and high CSF protein content, the suspicion of a spinal tumor should be raised.
Axial T2-weighted image of the brain demonstrating communication hydrocephalus.

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Surfer's Myelopathy: an Acute Nontraumatic Cause of Myelopathy Reported from the West Coast.

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Purpose
Describe the imaging and clinical characteristics of surfer's myelopathy, a rare form of nontraumatic myelopathy with a unique predisposing history.

Materials and Methods
A 21-year-old male surfer was trying to stand up on the surfboard off the coast of Central California when he suddenly began to have numbness and tingling in his feet. Shortly afterward he had lower extremity weakness which progressed to an inability to ambulate. He also developed saddle paresthesias and urinary retention. He then presented to the emergency department and underwent imaging with MRI. Following imaging, he began steroid therapy and within 48 hours experienced significant improvement in symptoms.

Results
MR imaging of the thoracic and lumbar spine at the time of presentation demonstrated T2 hyperintense signal within the central cord extending continuously from T9 through the conus with mild, fusiform expansion of the cord and conus. No significant enhancement or T1 signal abnormality. No spinal stenosis or compressive lesion. Repeat imaging 24 hours later was not changed significantly.

Conclusions
Surfer's myelopathy is a rare form of acute nontraumatic myelopathy theorized to be secondary to vascular injury to the artery of Adamkiewicz from prolonged hyperextension of the spine. This gives rise to the typical imaging appearance of continuous central cord T2 signal hyperintensity involving the lower thoracic cord and extending to the conus with associated mild fusiform swelling of the cord and conus. Typically there is no T1 signal abnormality or abnormal enhancement, but this has been reported to rarely occur. History is paramount and classically describes inexperienced surfers who remain prone and with the spine in hyperextension for prolonged periods of time while paddling on their surfboards, without identifiable traumatic event. While the largest collections of reported cases have been from Hawaii, awareness of this entity in any coastal community where surfing occurs is of great importance. Rapid recognition of this entity is crucial as neurologic morbidity often can be reduced with timely treatment, as was seen in this case.
The Presyrinx State in Chiari Malformation

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Purpose
The presyrinx state is reversible cord edema that results from alterations in the cerebrospinal fluid (CSF) flow at the craniocervical junction. Etiologies that obstruct CSF flow include Chiari malformations, cervical stenosis, basilar meningitis, posterior fossa mass, and decompensated hydrocephalus with marked fourth ventricular dilatation. Current hypotheses about the pathophysiology and CSF flow dynamics will be reviewed.

Materials and Methods
A 21-year-old female with a history of migraine headaches for 6 months, right arm weakness and numbness for 2 weeks, and papilledema with blurry vision in the right eye for several weeks. She denied nausea or vomiting. Physical examination demonstrated subjective sensory changes in her right face and arm. Her motor strength was 4+/5 bilaterally.

Results
Noncontrast CT head showed obstructive acute hydrocephalus likely at the level of the cerebral aqueduct with transependymal flow. MR imaging brain demonstrated hydrocephalus and stigmata of Chiari malformation, including cerebellar tonsillar herniation and a dysmorphic tectum. Additionally, there was abnormal intramedullary signal with the cervical cord. Imaging of the entire neuroaxis showed extensive diffuse abnormal cord signal predominantly centrally from C2 to T10 with associated cord expansion. There was no cord enhancement. Diffuse cord edema secondary to hydrocephalus was suspected. Placement of a ventriculoperitoneal shunt resulted in improvement in hydrocephalus on CT head. Follow-up MRI brain performed 3 months later revealed resolution of hydrocephalus, tonsillar herniation, and abnormal cord signal. MR imaging cervical spine performed 5 months after shunt placement demonstrated resolution of intramedullary cord signal and cord expansion with a tiny syrinx in the cervical cord. The patient also reported resolution of her neurologic symptoms.

Conclusions
Presyrinx is characterized by diffused, T1 hypointense, T2 hyperintense signal within the cord without associated enhancement. The abnormal cord signal is predominantly central and usually affects the cervical cord. Cord expansion may be seen. Neurologic symptoms and imaging findings in presyrinx, including tonsillar herniation and cord edema, usually regress following treatment. Because the presyrinx state is potentially reversible, it should be considered strongly in the differential diagnosis of cases with diffuse cord signal abnormality in the setting of abnormal CSF flow dynamics. Awareness of this entity enables timely surgical intervention which can limit progression to syringomyelia.
Lumbar Puncture Induced Reversible Spinal Cord Signal Changes in the Background of Chiari 1 Malformation and Cerebral Sinus Thrombosis.

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Purpose
To highlight the risks of lumbar puncture (LP) and the associated imaging features in the background of cerebral sinus thrombosis and Chiari malformation.

Materials and Methods
A 24-year-old female presented to an outside institution with 1-week history of headache. Acute cerebral sinus thrombosis and tonsillar herniation were overlooked on head CT. Lumbar puncture was performed to exclude meningitis. A short while later, she developed numbness and tingling followed by weakness in lower extremities. Subsequently, she developed respiratory failure requiring intubation. MR imaging brain and cervical spine identified features of intracranial hypotension and cervical cord T2 signals. She was transferred to our institution for definitive management. She received heparin therapy and steroids. She progressively demonstrated improvement in neurologic status and imaging features over the next 2 weeks before her discharge to a rehab hospital on Coumadin therapy.

Results
Initial CT head showed acute superior sagittal and right transverse sinuses thrombosis and tonsillar herniation with partial crowding of foramen magnum cisterns. Computed tomography (CT) head after LP showed worsening effacement of suprasellar and foramen magnum cisterns. Subsequent MRI brain and cervical spine demonstrated superiorly bulging pituitary, descending floor of the third ventricle, tonsillar herniation, long segment cervical cord T2 signals and epidural fluid in lower cervical spine all pointing to features of intracranial hypotension (Figure 1A). MR imaging cervical spine 2 weeks later demonstrated significant improvement in tonsillar herniation with patent cisterns and near total resolution of cord signals (Figure 1B).

Conclusions
Prior to LP, it is important to assess the status of cerebellar tonsils and foramen magnum cisterns. It also is equally important to identify the worsening tonsillar herniation, developing cord signals and recognize the subsequent improvement. Foramen magnum decompression in this situation can be potentially dangerous. Our case is one more example of the perils of a missing diagnosis of cerebral sinus thrombosis.
Downward displacement of the floor of the 3rd ventricle

Bulging pituitary

Effacement of the prepontine cistern

Sinus thrombus

Tonsillar herniation with crowding of the cisterns and foramen magnum

Intramedullary cord signals

Improved contour of the pituitary

Improved tonsillar herniation with resolved crowding of the foramen magnum and effacement of the cisterns

Epidural fluid
Gowers Intrasyringeal Hemorrhage in Chiari I Malformation

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Purpose
To report the sixteenth case of idiopathic intrasyringeal hemorrhage since the entity was first described by Dr. Gowers in 1904.

Materials and Methods
A 37-year-old female with Chiari I malformation presented with several months of worsening headache, weakness, and paresthesias. On physical exam, the patient was hyper-reflexic in her lower extremities and was unable to perform tandem gait. The patient underwent suboccipital craniectomy and C1 decompressive laminectomy. She was discharged home in stable neurologic condition.

Results
Cervical spine MR showed syringohydromyelia involving the cervical and upper thoracic cord. Hemorrhage within the cord appeared as heterogeneous signal including intermediate-to-high signal on T1-weighted series and an irregular hemosiderin rim on T2-weighted and gradient series. Postcontrast imaging showed no abnormal enhancement to suggest underlying mass or vascular abnormality.

Conclusions
Gowers intrasyringeal hemorrhage is a rare complication of syringohydromyelia. Increasing girth of the syrinx in Chiari malformation may raise intrasyringeal pressure and place the patient at higher risk for hemorrhage. Risk factors include trauma, surgical treatment of syringomyelia, and acquired coagulopathy. Chiari I malformation or long-standing scoliosis are common in unprovoked cases of hemorrhage. Decompressive laminectomy and hemorrhage evacuation have had variable success, with some patients recovering from quadriparesis over a few months.
Dynamic Compression of the Cervical Spine by the Paraspinal Muscles Following Cervical Laminectomy: Diagnosis Using Flexion-Extension MRI

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Purpose
Cervical spondylotic myelopathy (CSM) develops through narrowing of the spinal canal and repetitive injury to the spinal cord as a result of osteophyte formation, disc herniation, and ligament hypertrophy. Previous studies using flexion-extension MRI have demonstrated dynamic compression of the cervical cord prior to intervention. The use of flexion-extension MRI to detect postoperative complications is not as well described. We report a case of a 90-year-old male with progressively worsened myelopathy following cervical laminectomy for CSM. Postoperative MRI in neutral alignment demonstrated adequate spinal decompression, and flexion-extension x-rays showed no cervical instability. Kinematic MRI demonstrated compression of the cervical cord by paraspinal musculature during neck extension.

Materials and Methods
A 90-year-old male presented in clinic with functional decline related to worsening right arm weakness and gait instability. He was unable to ambulate without assistance and had difficulty holding objects. Neurologic examination revealed subtle extremity weakness. MR imaging of the cervical spine revealed severe multilevel stenosis of the spinal canal. Disc degeneration, prominent posterior osteophytes, and hypertrophied ligaments with cerebospinal fluid (CSF) effacement and cord compression. No abnormal cord signal. Due to the progressive symptoms and functional impairment, surgical intervention was recommended with posterior decompression. Following surgery, the patient developed increased right deltoid weakness. A postoperative MRI demonstrated decompression of the central canal, and no evidence of hematoma or other compressive lesion. In the ensuing weeks he experienced progressive weakness of his extremities, paresthesias, and urinary symptoms. He was unable to ambulate. MR imaging and flexion-extension radiographs were repeated. There was no evidence of cord compression or cervical instability to account for his decline. Nerve conduction studies and EMG negative. A flexion-extension MRI of the cervical spine then was performed. The cord was decompressed in flexion. With neck extension, however, there was significant compression of the cord by the paraspinal musculature at the site of laminectomy. Compression did not result from spinal motion, but rather from anterior translation of the dorsal soft tissue mass into the spinal canal.

Results
Figure 1: Pre and postoperative T2-weighted sagittal MRI (static): Postoperative imaging in the neutral position appears to show satisfactory decompression. Figure 2: Postoperative T2-weighted sagittal MRI (flexion and extension): Spinal cord is compressed by dorsal musculature when the neck is extended. Subaxial spinal alignment (Cobb angle) does not change with flexion-extension, reflecting rigidity of the patient's spondylotic spine.
Conclusions
Dynamic compression of the spinal cord by paraspinal musculature and dorsal soft tissue is a potential cause of poor outcome following simple cervical laminectomy. Diagnosis requires consideration of dynamic compression and evaluation using flexion-extension MRI.
Acute spinal subarachnoid hemorrhage and right vertebral dissection: Association or coincidence?

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Purpose
To demonstrate the potential relationship between cervical spinal subarachnoid hemorrhage (SAH) and an extracranial vertebral artery dissection.

Materials and Methods
A 32-year-old woman presented to our ER after sudden onset of sharp stabbing posterior neck pain which initially radiated to the right shoulder, but then radiated from the mid thorax down the back and legs. One month ago, she had sudden posterior neck pain and headache lasting a few days, and an outside institution head CT was reportedly negative. At that time, she was diagnosed with torticollis, and treated with Flexiril and physical therapy. In our ER, she presented with hypertensive urgency leading to NSTEMI. Due to persistent neck pain, multiple imaging studies were obtained that revealed an acute cervicothoracic spinal SAH and right vertebral artery dissection.

Results
On initial presentation, CTA chest, abdomen, and pelvis was performed to exclude aortic dissection, which was negative. An MRI cervical spine showed an acute ventral cervicothoracic spinal SAH (Figure 1a). CT brain showed trace SAH in comparison to the MRI spine. MR
angiography (MRA) and CTA identified a 1 cm right vertebral artery dissection at C5-C6. Conventional cerebral and spinal digital subtraction angiography was performed. Mild intracranial vasospasm was identified, without intracranial dissection, aneurysm, AVM, or other vascular malformation. Mild fibromuscular dysplasia was found in the bilateral cervical vertebral arteries, and an irregular focal right vertebral artery dissection again confirmed (Figure 1b). No cervical spinal aneurysm, AVM, dural/pial arteriovenous fistula, or other vascular malformation was found. Ten days later, a repeat conventional cerebral angiogram showed stable right vertebral artery dissection, and improved intracranial vasospasm.

Conclusions
The clinical presentation suggests that the patient's neck pain was due to an acute spinal SAH. Whether the dissection was a causative etiology or coincidence is debatable. Spinal SAH associated with dissection is extremely rare, and so is spontaneous spinal SAH. We review this case and the literature on these two associated entities.

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Purpose
Describe the utility of multidetector CT angiography (CTA) in a case of a type I spinal dural AV fistula (SDAVF) where multidetector CTA was able to localize a fistula after extensive evaluation with digital subtraction angiography (DSA) and a spinal MR angiography (MRA) were unable to identify the fistula site.

Materials and Methods
A 54-year-old male presented with 2 months of lower extremity weakness and development of urinary retention. An MRI of the spine confirmed a SDAVF. Spinal, cervical, and cerebral DSA could not identify a fistula. Spinal MRA also could not localize the level of the fistula. A repeat spinal DSA was performed and again was unable to identify a fistula. Multidetector CTA of the spine was able to localize the fistula leading to successful treatment with embolization.

Results
MR imaging of the cervical, thoracic, and lumbar spine showed prominent flow voids on the surface of the cord extending from C3 to the conus with T2 hyperintense signal within the lower thoracic cord and conus. Spinal, cervical, and cerebral DSA showed no evidence of SDAVF. Spinal MRA showed findings of SDAVF including dilated perimedullary veins without identification of the fistula site. Repeat and more extensive spinal DSA again did not reveal the SDAVF. Multidetector CTA showed a small left medial sacral artery communicating with dilated perimedullary veins at the left S1 neural foramen compatible with a fistula site. Selective sacral angiogram showed a type I SDAVF arising from small bilateral medial sacral arteries. This was followed by successful embolization.

Conclusions
Catheter angiography has been the gold standard for evaluation and treatment of SDAVF, which if unrecognized can lead to serious morbidity in affected patients. However, this can be very cumbersome and radiation intensive, involving an exhaustive search of bilateral thoracic, lumbar, and sacral arteries. Rarely cervical and cerebral angiograms are needed to successfully localize a fistula leading to further radiation dose. MR angiography and multidetector CTA have been shown to be effective in localizing the level of a SDAVF, potentially leading to reduced procedure length and earlier treatment by catheter angiography. The disadvantages of CTA are well known, primarily relating to increased radiation exposure and risks associated with IV contrast administration, but in cases where extensive conventional angiography is needed to identify an atypical fistula site, may lead to overall decreased dose. In this case CTA was paramount in the problem-solving process of localizing a fistula and initiating treatment.
Symptomatic Venous plexus enlargement in sunken flap syndrome

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Purpose
Sunken flap syndrome is a rare complication after craniectomy presumably due to an abnormal relationship between the atmospheric and intracranial pressures. Epidural venous plexus engorgement has been described in other conditions, e.g., intracranial hypotension and underlying arteriovenous malformations/fistulas. We report a patient with sunken flap syndrome who developed symptomatic upper cervical epidural venous plexus engorgement.

Materials and Methods
This 35-year-old male presented with ataxia and new bilateral upper extremity weakness with headaches for several weeks. His past medical history was significant for traumatic brain injury after a gunshot wound and subsequent decompressive left hemicraniectomy.

Results
Head CT demonstrated a new depression of the skin flap at his left hemicraniectomy with flattening of underlying brain and 6 mm midline shift to the right consistent with sunken flap syndrome (A). Contrast-enhanced MR of the brain and cervical spine at this time demonstrated marked enlargement of epidural venous plexus along the ventral C1-C3 cervical cord with effacement of cerebrospinal fluid (CSF) spaces (B, C arrow). The patient was improved with conservative treatment and follow-up imaging demonstrated complete resolution of the findings in the head and neck.

Conclusions
Symptomatic venous plexus can occur in the setting of sunken flap syndrome in upper cervical
spine. The mechanism of sunken flap syndrome is not certain and the appearance of dilated epidural veins in this setting may provide an important clue regarding its cause.

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E-32

4:25PM - 4:30PM

Reversible dilatation of lumbar epidural venous plexus secondary to pelvic venous compression: Mimicker of pathology

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Purpose
Radiculopathy from dilated epidural varices is very rare and oftentimes the varices mimic disc herniation. Prior case reports of this clinically unsuspected entity only have been diagnosed during surgical exploration of those pseudo-discs. We report a case of reversible pelvic venous compression leading to epidural venous plexus engorgement from a distended bladder, masquerading as a dural arteriovenous fistula (dAVF) and/or pseudo disc.

Materials and Methods
A 37-year-old man with a history of poorly controlled type II diabetes presented with acute kidney injury, rhabdomyolysis, and acute decreased distal lower extremity sensation. Cauda equina compression was suspected and a lumbar spine MRI was performed. A follow-up spine MRI and spine MR angiography (MRA) were performed the next day. Transverse myelitis ultimately was diagnosed as the cause of the patient's lower extremity weakness and bladder distention.

Results
Axial and sagittal T2-weighted images of the initial lumbar spine MRI showed marked engorgement of the epidural venous plexus (arrow), effacement of the CSF space, and crowding of the cauda equina at the level of L5-S1 (Figure 1a-b). A distended bladder pushes against the lumbosacral spine (asterisk). A urinary catheter was placed which drained a large volume of
urine. Axial and sagittal T2-weighted images of the follow-up spine MRI showed bladder decompression and spontaneous resolution of epidural venous plexus engorgement resulting in a patent spinal canal (Figure 1 c-d). The spinal cord showed extensive nonenhancing T2 hyperintensity and no definite evidence of a dAVF.

Conclusions

This case report demonstrates that a distended bladder can cause reversible pelvic venous congestion and lead to epidural venous plexus engorgement. This phenomenon may mimic disc herniation and/or pathologic venous enlargement as in dAVF, and familiarity with this clinical entity is crucial to avoid misdiagnosis and to prevent potential unnecessary surgical intervention.
E-88

A rare case of Crossed Cerebellar Diaschisis Secondary to Hypoglycemic Seizures with Unilateral Pancortical Pseudolaminar necrosis.

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Purpose
Hypoglycemia-induced encephalopathy is a well known entity resulting in diverse clinical manifestations. MR imaging findings include bilateral symmetric or asymmetric involvement of the cerebral cortex, internal capsule, corona radiata, corpus callosum and basal ganglia. We present a case of unilateral pancortical involvement with crossed cerebellar diaschisis. To our knowledge, this pattern of involvement secondary to hypoglycemia has not been reported previously.

Materials and Methods
A previously healthy 19-year-old boy presented to ER with acute onset altered mental status and status epilepticus. He had left sided partial seizures. At the time of presentation, the patient was severely hypoglycemic with blood glucose level of 44. LP and other metabolic work up including drug screen was negative. He admitted a suicidal attempt by ingesting antidiabetic medication Glimepiride.

Results
Initial MRI of the brain showed restricted diffusion with FLAIR hyperintensity involving right hemispheric cortex, head of right caudate nucleus and splenium of corpus callosum. A repeat MRI 10 days later showed improving areas of restricted diffusion in the right hemispheric cortex and splenium of the corpus callosum and a new area of FLAIR hyperintensity and restricted diffusion in the left cerebellar hemisphere consistent with the diagnosis of crossed cerebellar diaschisis.

Conclusions
Hypoglycemia-induced hemiparesis is not uncommon; however unilateral pancortical pseudolaminar necrosis with delayed development of crossed cerebellar diaschisis on MRI is unknown in hypoglycemia.
Differentiation of Radiation Necrosis from Recurrent High Grade Glioma Using Multiparametric MRI

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Purpose
Distinguishing radiation necrosis from tumor recurrence after adjuvant radiation treatment of patients with high grade glioma (HGG) remains a diagnostic challenge. The purpose of this study was to evaluate the diagnostic accuracy of multiparametric MRI using a combination of MR
perfusion and diffusion biomarkers to differentiate recurrent HGG from radiation necrosis and to compare the results with surgical pathology.

Materials and Methods
Inclusion criteria for this retrospective study were: 1) Patients with HGG who developed a new enhancing mass 4-6 months after completion of their standard treatment (gross total resection, radiation and temozolomide) with the clinical question of recurrence versus radiation necrosis. 2) Pre-operative MRI including DWI, dynamic contrast-enhanced (DCE) and dynamic susceptibility contrast (DSC) perfusion followed by surgical pathology to be used as gold standard. The arterial input function was selected automatically and multiparametric perfusion maps were calculated using an extended toft model\(^1\) for DCE and Bayesian probabilistic method\(^2\) for DSC. Using coregistered images, voxel-based ADC, Ktrans and rCBV values were obtained using volume-of-interest (VOI) analysis of the enhancing lesion. Data were analyzed by logistic regression and analysis of variance. Receiver operating characteristic (ROC) analysis was performed to determine the optimal parameter(s) and threshold for prediction of recurrence versus radiation necrosis.

Results
Fifteen patients had recurrent HGG and seven patients had radiation necrosis confirmed by surgical pathology. The mean ± SD of imaging biomarkers for recurrent HGG versus radiation necrosis were 4.5 ± 1.9 versus 1.7 ± 0.4 for rCBV (p<0.01), 0.25 ± 0.13 versus 0.14 ± 0.08 (1/min) for Ktrans (p=0.07), 1125 ± 248 versus 1398 ± 324 x 10\(^{-6}\) mm\(^2\)/s for ADC (p=0.04), respectively. The results of ROC analysis including area under the curve (AUC), optimal threshold value and corresponding sensitivity/specificity for imaging biomarkers to differentiate radiation necrosis from recurrent HGG are summarized in Table 1. The best discriminative power was obtained from a combination of the following imaging biomarkers/threshold values: rCBV (1.89), Ktrans (0.13 1/min) and ADC (853 x 10\(^{-6}\) mm\(^2\)/s), resulting in an AUC of 0.98 with sensitivity/specificty of 100/97%.

Conclusions
Multiparametric MRI using a combination of rCBV, Ktrans and ADC can differentiate recurrence from radiation necrosis with an AUC of 0.98, superior to any individual or combination of other classifiers.

**Table 1.** ROC analysis for differentiation of radiation necrosis vs recurrent HGG using rCBV, ADC and K\(^{\text{trans}}\)

<table>
<thead>
<tr>
<th></th>
<th>AUC</th>
<th>Threshold</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>rCBV</td>
<td>0.91</td>
<td>2.47</td>
<td>88%</td>
<td>97%</td>
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<tr>
<td>ADC ((10^{-6}\text{ mm}^2/\text{s}))</td>
<td>0.74</td>
<td>1368.8</td>
<td>38%</td>
<td>85%</td>
</tr>
<tr>
<td>K(^{\text{trans}}) ((1/\text{min}))</td>
<td>0.76</td>
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<td>81%</td>
<td>71%</td>
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(Filename: TCT_O-66_Table-1abs516-rxvsrec.jpg)
Pseudoprogresison in Patients with Glioblastoma: Assessment Using Volume-Weighted Voxel-based Multiparametric Clustering in an Independent Validating Set

J Park¹, H Kim¹, S Kim¹, C Choi²
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Purpose
To validate a volume-weighted voxel-based multiparametric clustering (VVMC) designed to differentiate between pseudoprogresison and early tumor progression (ETP) in independent validating patients diagnosed with glioblastoma.

Materials and Methods
This retrospective study was approved by the local institutional review board. The study patients were divided chronologically into a training set (108 patients) and a test set (54 patients). The reference standard consisted of pathologic findings or subsequent clinico-radiologic studies. Using the optimal cutoff determined in the training set, the diagnostic performance of VVMC subsequently was tested in the test set and compared with that of single parameter measurements [apparent diffusion coefficient (ADC), normalized cerebral blood volume (nCBV), and initial area under the time-signal intensity curve (IAUC)].

Results
Inter-reader agreement was highest for VVMC (intra-class correlation coefficient, 0.87 - 0.89). Receiver operating characteristic (ROC) curve revealed that VVMC performed the best as a classifier, although statistical significance was not demonstrated with respect to the nCBV in the training set. In the test set, the diagnostic accuracy of VVMC was higher than that of any single parameter measurements but this trend only reaches statistical significance with respect to the ADC. Using the entire population, VVMC revealed significantly better diagnostic accuracy than did any single parameter (P-values, .003-.046 for reader 1; .002-.016 for reader 2). Results of five-fold cross-validation confirmed the trends in both training and test sets.

Conclusions
Volume-weighted voxel-based multiparametric clustering is a superior and more reproducible imaging biomarker than single parameter measurements for differentiating between pseudoprogresison and ETP in patients with glioblastoma.
Estimating Glioblastoma Infiltration and Future Recurrence Using Multi-parametric MRI Pattern Analysis and Machine Learning Methods

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Purpose
The goal of this study is to integrate multi-parametric MRIs via machine learning methods in
order to obtain a finer characterization of heterogeneity in peritumoral tissue. We hypothesized that these methods would capture and quantify subtle but important characteristics of peritumoral tissue heterogeneity in patients with glioblastoma, which may relate to tumor infiltration and probability of earlier tumor recurrence.

Materials and Methods
This research consists of a retrospective cohort of 31 de novo glioblastoma followed by an additional prospective study of 34 patients. In addition to rCBV, principle components of dynamic susceptibility contrast (DSC) MRI were calculated and combined with features extracted from multiparametric MRI data (T1, T1-Gad, T2, T2-FLAIR, and DTI) in conjunction with a machine learning method to create a model for infiltrated tissue. The potential value of this model was presented by generating a probability map, which represented the predicted spatial pattern of subsequent tumor recurrence, using baseline pre-resection images. This map was evaluated against regions of postresection recurrence in follow-up studies based on pathology reports.

Results
These areas tended to coincide with areas that later harbored tumor recurrence. The generated recurrence probability maps produced predictions with a mean AUC of 0.84, sensitivity of 91%, specificity of 93%, and odds ratio estimates of 9.29 (99% CI, 8.95-9.65) for in the prospective cohort and mean cross-validated AUC of 0.80, sensitivity of 93%, specificity of 88%, accuracy of 87% and recurrence odds ratio estimates of 11.17 (99% CI, 10.71-11.64) in the retrospective cohort study.

Conclusions
Multi-parametric imaging pattern analysis provides imaging biomarkers that reflect subtle but predictive heterogeneity in peritumoral edematous tissue of glioblastoma. This heterogeneity is not distinguishable using conventional imaging sequences and/or visual inspection, and potentially can assist in the quantitative neuroradiologic reading of advanced MRI of glioblastoma.
Increasing Diffusion Restriction Predicts Poor Survival in Bevacizumab Treated Glioblastoma Patients

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Purpose
In glioblastoma patients, diffusion restriction has been correlated with increasing tumor cellularity and worse prognosis as well as with stable atypical gelatinous necrosis and better prognosis. The purpose of this retrospective study is to examine changes in diffusion restriction in bevacizumab treated glioblastoma and implications on patient outcome.

Materials and Methods
We analyzed 67 consecutive patients (42M/25F) with primary glioblastoma who received bevacizumab for first (n=54) or later (n=13) progression after standard surgical resection, radiation therapy and temozolomide. Using NordicIce (NordicNeuroLabs, Milwaukee, WI), the MRI scans were analyzed with a 3D volume-of-interest drawn around the entire lesion on diffusion-weighted images (DWI) and transferred onto apparent diffusion coefficient (ADC) maps. The measurements were binned and histogram analysis was performed to determine the percentile ADC values. Measurements were performed for the pre-bevacizumab and first post-bevacizumab scans. Statistical analysis was performed with t-tests and p=.05. The Cox hazard ratio (HR) was calculated to analyze the effect on overall survival (OS).

Results
Patients received bevacizumab for a median 189 days (range, 48-1043). The volume of diffusion restriction increased 30% to a median 18.8 cm³ post-bevacizumab from 14.5 cm³ pre-bevacizumab (p=.23). The magnitude of decreases in the 5th, 10th and 25th lowest percentile ADC values post-bevacizumab were all significant (p<.0001). Sixty-six deaths occurred with a median OS of 22 months (range, 7-99). The change in the 5th lowest percentile ADC had the highest HR=4.5 (95%CI=1.05,19.00, p=.04).

Conclusions
Glioblastoma may show early albeit small increases in diffusion restricted volume after bevacizumab therapy. Volumetric histogram analysis suggests that bevacizumab induced increases in diffusion restriction correlate with worse survival. Additional work is necessary to determine the evolution and mechanism of these diffusion changes during bevacizumab therapy.
Diffusion MRI quality control and functional diffusion map (fDM) results in ACRIN 6677/RTOG 0625: A multicenter, randomized, phase II trial of bevacizumab and chemotherapy in recurrent glioblastoma

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Purpose

Functional diffusion mapping (fDM) is a cancer imaging technique that quantifies voxelwise changes in apparent diffusion coefficient (ADC). Previous studies have shown value of fDMs in bevacizumab therapy for recurrent glioblastoma (GBM). The goal of the current study was to implement explicit criteria for diffusion MRI quality control and independently evaluate fDM performance in a multicenter clinical trial (RTOG 0625/ACRIN 6677).

Materials and Methods

A total of 123 patients were enrolled in the current multicenter trial and signed institutional review board-approved informed consent at their respective institutions. MR imaging was acquired prior to and 8 weeks following therapy. A 5-point QC scoring system was used to evaluate DWI quality. Functional diffusion mapping performance was evaluated according to the correlation of these metrics with PFS and OS at the first follow-up time point.

Results

Results showed ADC variability of 7.3% in NAWM and 10.5% in CSF. A total of 68% of patients had usable DWI data and 47% of patients had high quality DWI data when also excluding patients that progressed before the first follow-up. Functional diffusion mapping performance was improved by using only the highest quality DWI. High pretreatment contrast enhancing tumor volume was associated with shorter PFS (P=0.0003) and OS (P=0.006). When examining only the highest quality DWI, a high volume fraction of increasing ADC after therapy was associated with shorter PFS (P=0.042) and a high volume fraction of decreasing ADC was associated with shorter OS (P=0.035).

Conclusions

Functional diffusion mapping results were consistent with previous reports when only the highest quality data were included in the analysis. Diffusion-weighted imaging in multicenter trials are currently of limited value due to issues with image quality. Geometric distortions and inconsistency in ADC measurements were the primary source of poor image quality. Results imply that more stringent quality control is necessary for further advancement of DWI biomarkers in brain tumor multicenter clinical trials.
Can Detection of Tumor Infiltration into the Corpus Callosum by DTI be Predictive of Overall Survival in Patients with Glioblastomas?

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Purpose
Glioblastomas are characterized by the absence of discrete boundaries. The occult invasion of tumor cells into the normal brain is a key feature of glioblastomas which leads to its incurability and poor prognosis. Corpus callosum (CC) being the largest commissural tract in the brain perhaps is the most important conduit for neoplastic cells to infiltrate into the contralateral hemisphere. The purpose of this study was to investigate whether diffusion tensor imaging (DTI) can detect tumor infiltration in the CC and predict survival in patients with glioblastomas.

Materials and Methods
Fifty-eight patients (32M/26F; age 22-89 years) with pathologically proven glioblastomas were included in this retrospective study, along with 17 normal controls. Patients were divided into four groups based on CC invasion and survival. All patients underwent DTI before surgery and were treated with standard chemo-radiation. Fractional anisotropy (FA) values were calculated by freehand drawn regions of interest (ROI) at the level of genu, mid-body, and splenium of CC. Three measurements were made at each level, and the mean values then were computed for each level. Fractional anisotropy values were compared between patients with long survival (≥ 15 months) and short survival (< 15 months).

Results
Thirty-two patients demonstrated CC invasion on conventional imaging whereas 26 patients had no CC invasion. There was significant difference between all the groups (p<0.05) except between group of short survival without CC invasion and group of long survival with CC invasion. The control subjects had the highest FA values (0.87±0.03) followed by groups of long survival without CC invasion (0.85±0.02), short survival without CC invasion (0.77±0.08), long survival with CC invasion (0.77±0.05) and short survival with CC invasion (0.64± 0.05).

Conclusions
Our results indicate that DTI can quantify tumor infiltration in the CC and predict survival in patients with glioblastomas.
**Fig.1** Box plot of FA from the corpus callosum (CC) in glioblastoma patients and long survival. 0 control group; 1 long survival without CC invasion; 2 short survival without CC invasion; 3 long survival with CC invasion; 4 short survival with CC invasion.

(Filename: TCT_O-71_Figure1.jpg)

**O-72**

**Abstract**

Apparent Diffusion Coefficient Histogram Analysis Stratifies Progression-Free and Overall Survival in Glioblastoma Patients After Temozolomide and Radiotherapy

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¹UCLA, Los Angeles, CA, ²University of California Los Angeles, Los Angeles, CA
Purpose
The standard of care for newly diagnosed glioblastoma (GBM) is surgery, then radiotherapy (RT) with concurrent temozolomide (TMZ) for 6 weeks, followed by adjuvant TMZ (1). The apparent diffusion coefficient (ADC) has been shown to be decreased in tumors with high cellularity, and therefore is a potential imaging biomarker. Previous studies have used apparent diffusion coefficient (ADC)-derived metrics to identify a subset of patients with increased progression-free survival (PFS) after bevacizumab therapy (2-3). In the current study, we examined a cohort of patients who were treated with surgery followed by concurrent RT/TMZ, imaged with MRI/DWI, and then treated with adjuvant TMZ. We hypothesized that ADC histogram analysis performed 4 weeks after the completion of RT/TMZ could identify patients with longer PFS and overall survival (OS).

Materials and Methods
One hundred twenty patients with histologically confirmed GBM treated with surgery and concurrent RT/TMZ followed by adjuvant TMZ with contrast enhancement suspicious for residual/recurrent tumor on MRI were included in this retrospective study. Diffusion-weighted imaging (DWI)/structural MRI was performed 4 weeks after the completion of RT/TMZ. Enhancing tumor regions were segmented on postcontrast T1 images and the corresponding ADC data were extracted. ADC histograms were calculated with a double Gaussian model. ADCL was defined as the mean ADC value of the lower Gaussian distribution, and designated as high (> 1 um2/ms) or low (<= 1 um2/ms). Time to progression was defined as time to either radiographic recurrence or neurological decline per modified Macdonald criteria (4). Kaplan-Meier curves were generated and compared with an univariate log-rank test. Cox proportional hazards test also was used, generating hazard ratios (HR) with 95% confidence intervals (CI).

Results
Patients with high ADCL had significantly longer PFS compared to patients with low ADCL (HR 0.12, CI 0.038 – 0.36, P = 0.0002). Patients with high ADCL had almost twice the median PFS (288 versus 156 days) of patients with low ADCL. OS also was significantly longer in patients with high versus low ADCL (644 versus 407 days, HR 0.31, CI 0.11 – 0.86, P = 0.024).

Conclusions
ADCL acquired 4 weeks after the completion of RT/TMZ stratified PFS and OS in GBM patients. This could be related to decreased tumor cellularity, pseudoprogression and/or sensitivity to adjuvant TMZ therapy (5); elucidating the underlying tumor biology will require additional investigation. These findings may have clinical value for identifying patients with more favorable prognoses and potentially could be used to select patients for enrollment in clinical trials.
Apparent Diffusion Coefficient Analysis of Glioblastoma Infiltrative Margins as a Quantitative Metric for Tumor Cellularity

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1Columbia University Medical Center, New York, NY, 2Columbia Presbyterian, New York, NY, 3Columbia University, New York, NY

Purpose
Glioblastoma multiforme (GBM) is an invasive and aggressive tumor with poor prognosis. Postsurgical recurrence is inevitable as limitations to current approaches includes difficulty in identifying nonenhancing tumor. In patients with GBM, decreases in mean diffusivity quantified...
from apparent diffusion coefficient (ADC) maps of perilesional vasogenic edema may correlate to tumor cellularity not represented by contrast imaging. The purpose of this study is to correlate tumor cell density obtained from stereotactic biopsies with ADC values within the nonenhancing peritumoral margin of patients with GBM.

Materials and Methods
This retrospective study included patients with native glioblastomas with MR imaging performed at 24-48 hours prior to resection. Multiple stereotactic guided biopsies of the tumoral contrast-enhancing and peritumoral nonenhancing/FLAIR edema regions were obtained for all patients. Regions of interest (ROIs) were recorded using a Cartesian coordinate system at time of surgery. Apparent diffusion coefficient (ADC) values were obtained for each ROI and correlated with corresponding tissue histopathology. Histopathology included H&E staining for cellularity analysis, as well as NeuN staining for neuronal cell quantification, as a proxy for relative composition of non-tumor cells. Pearson's correlation coefficient analysis was used to determine statistical significance.

Results
A total of 32 biopsies were taken from 14 patients. This included 20 and 12 biopsies taken from tumoral contrast-enhancing and peritumoral nonenhancing/FLAIR regions, respectively. A significant inverse correlation between cellularity and ADC signal was observed in ROIs obtained from FLAIR regions, (R2=0.7, p=0.04). The correlation between cellularity and ADC values from contrast enhancing biopsies was not significant, (R2=0.20, p=0.39). Biopsies taken from FLAIR regions contained a higher proportion of NeuN positive cells, but no significant correlation existed between NeuN and ADC values in FLAIR regions (R2=0.08, p=0.87).

Conclusions
At the infiltrating margin of glioblastoma, cellularity is inversely correlated to ADC values and may serve as a radiographic marker of tumor infiltration.
Patterns of Glioblastoma Multiforme Recurrence Are Predicted by the Cortical Involvement of Tumor at the Initial Presentation

B Weinberg\(^1\), I Baran\(^1\), S Cha\(^1\)

\(^1\)University of California San Francisco, San Francisco, CA
Purpose
Glioblastoma multiforme (GBM) is a highly malignant but heterogeneous tumor with variable biology and recurrence pattern. The traditional model describing GBM as originating from malignant transformation of astrocytes has been challenged recently, with a new model proposing that some subtypes of GBM originate from neural stem cells. These tumors invade the cortex and tend to recur in an unusual pattern which is remote and distant from the original tumor bed, often involving the subventricular zone (SVZ). The purpose of our study was to evaluate characteristic imaging patterns of recurrence in GBM based on the initial tumor in relation to cortex.

Materials and Methods
A retrospective review of medical and imaging findings of a subset of consecutive patients diagnosed with GBM and treated with radiation therapy at our institution was performed. The location of GBM in relation to cortex prior to therapy and multifocality of lesions, extent of initial surgical resection, radiation therapy field, and serial imaging findings were evaluated. Research was approved by the institutional committee on human research.

Results
A total of 15 patients diagnosed with GBM and treated with surgery and radiation therapy had an average of 485 days of follow up. At the time of diagnosis 8/15 (53%) patients had tumors that involved the SVZ +/- the cortex, while 7/15 (47%) were confined to the cortex alone. Glioblastoma multiformes with enhancement initially confined to the cortex were smaller at the time of diagnosis when compared to those involving the SVZ (29 versus 54 cm3) and had better overall survival (519 versus 448 days). However, a greater percentage of cortical GBMs (5/7, 71%) than SVZ GBMs (2/8, 25%) ultimately had disease progression distant from the original tumor location (Figure 1).

Conclusions
Our preliminary study suggests that GBMs initially confined to the cortex exhibit a characteristic remote and distant tumor recurrence pattern. These cortically based GBMs were smaller in size at initial diagnosis but were more likely to recur distant to the original tumor bed, particularly in the SVZ. Further insight into the pattern of GBM recurrence based on the original tumor location may alter radiation therapy planning and allow for earlier detection of tumor recurrence on imaging.
Figure 1. Two different patients with glioblastoma originally confined to the cortex (A, C). After resection and radiation, both patients had recurrence of disease at distant sites along the subventricular zone (B, D).
The Value of Post-Resection Pericavity Volume of Edema/Invasion as a Predictor of Survival in Glioblastoma Multiforme.

A Kotrotsou, A Elakkad, P Zinn, R Colen
MD Anderson Cancer Center, Houston, TX

Purpose
To investigate the role of residual postoperative volume of abnormal FLAIR as a prognostic tool in patients with glioblastoma (GBM).

Materials and Methods
Thirty-seven patients (16 females, 21 males) with newly diagnosed and histologically proven GBM, who underwent maximal tumor resection, were studied retrospectively. The Institutional Review Board of MD Anderson Cancer Center approved this retrospective study. All patients underwent MRI studies that included T2-FLAIR, and post-gadolinium (GD) contrast T1-weighted (T1WI) images. The FLAIR image was registered to the postcontrast T1WI using affine registration (12 degrees of freedom). An experienced radiologist outlined pericavity edema/invasion (hyperintense T2-FLAIR image) and enhancing region (hyperintense T1 post-contrast image) resulting in a label volume with a single ROI per patient (Figure 1). For each ROI we calculated the volume by multiplying the number of voxels in the ROI with the volume of the voxel. Survival was measured from the time of operation to the time of death or last follow up. Possible relevant prognostic factors included: age, gender, Karnofsky performance scale (KPS) score, presence of enhancement, and presence of necrosis. Univariate analyses on continuous prognostic factors were performed using Cox regression, and categorical prognostic factors were analyzed using Kaplan-Meier and log-rank methods. Finally, a multivariate analysis was performed containing the prognostic factors with P<0.1 in univariate models.

Results
Univariate analyses suggested that age, gender, presence of enhancement and volume of edema/invasion, were significant prognostic factors for overall survival. Multivariable analysis suggested that there was significantly greater risk of mortality associated with greater age, presence of enhancement, and greater volume of edema/invasion. Finally, a cutoff value of 62940 mm3, obtained by recursive partitioning analysis (RPA), was used and a survival determined using Kaplan-Meier analysis.

Conclusions
Increased volume of edema/invasion around the resection cavity was found to be a significant predictor of survival after GBM resection. This is important as the volume of FLAIR after gross total resection is associated with patient survival. This study serves as a initial investigation upon which further studies elucidating which part of the FLAIR might be suggested to be removed, in addition to the area of enhancement.
Survival Analysis in Patients with Recurrent Glioblastoma Using Pre- and Post-Avastin® therapy DSC Perfusion MRI and DCE MRI

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¹University of Southern California, Los Angeles, CA, ²Departamento de Diagnóstico por Imagens, Universidade Federal de São Paulo, São Paulo, Brazil, ³iCAD, Nashua, NH, ⁴USC Keck School of Medicine, Los Angeles, CA, ⁵USC Keck School of Medicine, Univ of So CA, Los Angeles, CA

Purpose
Avastin® (bevacizumab), an antiangiogenesis agent, is used to treat recurrent glioblastoma multiforme (GBM). Noninvasive MRI imaging biomarkers need to be correlated with patient survival in order to develop predictive models for prognosis as well as for treatment response. The purpose of this study was to perform survival analysis with both initial dynamic susceptibility contrast (DSC) perfusion and dynamic contrast-enhanced (DCE) metrics, as well as with changes in these parameters with Avastin® therapy.

Materials and Methods
Thirteen patients with recurrent GBM and with MRI imaging pre- and post-Avastin® therapy were evaluated retrospectively. Dynamic susceptibility contrast perfusion and DCE images were acquired during the same MRI exam. Dynamic contrast-enhanced MRI images were postprocessed in CADvue. Metrics extracted from DCE MRI were: ve, vp, Ktrans, and Kep.
Dynamic susceptibility contrast perfusion images were postprocessed in Synapse 3D. Metrics extracted from DSC perfusion MRI were: rCBV, rMTT, rCBF, and rTTP. For DCE, 3-dimensional regions of interest were drawn using the area of enhancement on postcontrast imaging. For DSC, 2-dimensional regions of interest were drawn corresponding to the region of highest CBV within each tumor with contralateral normal comparison areas to obtain relative parameters. Cox regression was used to examine the association between DSC/DCE and patient survival status. Hazard ratios for each predetermined unit increase in DSC/DCE measurement were calculated at pre-therapy scans and change from pre- to post-therapy scan.

Results
Thirteen patient (6 died, 7 censored) were included in the study. The median survival time was 673 days (Q1 629, Q3 914). The median Avastin ® exposure was 98 days (Q1 29, Q3 154). As shown in Table 1, the only parameter with statistically significant hazard ratio is the initial extracellular extravascular volume fraction ve: every 0.1 increase of ve is associated with 4.15 (95% CI: 1.24, 13.90) times the risk of death (p=0.02).

Conclusions
Survival analysis was performed both with the initial DSC and DCE parameters, as well as with changes in these parameters with Avastin ® therapy. Statistically significant hazard ratio was observed only for initial extracellular extravascular volume fraction ve, where every 0.1 increase of ve was associated with 4.15 times the risk of death. It has been suggested ve may represent a marker for increased tumor necrosis and aggressiveness (1).
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Hazard Ratio per unit change of variable</th>
<th>P value</th>
<th>Unit change</th>
</tr>
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</tr>
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<td>Difference in rMTT</td>
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<td>Difference in rBF</td>
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<td>0.5</td>
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<td>Difference in rTTP</td>
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<td>Difference in $V_{e}$</td>
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<td>Initial $V_{e}$</td>
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<td>0.1</td>
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<tr>
<td>Initial $V_{e}$</td>
<td>0.51</td>
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</tr>
</tbody>
</table>

Table 1: Results of statistical analysis

Figure 1: Perfusion, T1 post, and $V_{e}$ images for a study patient with GBM
(Filename: TCT_O-76_Pictures.JPG)

Monday
3:15PM - 4:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

05E - PARALLEL SCIENTIFIC PAPER SESSION-DEGENERATIVE DISEASES
O-77
3:15PM - 3:23PM
Detection of Blast-Related White Matter Injury in Iraq and Afghanistan Combat Veterans is Modulated by Control Group Composition

A McClelland¹, W Mu¹, R Fleysher¹, N Kim¹, M Wagshul¹, E Catenaccio¹, M Lipton¹
¹Albert Einstein College of Medicine, Bronx, NY

Purpose
Blast-related mild traumatic brain injury (mTBI) has been termed the "signature wound" of modern combat and has been associated with abnormal white matter diffusion. Concern has been raised that baseline differences between mTBI subjects and controls, perhaps due to genomic, environmental or socioeconomic factors, may account for part or all of the changes reported in prior studies. To more directly address the hypothesis that white matter changes are related to combat and not other baseline factors, we assessed DTI in veterans with mTBI in comparison to both close relatives and unrelated age-matched controls.

Materials and Methods
Sixteen veterans (age 22-40 years, all male) exposed to combat blasts, 18 mostly first-degree civilian relatives without blast exposure (age 18-51 years, all male) and 22 age-matched males from the local community underwent 3T diffusion tensor imaging using a 32-channel head coil. Voxel-wise comparison of each veteran was performed separately with each reference group to identify contiguous clusters of at least 100 voxels in which the subject's fractional anisotropy (FA) values differed from the control group at a significance level of 0.01 (1). Relatives also were compared to the unrelated control group in a similar manner. The number of abnormal FA regions was compared using unpaired t-tests for group-wise comparisons of veterans and relatives and paired t-tests to compare veteran findings detected with each of the two other groups as the reference.

Results
Multiple areas of abnormally low FA were detected in veterans. Using unrelated controls for reference, veterans demonstrated more abnormal clusters than their relatives (veterans 4.19 regions; relatives 2.72 regions; p=0.088). We next explored the number of abnormal areas detected in veterans, as the control group used for reference differed. While some abnormally low FA regions were detected in veterans when related controls were used as the reference (0.81 clusters), more regions of abnormality were identified when unrelated controls were used as reference (4.19 regions; p=0.000085).

Conclusions
We found more regions of abnormally low FA in veterans exposed to blast compared to a cohort of close same gender civilian relatives. This finding supports the hypothesis that exposure to combat-related blasts is associated with white matter injury. However, we also found that the detection of areas of abnormal FA within a single subject differs greatly depending on the control group used to identify abnormal clusters, with fewer areas of abnormality identified when relatives comprise the reference group. Thus, baseline differences between subjects and controls, which are at least partially accounted by familial similarities suggest that care should be taken in defining reference groups and that the burden of white matter pathology in an individual subject or patient should be interpreted with regard to these contextual factors.

O-78
Threshold effects of aging on fractional anisotropy of posterior white matter tracts

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Purpose
Linear association has been frequently assumed in neuroimaging studies for relationship between aging and fractional anisotropy (FA); gradual decrease in FA is assumed to occur during normal aging. A recent publication by Lipton et al. (2013) proposed a nonlinear threshold model to delineate thresholds for soccer heading exposure beyond which abnormally low FA is detected. We, in this study, apply the threshold model to investigate the presence of threshold effects of white matter changes that occur during normal aging.

Materials and Methods
Sixty-two healthy subjects with 26 females, ages ranging from 20 to 67 years, years of education ranging from 7 to 25 years, and no history of medical, neurological or psychiatric disease were recruited. Diffusion tensor imaging (DTI) (3.0T; 32 directions; b=1000) was performed. Individual FA volumes were registered to JHU T1 template and white matter (WM) tracts were extracted by using JHU-MNI-SS-WMPM-Type-II with comprehensive WM parcellation. Based on our hypothesis, an inverse S shape was assumed for FA measurements against age. Such nonlinear shapes (inverse S) were modeled based on Inverse Logit (IL) functions with four parameters: (1) baseline level (2) scale and direction, the drop-off point, and the slope of the exponential curve, where \( \beta \) is of our interest. These parameters were estimated by nonlinear least square estimates (Bates and Watts, 1988) for each WM tract.

Results
Threshold effects were detected in three posterior WM tracts; posterior thalamic radiation (p <0.0001), posterior corona radiata (p=0.0064), and tapatum (p=0.0036), where significant decrease in fractional anisotropy was detected with onset in the late 40s. Such threshold effects may be explained as delayed onsets of demyelination and are consistent with the "last in, first out" theory of brain aging.

Conclusions
Although linear decline of white matter integrity has been shown previously as a function of age, our approach suggests the possibility of nonlinear threshold effects in the association.

O-79

Smoking associated white matter microstructural alterations in young adults with Attention Deficit Hyperactivity Disorder

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Purpose
Smoking in young adults is a priority public health concern. Ninety-nine percent of all smokers initiate smoking before age 26 (1) and nearly 25% of U.S. high school students reported use of tobacco products (2). In youth, amongst various risk factors predisposing to smoking addiction,
is also attention deficit hyperactivity disorder, (ADHD) with greater addiction, and severity of smoking in this high risk vulnerable group (3). Despite this, there is limited understanding of smoking-related brain changes in this high risk population. In this study, we utilized diffusion tensor imaging (DTI) to evaluate smoking-related changes in white matter integrity in young adults with ADHD.

Materials and Methods
A total of 18 community dwelling young adult males between ages of 18 and 25 years and diagnosed with ADHD between ages of 18 and 25 years were recruited for this study. Six nonsmokers, (mean age (±SD): 21±2 years) were compared with 12 age-matched smokers, (smoking tobacco and/or cannabis; with mean age (±SD): 22±1.8 years). Single-shot spin echo planar imaging on 3T MRI system with 32 gradient directions was performed. Diffusion tensor imaging studio (S Mori and H Jiang Johns Hopkins University) was used for 3D tractography with measurement of tract-constrained diffusion metrics. Statistical software STATA, version 11, (StataCorp, TX) was used for statistical analyses.

Results
There was no significant difference in performance on an attention task between smoker ADHD and nonsmoker ADHD groups. However, there was a significant decrease in axial diffusivity in cingulum hippocampal segment and forceps minor in smoker ADHD compared to nonsmoker ADHD, (p=0.004, p=0.03). The anterior thalamic radiations had significant reduction in trace measurement (p=0.009) with an underlying trend of reduction in axial diffusivity and radial diffusivity (p=0.1). The uncinate fasciculus, also had significantly lower trace and radial diffusivity, (p=0.03 and p=0.02). Nonparametric bootstrap median regression with 1000 simulations was performed for robust analyses. This shows a significantly lower trace measurement in anterior thalamic radiation and forceps minor in ADHD smokers compared to nonsmoker ADHD (p=0.04 and p=0.02 respectively).

Conclusions
Our results demonstrate significantly lower diffusion metrics in various fiber networks in young adult smokers with ADHD compared to the nonsmokers with ADHD. These changes were seen despite no difference in performance on an attention-related task between these groups. This indicates presence of smoking associated microstructural alteration in this high risk vulnerable population at a young age. Such changes may predispose them to downstream neurocognitive deficits and therefore warrant further investigation with the goal of development of targeted primary prevention strategies in the future.

O-80

Structural Changes in Parkinson’s Disease: Diffusion Tensor Imaging (DTI) and Voxel-Based Morphometry (VBM) Analysis Based on 123I-MIBG Uptake

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Purpose
Patients with Parkinson's disease (PD) could show symptoms of sympathetic dysfunction which can be measured on 123I-MIBG myocardial scintigraphy. The purpose of this study was to investigate the changes in brain structures of PD based on both diffusion tensor imaging (DTI)
data measured by tract-based spatial statistics (TBSS) and voxel-based morphometry (VBM) depending on MIBG uptake.

Materials and Methods
This retrospective study included age-matched 22 PD patients, divided into two groups; 11 MIBG-positive and 11-negative cases (10 men and 12 women; age ranged 60-81 years) who underwent DTI at 3T MR scanner and 123I-MIBG scintigraphy. For DTI, motion probing gradients were conducted at 15 directions with b-values of 0 and 800 s/mm². The other imaging parameters were: TR/TE = 5,920/70 msec; matrix = 128 x 128; slice thickness = 2.5 mm, field of view = 230 x 230 mm²; number of slices = 60, sensitivity encoding factor 2.5; scan time = 3 min 47 sec. A high-resolution 3D-T1WI was used for VBM analysis with following parameters; TR/TE = 8.2/3.8 msec; TI = 1,027 msec; FA = 8°; matrix = 240 x 240; slice thickness = 1 mm, field of view = 240 x 240 mm²; number of slices = 190, sensitivity encoding factor = 1 (phase) and 2.5 (section); scan time = 5 min 20 sec. The heart/mediastinum count (H/M) ratio was calculated on anterior planar 123I-MIBG images obtained 4 hours after injection. The H/M ratio less than 2.00 was considered positive. Fractional anisotropy (FA) and mean diffusivity (MD) with a TBSS were calculated to investigate structural changes between these two groups. Voxel-based morphometry also was performed to detect structural difference between these two groups.

Results
Patients with low H/M ratio showed significantly lower FA in bilateral anterior thalamic radiation, bilateral corticospinal tracts, bilateral cingulate gyri, forceps minor, bilateral superior longitudinal fasciculi and bilateral inferior longitudinal fasciculi than in those with high H/M ratio (p<0.05). There were no statistically significant differences in MD in any tracts between patients with high and low H/M ratio (p>0.05). Patients with low H/M ratio demonstrate a significant reduction of brain volume in left superior temporal gyrus, right postcentral gyrus and right precentral gyrus.

Conclusions
There were significant structural differences in PD patients with high and low H/M. These findings may be a clue for the mechanism of progression of PD.
Resting-State Functional Connectivity of the Basal Ganglia as a Biomarker for Parkinson’s Disease

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Purpose
Parkinson's disease (PD) is characterized by the degeneration of nigrostriatal dopaminergic neurons, resulting in dysfunctional cortico-striato-thalamic-cortical loops. Parkinson's disease patients suffer from chronic movement disabilities as well as cognitive impairments and other nonmotor symptoms, which implies a system-wide effect on overall brain function. Because the disease currently has no cure, the discovery of a biomarker for specific PD symptoms is crucial for monitoring treatment potency. This study aimed to evaluate the validity of using functional connectivity between regions of the basal ganglia as a biomarker for specific symptoms of PD.

Materials and Methods
Data from this study were obtained from the Parkinson's Progression Markers Initiative. Resting-state functional magnetic resonance imaging (rs fMRI) and seed based analysis were used to measure functional connectivity between regions of the basal ganglia in 72 PD patients. Parkinson's disease motor symptoms were measured with the Unified Parkinson's Disease Rating Scale Section III (UPDRS-III). Statistical analysis was performed assessing the correlation between connectivity values and PD motor symptoms, taking into account the effect of age, sex, and medication.

Results
Analysis shows a decrease in functional connectivity between regions of the caudate are highly correlated with the increase of rigidity symptoms in PD patients.

Conclusions
This study suggests using functional connectivity within in the basal ganglia to understand both motor and cognitive deficits. It introduces the possibility of using functional connectivity between brain regions as a biomarker for specific symptoms of PD. Future investigations will be conducted to determine the effect of functional connectivity on cognitive symptoms of PD.
Alterations in Functional Connectivity of the Dorsal Frontoparietal Network in Alzheimer Disease

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Purpose
Studies have shown an increased risk of developing Alzheimer Disease (AD) in people who have had mild traumatic brain injury (mTBI). While reports of alterations in the default mode network have been shown in AD, we hypothesize that subjects with AD may have similar functional connectivity alterations in the dorsal frontoparietal network as those who have had mTBI.

Materials and Methods
The Alzheimer's Disease Neuroimaging Initiative (ADNI) database was queried, and subjects with AD as well as the normal control (NC) subjects in the database that have resting-state fMRI (rs-fmRI) data were selected for analysis. Thirty-three AD and 42 NC subjects were selected for analysis. The rs fMRI data were processed and analyzed using SPM8 and CONN. All subjects underwent data processing of coregistration, motion correction, slice timing correction, spatial normalization to a standard anatomical space, and spatial smoothing. Region of interest (ROI) analysis of the parietal cortex, dorsolateral prefrontal cortex, and frontopolar regions, which have been demonstrated to have altered functional connectivity in subjects who have experienced mTBI (Reference 1), then were performed, and the functional connectivity metrics corrected for multiple comparisons at a false discovery rate of p < 0.05 at both the connection and network levels.

Results
Differences in intensity and number of connections to the regions of interest (ROIs) were observed between the AD and NC groups, most pronounced in the inferior parietal lobe, with the AD group demonstrating less intensity of the functional connections to the region as compared to the NC group.

Conclusions
Functional connectivity alterations may occur in people with AD in a similar fashion as those who have experienced mTBI. The preliminary data is encouraging for further assessment of statistical significance of the findings as well as for the exploration of alterations in other functional metrics in the dorsal frontoparietal network.
Motor Gains in Stroke Patients Receiving Rehabilitative Therapy Using a Brain-Computer Interface with Concurrent Training of the Unimpaired Hand

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Purpose

Brain-Computer Interface (BCI) technology is a real-time image-guided EEG-based therapy being incorporated into new rehabilitative devices. We investigate brain-behavior relationships among stroke patients receiving BCI therapy.
Materials and Methods
We collected high-resolution anatomical (TR=8.16ms, TE=3.18ms, flip angle=12) and functional (TR=2.6s, TE=22ms, flip angle=60) MRI of 19 stroke patients (13M, mean age= 59.9 years) with persistent upper extremity motor impairment using GE 3T MR scanners. Eighteen patients received BCI therapy and were scanned pretherapy, midtherapy, post-therapy, and one month after therapy completion. Subjects performed unimpaired finger tapping during functional MR imaging (fMRI). Nine patients in a cross-over control group were scanned three additional times before therapy administration. Laterality index (LI) was computed using 3 mask sets at 2 thresholds. Unimpaired grip strength and 9-Hole Peg Test (9-HPT) were assessed out of scanner. We examined LI and behavioral scores for changes from baseline. We also examined relationships between LI changes and behavioral changes.

Results
Subjects' 9-HPT performance improved mid-therapy. Grip strength and 9-HPT performance improved one month after therapy. Laterality index was reduced mid-therapy using one mask-threshold combination. Increased grip strength correlated with LI changes during the therapy period using 3 mask-threshold combinations. Changes in 9-HPT scores correlated with LI changes using 1 mask-threshold combination during the therapy period and using 2 mask-threshold combinations during the control period. All findings reported were significant at p<0.05. During the control period, LI and behavioral scores did not change significantly from baseline and no relationships were identified between LI and grip strength.

Conclusions
Improvements in unimpaired hand motor function can be observed with rehabilitative BCI therapy after stroke. These changes may be mediated by modulations in brain activity, with LI serving as a potential biomarker for tracking such improvements.

O-84

Reciprocal alterations of white matter microstructure in carriers of deletions versus duplications at the 16p11.2 chromosomal locus are associated with cognitive and behavioral impairments

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Purpose
Copy number variants (CNVs) at the 16p11.2 chromosomal locus are associated with several neuropsychiatric disorders, including autism, schizophrenia, and bipolar disorder. Individuals with 16p11.2 deletions may have high body mass index (BMI) and large head size, while people with the reciprocal duplications often demonstrate low BMI and small head size, suggesting a gene dosage dependence. Using diffusion magnetic resonance imaging (MRI), we recently reported widespread alterations of white matter (WM) microstructure in human children with 16p11.2 deletions, compared to typically developing children (1). In this study, we characterize
and compare white matter alterations in pediatric and adult human carriers of the 16p11.2 duplication and 16p11.2 deletion, and relate these alterations to cognitive and behavioral function, as part of the Simons VIP project (2).

Materials and Methods
This study includes data from 30 pediatric deletion carriers (ages 8-16 years, 15M, 15 female), 13 pediatric duplication carriers (ages 7-16 years, 12 male, 3 female), 7 adult deletion carriers (ages 20-48 years, 4 male, 3 female), 23 adult duplication carriers (ages 20-63 years, 13 male, 10 female), and age-, gender-, and handedness-matched control participants for each cohort. Nonverbal IQ (NVIQ), verbal IQ (VIQ), and social responsiveness scale (SRS) scores were obtained for all cohorts. High resolution 3T structural MRI and whole-brain diffusion-weighted MRI using 30 directions at b=1000 s/mm² were acquired for all subjects. Fractional anisotropy (FA), mean diffusivity (MD), radial diffusivity (RD), and axial diffusivity (AD) were compared on global, regional, and voxel-wise bases. Correlations of NVIQ, VIQ, and SRS were performed with the absolute value of z-scored DTI values in global and regional white matter.

Results
The voxel-wise results reveal extensive increases of FA and AD throughout the white matter in the pediatric deletion carriers relative to their controls, while the pediatric duplication carriers show extensive decreases of FA and elevations of MD and RD throughout the white matter. The adult duplication carriers similarly exhibit decreased FA and increased RD relative to their controls, but with additional extensive decreases of AD. Significant correlations between NVIQ and the absolute value of z-scored DTI metrics in the callosal, association, and projection tracts were found in children. The adults showed significant correlations of NVIQ and SRS with the absolute value of z-scored DTI metrics in the callosal and limbic tracts.

Conclusions
We have demonstrated widespread and opposing white matter alterations in carriers of the 16p11.2 deletion versus the reciprocal duplication. Carriers of this deletion and duplication show reciprocal effects in FA, the most commonly used biomarker for white matter integrity, which fall in line with the theory of dosage-dependence of genes at the 16p11.2 locus. We have further shown associations of cognitive and behavioral impairment with deviation in either direction from normative microstructural white matter values.
Brain Death Scan in the Current Era of Transplant

N Nahm¹, I Dalal¹

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Purpose
Brain death is defined slightly differently by various organizations, but the overlying concept is of complete and irreversible loss of function of the brain. The clinical diagnosis of brain death and use of confirmatory tests varies among institutions (1). Cerebral scintigraphy may be used to verify the presence or absence of intracranial perfusion, typically in the context of factors confounding the clinical diagnosis of brain death. The term "brain death" usually is applied in the context of continued function of other organ systems, such as the cardiovascular system. In this scenario, an accurate and timely determination of brain death is necessary to best address the grief and anxiety of family members and to allow timely assessment for possible organ donation.

Materials and Methods
Institutional Review Board approval was obtained. A retrospective study of consecutive brain death scans performed at a single multi-organ transplant center from January 2007 through September 2014 was done. At this institution, a brain death scan was obtained by the referring service in patients with a clinical exam consistent with brain death (absent brainstem reflexes and no spontaneous respirations after PCO2 greater than 60 mmHg or greater than 20 mmHg from baseline) and with catastrophic trauma, difficult cranial nerve exam, or other confounding factors. Technetium-99m ECD was utilized with up to 30 mCi used. Flow, static, and SPECT images were obtained with SPECT/CT performed in equivocal cases.

Results
Brain death was suspected clinically in 154 patients who received a brain death scan. Brain death was confirmed by nuclear scan in 136 patients (88%). Repeat scans were performed in whom brain death scan was not positive during first scan in 10 patients 24 hours after initial scan (Figure 1). Brain death was confirmed on all repeat examinations. Among patients receiving repeat scans, all eligible patients underwent organ harvesting (n=4). Among the remaining patients, one patient was discharged to long term acute care facility, two patients had brain death confirmed on transcranial Doppler, four patients expired prior to repeat scans, and one patient had an incomplete medical record. Confounding factors leading to a brain death scan discordant with a clinical diagnosis of brain death included radiotracer uptake in the clivus (Figure 2) and venous reflux.

Conclusions
In the current era of transplant, goal of cerebral scintigraphy is to corroborate the clinical impression of brain death by determining the presence or absence of intracranial perfusion. An accurate and timely determination helps the process of organ harvesting. This study examines the concordance and discordance of brain death scan with clinical diagnosis of brain death.
Figure 1. Initial pool images (left) in a patient with a clinical diagnosis of brain death demonstrated cerebral perfusion. Repeat examination 24 hours later (right) demonstrated no cerebral perfusion.

Figure 2. Repeat pool image (left) in a patient with a clinical diagnosis of brain death. There was question of radiotracer uptake in the brain stem which was shown to be in the clivus on SPECT/CT imaging.
Correlation between Cortical Thickness and Functional Connectivity in Alzheimer’s Disease

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Purpose
Cortical thinning is a well known structural change in Alzheimer disease (AD) patients. Decreased connectivity in default mode network (DMN) is reported particularly relevant to AD. However, the relationship between cortical thickness and DMN changes is still unknown. We intended to investigate the potential coupling between cortical thinning and decrease in DMN connectivity in AD.

Materials and Methods
Seven patients with AD and nine age-matched cognitively normal (CN) subjects were enrolled in this study. 3D-T1 anatomical images and resting state functional MRI (rs fMRI) were obtained in addition to the conventional T2 and fluid-attenuated inversion recovery (FLAIR) images in both groups. Cortical thickness of the whole brain was analyzed using FreeSurfer software (http://surfer.nmr.mgh.harvard.edu) and connectivity between posterior cingulate cortex (PCC) and medial frontal cortex (MFC) was analyzed by AFNI software (http://afni.nimh.nih.gov/). Correlation between cortical thickness and DMN connectivity were analyzed in the whole brain and areas with significant correlation were scrutinized.

Results
We found that cortical thickness in the left inferior parietal lobule (IPL) was significantly correlated to DMN connectivity strength between PCC and MFC only in AD patients. Alzheimer disease group showed decreased cortical thickness in the left IPL and decreased DMN connectivity with significant positive correlation while CN group failed to show significant correlation. Cognitively Normal group did not show cortical thinning in the left IPL or decreased DMN connectivity.

Conclusions
Our results revealed that AD patients had significant correlation between cortical thinning of the IPL and decreased DMN connectivity. Our results suggest that examining correlation between cortical thickness and DMN connectivity might be useful in the diagnosis and monitoring of patients with AD.
Multivoxel MR Spectroscopy in a Pilot Crossover Study of Natalizumab to Dimethyl Fumarate Therapy

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MR spectroscopy (MRS) was obtained to assess its ability to predict disease relapse in a cohort of MS patients scheduled for crossover from natalizumab to dimethyl fumarate therapy.

Materials and Methods
Thirty subjects at high risk (>2 years on therapy, JCV index >1.5) for developing PML on natalizumab and scheduled to crossover to dimethyl fumarate were enrolled in an observational trial to monitor the transition. Standard brain MRI was obtained along with MRS at the time of the last infusion of natalizumab, and at 4, 16, 24 and 52 weeks. Standard MRI sequences included FLAIR, T2-weighted FSE, and T1-weighted FSE before and after Gadavist contrast. MR spectroscopy sequences were performed at 1.5 Tesla on a GE MR scanner. Both single voxel and multi-voxel 3D techniques were employed. Single voxel acquisition used PRESS acquisition (TR/TE:1000/144 ms). The volume was 5.0 x 5.0 x 2.0 cm and was positioned in the midline and centered on the corpus callosum using the sagittal localizer. The multi-voxel sequence included a 3D excitation volume of 7.5 x 7.5 x 2.0 cm containing 4 slices of 5 mm in thickness (TR/TE:1500/144 ms). All of the voxels (5 x 5 matrix) in each slice were combined and then each slice was analyzed separately. Processing of the spectra was performed by measuring peak height for NAA, Cr, Ch and an amino acid composite resonance (a) observed at 2.54 parts per million. In addition to the 30 MS patients, a group of 32 normal volunteers were recruited who underwent the same MRS sequences.

Results
The patients differed from normal in all of the metabolite ratios evaluated. Significant correlations were observed between the EDSS measured at baseline and the NAA/Cr and a/Cr ratios. When these two ratios were normalized and summed, the correlation with EDSS was increased (r=0.53, p<0.002). Clinical relapse occurred in 11 of 30 patients during the 24-week crossover to dimethyl fumarate. Among the relapsing group a significant reduction in NAA/Cr was observed at 16 weeks in slices 2 and 3 only (p=0.024 and p=0.038). This reduction moderated by week 24. The slice 1 a/NAA and a/Cr ratios both were elevated at baseline among the group that would subsequently relapse after crossover from natalizumab to dimethyl fumarate (p=0.05 and p=0.003). Among the nonrelapse group, significant reductions in the a/NAA and a/Cr ratios was observed in slice 1 at week 16 that returned to normal at 24 weeks. Among all 30 patients the change in EDSS was weakly correlated with change in both NAA/Cr and a/Cr in slice 1 (r=0.33, p<0.5).

Conclusions
1. MRS clearly separates normal controls from a chronic MS population with significant differences in Ch/Cr, NAA/Cr and a/Cr. 2. Single voxel MRS (NAA/Cr and a/Cr ratios) correlate with EDSS in a chronic MS population. 3. During the first 24 weeks after crossover from natalizumab to dimethyl fumarate 11 of 30 patients experienced clinical relapse. The NAA/Cr and a/Cr ratios were significantly different between the relapsing and nonrelapsing groups.
Microstructural Changes Underlying White Matter Tract Maturation in the Neonatal Brain

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Purpose
A more complete picture of microscopic white matter development in the neonatal brain would provide an improved understanding of the microstructural basis of normal brain development as
well as developmental delay following early neurological injury. In this work, we sought to apply a new diffusion imaging tool to reveal these microstructural changes during early development.

Materials and Methods
We performed multi-shell diffusion tract imaging in twenty-five term infants at either 0 months or 6 months of age and processed these data using neurite orientation dispersion and density imaging to determine fractional anisotropy (FA), neurite density (ND), orientation dispersion (OD), and free water fraction (FW) in major white matter tracts. Mean values of these parameters were characterized within white matter tracts using regions of interest drawn by a neuroradiologist. Statistical analysis was performed using Student's two-tailed t test and $\alpha=0.0021$ based on Bonferroni correction of a naive threshold of $\alpha=0.05$.

Results
Between 0 months and 6 months, we found significant increases of FA within the internal capsules, optic radiations, and corpus callosum (see Table). However, there was significant ND increase only within the internal capsules and optic radiations. There was a significant increase in OD within the optic radiations.

Conclusions
Patterns of change in white matter microstructure vary between tracts, though these changes are not evident through analysis of FA alone. Similar imaging approaches may aid more detailed characterization of development in both normal and injured brains.
Table. NODDI microstructural parameters within white matter tracts at 0 months and 6 months. Asterisks denote statistical significance.

<table>
<thead>
<tr>
<th>Tract</th>
<th>0 months</th>
<th>6 months</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLIC</td>
<td>0.443 ± 0.049</td>
<td>0.602 ± 0.049</td>
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<tr>
<td>ALIC</td>
<td>0.306 ± 0.042</td>
<td>0.445 ± 0.084</td>
<td>&lt;0.0</td>
</tr>
<tr>
<td>OR</td>
<td>0.347 ± 0.042</td>
<td>0.447 ± 0.047</td>
<td>&lt;0.0</td>
</tr>
<tr>
<td>CC genu</td>
<td>0.511 ± 0.060</td>
<td>0.672 ± 0.048</td>
<td>&lt;0.0</td>
</tr>
<tr>
<td>CC body</td>
<td>0.492 ± 0.060</td>
<td>0.578 ± 0.035</td>
<td>0.0</td>
</tr>
<tr>
<td>CC splenium</td>
<td>0.597 ± 0.053</td>
<td>0.770 ± 0.044</td>
<td>&lt;0.0</td>
</tr>
<tr>
<td><strong>ND</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLIC</td>
<td>0.287 ± 0.033</td>
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</tr>
<tr>
<td>ALIC</td>
<td>0.208 ± 0.038</td>
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<td>&lt;0.0</td>
</tr>
<tr>
<td>OR</td>
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<td>&lt;0.0</td>
</tr>
<tr>
<td>CC genu</td>
<td>0.270 ± 0.107</td>
<td>0.302 ± 0.054</td>
<td>0.3</td>
</tr>
<tr>
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<td>0.255 ± 0.049</td>
<td>0.1</td>
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<td>CC splenium</td>
<td>0.315 ± 0.104</td>
<td>0.402 ± 0.042</td>
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<tr>
<td><strong>OD</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLIC</td>
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<tr>
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White Matter Changes of Neurite Density and Fiber Orientation Dispersion during Human Brain Maturation

Y Chang¹, J Owen², N Pojman², T Thieu², P Bukshpun², M Wakahirow², J Berman³, T Roberts³, S Nagarajan², E Sherr³, P Mukherjee⁴

Purpose
Diffusion tensor imaging (DTI) studies of human brain development have consistently shown widespread, nonlinearly increasing white matter (WM) anisotropy through childhood, adolescence, and into adulthood. However, despite its sensitivity to changes in tissue microstructure, DTI lacks the specificity to disentangle distinct microstructural features of white and gray matter. Neurite orientation dispersion and density imaging (NODDI) is a recently proposed multicompartent biophysical model of brain microstructure that can compute the noncollinear properties of neurite orientation dispersion index (ODI) and neurite density index (NDI) (1). In this study, we apply NODDI in healthy controls aged 7-63 years to investigate changes of ODI and NDI with brain maturation, with comparison to standard DTI metrics.

Materials and Methods
High resolution 3T structural MRI was acquired in 67 healthy subjects (ages 7-63 years), as well as whole-brain diffusion-weighted MRI using 30 directions at b=1000 s/mm² and 64 directions at b=3000 s/mm². Diffusion tensor imaging and NODDI fitting were performed to calculate maps of fractional anisotropy (FA), radial diffusivity (RD), axial diffusivity (AD), ODI and NDI. Using Tract-Based Spatial Statistics in FSL, the diffusion metric maps from all subjects were registered to and skeletonized using FSL’s FMRIB58 FA template. Analyses of age trajectory over regions of interest (ROIs) within the skeletonized WM were characterized and compared for core WM tract groups as well as WM regions adjacent to gray matter regions of interest (ROIs). Voxel-wise analyses also were performed to elucidate regional differences in development. Additionally, partial least squares regression (PLSR) was employed separately with NODDI and DTI to create and compare models for the prediction of age.

Results
We find that NDI exhibits striking increases throughout the studied age range following a logarithmic growth pattern, while ODI rises later in life, following an exponential growth pattern. Using PLSR, we further demonstrate that NODDI better predicted chronological age than DTI. The predicted root mean square error (PRMSE) of the model created using NODDI metrics was minimized using one PLS component with a PRMSE of 8.1 years, while the model created using DTI metrics was minimized using four PLS components with a PRMSE of 9.9 years.

Conclusions
Our results reveal that, while neurite density increases rapidly in childhood and more slowly in adulthood, fiber orientation dispersion increases more slowly in childhood, and accelerates in...
adulthood. This novel finding is consistent with well established age-related changes of FA over the lifespan. Our results suggest that the rise of FA during the first two decades of life is dominated by increasing NDI, while the fall in FA during late adulthood is driven by the exponential rise of ODI that overcomes the slower increases of NDI. These results further suggest that NODDI reveals biologically specific characteristics of brain development that are more closely linked to the microstructural features of WM than are the empirical metrics provided by DTI.

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O-90

Pontine anomalies by DTI: correlation with conventional MR and genetic analysis

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Purpose
Correlate the appearance of the pons by diffusion tensor imaging with conventional MR findings and genetic analysis.

Materials and Methods
Query of PACs for reports describing a congenitally abnormal pons by conventional MR (cMR) or diffusion tensor imaging (DTI) from 2007-14. Two experienced pediatric neuroradiologists characterized the cMR according to the dominant brain malformation and assessed the corticospinal tracts (CST), medial lemniscus (ML), and transverse pontine fibers (TPF) at the level of the Vth nerves on axial color maps. Medical records were reviewed for genetic analysis.

Results
There were 11 patients with lissencephaly complex associated with degrees of pontine hypoplasia; one had severe cerebellar hypoplasia. Diffusion tensor imaging showed a single TPF in seven of nine and absent TPF and normal pons in one each. Chromosomal microarray analysis (CMA) was normal in four, not done in two, showed PAFAH1B1 deletion in two, and copy losses (CNL) or gains (CNG) in regions not thought to be disease-causing in two. In coexistent pachygyria and semilobar HPE, DTI showed absent CST; CMA was not done. Partial and complete callosal agenesis was associated with absence of one or both CST in three patients; genetic analysis was not done while one patient had fetal alcohol syndrome (Figure 1). There were 10 patients with isolated pontine hypoplasia. Diffusion tensor imaging showed normally positioned variably hypoplastic pontine fibers in nine of 10; one of 10 had a single TPF. Chromosomal microarray analysis showed large deletions in 6q27 in two patients; CNG/CNL or loss of heterozygosity in three; trisomy 23 and 3p25 deletion with a DAX-1 mutation in one each; partial deletion of chromosome 2, and was not available in two. There were three patients with inferior pontine segmentation anomalies by cMR; DTI in two of three showed aberrant TPF at multiple levels and normally positioned pontine fibers in one; CMA was normal. Absence of TPF and CST were seen in molar tooth malformation (n=2), ventriculomegaly and dysplastic basal ganglia (n=2), brainstem disconnection syndrome, and pontine tegmental cap dysplasia (PTCD) associated with callosal agenesis. Chromosomal microarray analysis in PTCD showed multiple CNL and gains. The ML was consistently present.

Conclusions
A wide variety of cerebral malformations are associated with malformed pontine projection fibers by DTI, most often involving the CST and TPF and not predictable on the basis of conventional MR findings. Knowledge of associated mutations may aid in targeted gene sequencing.
Purpose
To determine and categorize the clinical presentation and associated MR imaging findings in children with structural anomalies of the olfactory apparatus.

Materials and Methods
A search of radiology reports using the keyword "Olfactory" from 2010-14 was performed. Inclusion criteria were diagnostic quality coronal T2 images, 4mm slice thickness or less, showing abnormalities of the olfactory bulb, nerve, or sulcus. MR imaging were reviewed by two experienced pediatric neuroradiologists (>18 years) by consensus. Medical records were reviewed for indication for MR and coexistent medical problems, genetic analysis, and syndromic associations.
Results
Forty-one patients were found; ages 0.03 -18 years (mean 4.5 years, M:F 19:22). Clinical presentations were pituitary dysfunction (n=14) with diabetes insipidus (n=5), seizures (n=12), developmental delay (n=10), optic nerve hypoplasia/nystagmus (n=7), and sensorineural hearing loss (n=6), and anosmia (n=3). Children commonly had multiple presenting symptoms. Olfactory anomalies were bilateral in 22 and unilateral in 19, most commonly absent bulb/nerve with hypoplastic olfactory sulcus; seven patients had otherwise normal MR studies. Cortical dysplasia seen in 12 patients was most often perisylvian polymicrogyria (n=7). Additional anomalies included brainstem hypoplasia (n=9), optic nerve hypoplasia (n=9), dyplastic hippocampi (n=9), callosal dysgenesis (n=8), and septal agenesis (n=5) (Figure). Coronal T2 images show a hypoplastic right olfactory bulb and associated sulcus as well as an abnormal chiasm/hypothalamus, sagittal T1 image shows an abnormal corpus callosum (hippocampal commissure by DTI) and brainstem]. Five patients had hypoplastic or absent V, VII, and/or VIIIth cranial and four had clival hypoplasia or hypersegmentation. Genetic testing performed in 23 patients was abnormal in 11 (7q31.32 copy number loss, 6q27 loss/11q24.1q25 gain, duplication terminal deletion 6, 13q12.12 gain, CHD7, trisomy 2p, 13 and 18). Other complex deletions, duplications and gains were present in two patients. Kallman screen was negative in one patient with hypogonadism. Most genetic abnormalities were associated with additional brain abnormalities. Syndromic associations included Di George (n=2), CHARGE (n=2), Fetal alcohol syndrome, Johanson-Blizzard, Jacobsen and PHACE.

Conclusions
While children with anomalies of the olfactory apparatus commonly had pituitary dysfunction, patients had a wide range of neurologic presentations and rarely olfactory dysfunction. The presence of absent, hypoplastic olfactory bulbs, nerves and or sulci often is associated with additional brain malformations. Knowledge of genetic mutations in this clinical setting may direct target genetic testing.
Neuro-axial Infantile Hemangiomas: Imaging Manifestations and Association with Systemic Disorders.

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Purpose
Infantile hemangiomas (IHs) are common lesions in the pediatric population. In rare cases an IH can be detected in intracranial or intraspinal locations (neuro-axial IH). Presence of a neuro-axial IH may require additional evaluation and treatment. The purposes of our study included: 1. Description of imaging spectrum of CNS infantile hemangiomas (IH) 2. Estimation of frequency of neuro-axial involvement of IH in a setting of neurocutaneous disorders, such as PHACES syndrome (Posterior fossa malformations, Hemangiomas, Arterial, Cardiac anomalies, Eye anomalies, Sternal cleft) and LUMBAR/PELVIS syndrome (Perineal hemangioma, External genitalia malformations, Lipomyelomeningocele, Vesicorenal abnormalities, Imperforate anus, and Skin tags) in comparison with cases of isolated superficial IH without underlying systemic disease.

Materials and Methods
MR imaging of the brain (and spine in selected cases) of 75 patients with segmental cutaneous infantile hemangioma referred for evaluation of suspected PHACES syndrome were reviewed retrospectively by two neuroradiologists blinded to the clinical history. The subjects' ages ranged from 2 weeks to 9 months. Electronic medical records were searched for relevant clinical data. Comparisons were performed with brain MRIs of 35 patients with isolated cutaneous IH without underlying systemic disease, randomly selected from our radiology database. Review of imaging studies was performed with special focus on presence or absence of neuro-axial lesions. The frequency of neuro-axial involvement by IH in both groups was analyzed by the Fisher's Exact test. All imaging was performed on 1.5 or 3.0 T MRI scanners.

Results
Evaluation of MRI examinations and patient's charts revealed 24 patients with confirmed PHACES syndrome and one patient with PELVIS syndrome. Central nervous system (CNS) involvement was seen in 13/25 (52%) of which three patients had both intracranial and intraspinal IH, six patients had intracranial and four patients had intraspinal lesions. Imaging findings consisted of enhancing extra-axial masses of variable location, predominantly at the skull base and midline and in the paraspinal regions, focal leptomeningeal enhancement and asymmetric enlargement of Meckel's cave. None of the patients with cutaneous IH without underlying disease from control group had imaging findings of neuro-axial lesion. The presence of neuro-axial IH in the syndromic patients in comparison to the control group was significant at p<0.05.

Conclusions
Although CNS involvement by infantile hemangiomas is considered to be an unusual occurrence, a significant number of pediatric patients with neurocutaneous syndromes, especially with PHACES had positive MRI findings of neuro-axial lesions.
Pelizaeus-Merzbacher disease: a Diffusion Tensor Imaging study in patients with PLP1 duplications

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Purpose

Pelizaeus-Merzbacher disease (PMD), an X-linked recessive dysmyelinating disorder caused by mutations in the gene encoding proteolipid protein (PLP1), the major structural protein in central nervous system (CNS) myelin. Although more than 100 point mutations in the PLP1 coding region currently have been identified, these account for only 15-25% of PMD cases. The most common cause of PMD, accounting for 50-75% of cases, is a variable sized duplication of the region of the X-chromosome containing the PLP1 gene. The aim of this study was to determine the extent of altered diffusion tensor imaging (DTI) parameters reflecting axon integrity in PMD patients compared to age-match healthy controls and to determine if there are correlations between DTI measures and patients functional disability.

Materials and Methods

Thirteen male PMD patients with well characterized and genetically confirmed PLP1 gene duplications have been analyzed in this neuroimaging study (mean age= 26). The DTI acquisition protocol included 55-gradient direction, conducted on a 3T MRI system. Image postprocessing and analysis was done using FSL. Radial (λ⊥) and axial (λ∥) diffusivities, apparent diffusion constant (ADC) and fractional anisotropy (FA) were measured through five white matter structures that include internal capsule (AIC and PIC), corpus callosum (genu and splenium) and cerebral peduncles. Each PMD patient was compared to age-match healthy controls and correlated to a functional disability score previously validated (Laukka J. et al. 2013).

Results

An increased λ⊥, was the most significant and remarkable DTI parameter found in all studied white matter structures (p=<0.01). Interestingly, λ∥ was nonsignificant and found in some patients to be decreased in comparison to age-matched controls. Pelizaeus-Merzbacher disease patients with PLP1 duplications in a recent human pathology study showed a diffuse breakdown of myelin into "myelin balls" which may introduce a physical barrier restricting λ∥ (unpublished findings). Reactive astrocytosis and upregulation of inflammatory mediators also may be confounding factors responsible for the nonsignificant changes in λ∥ diffusion. A decrease in FA was a significant finding in all studied white matter structures and likely suggests significant axon pathology that likely involves fiber constriction, transection and gradual loss. Fractional anisotropy, λ⊥ and λ∥ (PIC) showed a significant (p<0.01) correlation to functional disability score. Both, axonal degeneration and late-onset demyelination are likely responsible for the patient's functional disability and overall disease pathogenesis.

Conclusions

Myelination is perturbed in patients with PLP1 gene duplications that leads to a diffuse reduction
in myelin thickness. However, the severity of myelin loss is heterogeneous and depended on the elusive molecular genetics of PLP1 gene duplications. Diffusion tensor imaging is a remarkable MRI modality to study neurogenetics diseases, due to its inherent sensitivity to cytoarchitectural changes that parallel disease progression. This modality is a powerful tool for monitoring longitudinal changes in response to pharmacological treatment and stem cell therapies. The dissecting power of DTI alone or combined in a multimodal study can provide immeasurable value concerning the natural history of the disease, a precursor for more effective therapies.

**O-94**

**White Matter Findings on Brain MRI in X-Linked MCT-8 Deficiency: Implications for Integrity of Association Tracts**

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**Purpose**

Describe the brain MRI findings of Allan-Herndon-Dudley syndrome (MCT-8 deficiency), a rare X-linked neurodevelopmental disorder with distinct motor abnormalities in addition to moderate to severe intellectual disability (ID). The MRI findings, especially white matter (WM) tract abnormalities, appear to be the first visible sign of abnormal WM connectivity.

**Materials and Methods**

MCT-8 deficiency patients (n=6), ages 5 months - 7 years, were assessed clinically and with brain MRI. Fourteen MRIs were assessed with special attention to the basal ganglia, cerebellum and WM tracts. Sequences evaluated included SE T1W (13), T2W (13), DTI (5), FLAIR (12), volumetric T1 (10), and MRS (9).

**Results**

Clinical assessments revealed moderate-severe psychomotor disabilities including ID and a complex motor phenotype including hypotonia, muscular hypoplasia, and a dystonic movement disorder (n=6). Imaging demonstrated two common features in all studied patients: normal macromorphology of the cortex, cerebellum, and basal ganglia; and abnormally increased T2 signal affecting sub-cortical U fibers and periventricular white matter symmetrically with increased conspicuity over time. Diffusion tensor imaging revealed poor definition of the association tracts. MR spectroscopy showed mild elevation of lactate and lipid peaks.

**Conclusions**

Our case series revealed a common pattern of white matter abnormality in pediatric MCT-8 deficiency patients suggestive of selective hypomyelination affecting predominantly sub-cortical U fibers and periventricular white matter. Diffusion tensor imaging suggests microstructural abnormalities at the level of the hemispheric association tracts. Although our patient cohort is small, abnormal connectivity of association tracts may be the key component of the MCT-8 complex motor phenotype and should be further investigated.

**O-95**

**Predictable Progression of Restricted Diffusion in Nonketotic Hyperglycinemia**
Nonketotic hyperglycinemia (NKH) is a metabolic disorder caused by deficiency of the glycine cleavage enzyme system. Affected children most often present in the neonatal or early infantile period with seizures, coma, and apnea. Previous imaging reports of NKH have described restricted diffusion in central white matter tracts in early infancy (1-3). We describe the MRI, DWI and MRS findings in a large series of patients with NKH over a wide age range collected from three continents over 15 years.

Materials and Methods
Following informed consent on an IRB approved study, the MRI images of all patients with genetically confirmed diagnosis of NKH were reviewed. A biochemical geneticist categorized patient disease as either severe or attenuated based on neurodevelopmental outcome. All imaging was reviewed by two pediatric radiologists (NVS, LZF). Sites of restricted diffusion, anatomical abnormalities and MRS findings were recorded.

Results
Twenty-five MRI exams from 17 patients with NKH were identified and reviewed. Age at time of imaging ranged from 0 days to 10 years. Disease severity was classified as attenuated in five patients and severe in 12. The pattern of white matter restricted diffusion could be categorized based on age in all patients as follows: - 0 days through 5 days – Posterior limb of internal capsule (PLIC), brainstem, central tegmental tracts (CTT), cerebellar white matter. - 0 days through 2 months – Perirolandic white matter, corona radiata, PLIC, brainstem, CTT, cerebellar white matter. - 5 months through 9 months - Diffuse centrum semiovale (Figure). - 14 months through 10 years – No restricted diffusion. Anatomical abnormalities were identified only in patients with severe disease and include thin corpus callosum, hypomyelination or delayed myelination, and white matter volume loss. No malformation of cortical development was identified. Three of six patients with MRS demonstrated an abnormal glycine peak at 3.6 ppm at intermediate and long echo times; all three of these patients had severe disease.

Conclusions
White matter restricted diffusion in NKH progresses in a predictable pattern by age. Diffuse restricted diffusion in the centrum semiovale in infants age 5 through 9 months has not been described previously. At all ages, white matter with restricted diffusion mirrored areas of active myelination on T1 imaging. While the pattern of restricted diffusion evolved similarly and presented neonatally in both disease categories, only those patients with severe disease eventually demonstrated white matter injury and volume loss. These findings suggest that white matter restricted diffusion caused by hyperglycinemia is dependent on myelination stage and does not necessarily indicate severe neurodevelopmental outcome when identified in the neonatal period.
Figure illustrates mild, diffuse restricted diffusion of centrum semiovale in an 8 month old patient on DWI and ADC, with an age-matched control as comparison.
Cockayne syndrome: a DTI and volumetric study.

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Purpose
Cockayne syndrome (CS) is a rare disorder characterized by severe brain atrophy, white matter hypomyelination and basal ganglia calcifications. The aim of this study was to quantify brain atrophy and white matter abnormalities using diffusion tensor imaging (DTI) and volumetric analysis, and to evaluate possible differences between CS subtypes.

Materials and Methods
Fourteen CS patients and controls underwent brain MRI including DTI and a volumetric 3D T1-weighted sequence. Diffusion tensor imaging analysis was made through regions of interest (ROIs) within the whole brain to obtain FA and ADC values, and in the left semi-ovale center to obtain DTI eigenvalues. A t-test was used to compare patients and controls, and CS subtypes. Given the small number of CS patients, patients were pooled into two groups: mild (CS1/CS3) and severe (CS2/COFS).

Results
Total brain volume in CS was reduced by 57%, predominantly in the posterior fossa (68.68%). Total brain volume reduction was higher in the severe group, but the degree of atrophy of the posterior fossa was similar in the two groups. Mean FA values were lower, whereas apparent diffusion coefficient (ADC) was higher in most of the white matter in CS patients. Apparent diffusion coefficient in the splenium of the corpus callosum and in the posterior limbs of the internal capsules, and FA in the cerebral peduncles were significantly different between the two groups. All DTI eigenvalues were higher in CS patients, mainly for transverse diffusivity (+51%).

Conclusions
Diffusion tensor imaging and volumetric analysis are useful adjuncts to clinical evaluation and structural MRI for characterization of CS.
Purpose
Individuals with genetic microdeletions at 22q11.2 (22q11DS) have an increased risk of developing psychosis, other psychiatric disorders, and multiple deficits in cognition (1, 2). Simultaneous examination of cortical structure at high resolution has not yet been performed (3, 4).

Materials and Methods
Fifty-three patients with 22q11DS were recruited at the Children's Hospital of Philadelphia and the community. Two demographically matched nondeleted control populations of 53 individuals each were drawn from the Philadelphia Neurodevelopmental Cohort: a typically developing group and a second demographically matched group with psychotic symptoms. Psychotic symptoms also were present in 30 patients with 22q11DS. High-resolution MRI measures of cerebral volume, cortical thickness, surface area, and an index of local gyrification (lGI) were generated in FreeSurfer and compared between groups.

Results
Patients with 22q11DS demonstrated global increases in cortical thickness associated with reductions in surface area, reduced lGI, and lower cerebral volumes relative to typically developing controls. Findings were principally in the frontal lobe, superior parietal lobes, and in the paramedian cerebral cortex. Focally decreased thickness was seen in the superior temporal gyrus and posterior cingulate cortex in 22q11DS relative to typically developing populations. Patterns between nondeleted subjects with psychotic symptoms and 22q11DS were similar, but with important differences in several regions implicated in schizophrenia. Post hoc cluster analysis suggested that like the 22q11DS group, cortical thickness in nondeleted subjects with psychotic symptoms differed from typically developing controls in the superior frontal gyrus and superior temporal gyrus, two regions previously linked to schizophrenia.

Conclusions
Simultaneous examination of multiple measures of cerebral architecture demonstrates that differences in 22q11DS localize to regions of the frontal, superior parietal, superior temporal, and paramidline cerebral cortex. The overlapping patterns between nondeleted subjects with psychotic symptoms and 22q11DS suggest partially shared neuroanatomical substrates.
Preterm Brain Injury at 3T: Association of Imaging Scores with Cerebellar Growth and Neurological Outcome

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Purpose
Cerebellar hemorrhage (CbH) is a recently recognized pattern of injury in preterm infants, with a detection rate of 2-9% on head ultrasound (US) and 10-19% on 1.5T MR (1-3). Supratentorial imaging abnormalities in this age group include intraventricular hemorrhage (IVH), white matter injury (WMI), and ventriculomegaly (VM) (4-5). We report our institutional experience with preterm brain injury at 3T MR based on imaging scores, morphometric analysis, and neurodevelopmental assessment.

Materials and Methods
Fifty-nine preterm infants (< 33 weeks gestation at birth) admitted to our NICU between 2011-2014 underwent 3T MR scanning near the time of birth and/or hospital discharge (postmenstrual age 32.1±2.8, 36.0±1.7 weeks). MR imaging protocol included 3-D IR-FSPGR, axial T2 FSE, and axial SWI when tolerated (30 cases). Two pediatric neuroradiologists generated consensus scores for IVH (0-4), WMI (0-3), and VM (0-3) in each patient using established criteria. [4-5] The grading system for CbH was defined as 1 (<3 foci/≤2 mm), 2 (≥3 foci/3-5 mm), or 3 (>5% hemisphere/≥6 mm). For subjects with multiple MR examinations, the highest score in each category was utilized for analysis. Global volumetry of the cerebrum, brainstem, and cerebellum was performed using a supervised segmentation algorithm based on pattern learning from a training set of 10 cases. Surface-based regional morphometry of the cerebellum was also performed. Mixed-effect linear models were used to assess association between imaging scores and volumetry, while addressing within-subject changes and inter-subject effects. Neuromotor scores at birth, 6, and 12 months were assessed by a neonatal neurologist or developmental pediatrician.

Results
Of 59 infants, CbH was identified in 37%, IVH in 29%, WMI in 27%, and VM in 19%. Cerebral hemorrhage was associated with IVH (p=0.03), but not WMI or VM. Median CbH number was 3 (IQR 5). The most common locations were the tonsils in 77% and biventral lobule in 55%. Cerebral hemorrhage grade was 1 in 32%, 2 in 45%, and 3 in 23%. Global brain volume correlated with postmenstrual age. For both CbH and IVH, there was slower growth in moderate/severe injury compared to no/mild injury, averaging -6, -0.5, and -0.08 cm³/week in the cerebrum, cerebellum, and brainstem (p<0.05). Local cerebellar growth was more restricted in regions involved by hemorrhage, averaging -0.6 mm³/voxel/week (Figure). Impaired cerebellar growth, particularly in the anterior vermis and posterior lobes (mean -1.2 mm³/voxel/week), was predictive of poor neuromotor scores at 6 and 12 months (p<0.001).

Conclusions
At 3T MR, CbH was detected in 37% of preterm infants as a result of higher field strength and SWI technique. Physiologically, the association between CbH and IVH likely reflects combined damage to the immature germinal zones of the cerebellum and cerebrum. These injury patterns result in decreased global brain growth, as well as locally restricted growth in areas of hemorrhage. The combination of imaging scores and morphometric analysis has important implications for evaluating preterm brain injury and future prediction of neurodevelopmental outcomes.
Oligodendroglioma in Childhood: Are There Any Imaging Markers Predictive of Survival?

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Purpose
Childhood oligodendroglioma occurs rarely and does not reliably show 1p19q codeletion (1,2), hence there is no molecular marker similar to its adult counterpart that can facilitate diagnosis and provide prognostic information. The aim of this study was to analyze the imaging features of histologically documented oligodendroglioma in children, and determine if any features were predictive of overall clinical outcomes.
Materials and Methods
Thirteen children (mean age 9.3 years, 3 females, 10 males) with histopathologically documented oligodendroglioma who underwent clinical magnetic resonance imaging (MRI) during the years of 1995 to 2013 were included in this retrospective case study. The preoperative brain MRI and computed tomography (CT) exams were analyzed for various imaging features including tumor location, presence of enhancement, calcification, mass effect, cystic changes, and white matter versus both gray and white matter involvement. Clinical records were reviewed for type of treatment, overall survival, and progression-free survival. Kaplan-Meier survival analysis was performed for each of the imaging features. P ≤ 0.05 was considered statistically significant.

Results
Children with tumor involvement of only white matter on imaging did significantly worse than those with both white and gray matter involvement with regards to progression-free survival (p=0.0004), as well as overall survival (p=0.0339). Tumors with cystic changes on preoperative imaging or during a recurrence also predicted a poorer overall survival (p=0.0126), but not progression-free survival. All the other imaging features including tumor location, enhancement, calcification, and mass effect were not found to have a significant impact on either progression-free survival or overall survival.

Conclusions
In this small series of pediatric oligodendroglioma, pure white matter involvement is the most significant imaging predictor for a worse progression-free survival. Pure white matter involvement and tumors containing cystic changes also were associated with poorer overall survival.

O-100
3:23PM - 3:31PM

High Accuracy of Arterial Spin Labeling Perfusion Imaging in Differentiation of Pilomyxoid from Pilocytic Astrocytoma

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Purpose
Pilomyxoid astrocytoma (PMA) is a relatively new tumor entity which has been added to the 2007 WHO Classification of tumors of the central nervous system. The goal of this study is to utilize arterial spin labeling (ASL) perfusion imaging to differentiate PMA from pilocytic astrocytoma (PA).

Materials and Methods
Pulsed ASL and conventional MRI sequences of patients with pilomyxoid and pilocytic astrocytomas in the past 5 years were evaluated retrospectively. Patients with history of radiation, or treatment with anti-angiogenic drugs were excluded.

Results
A total of 24 patients (9 PMA, 15 PA) were included. There was a statistically significant differences between PMA and PA in mean tumor/gray matter (GM) cerebral blood flow (CBF) ratios (1.3 versus 0.4, p< 0.001), and maximum tumor/GM CBF ratio (2.3 versus 1, p<0.001).
Area under the receiver operating characteristic (ROC) curves for differentiation of PMA from PA was 0.91 using mean tumor CBF, 0.95 using mean tumor/GM CBF ratios, and 0.89 using maximum tumor/GM CBF. Using a threshold value of 0.91, the mean tumor/GM CBF ratio was able to diagnose pilomyxoid astrocytoma with 77% sensitivity, 100% specificity, and a threshold value of 0.7, provided 88% sensitivity and 86% specificity. There was no difference between the two tumors in enhancement pattern (p = 0.33), internal architecture (p = 0.15), or diffusion ADC values (p=0.07).

Conclusions
Arterial spin labeling imaging has high accuracy in differentiating PMA from PA. The result of this study may have important applications in prognostication and treatment planning especially in patients with less accessible tumors such as hypothalamic-chiasmatic gliomas.

O-101
3:31PM - 3:39PM

Pilocytic and Pilomyxoid Astrocytomas: Radiologic Pathologic Correlations with Emphasis on ADC Value Measurement

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Purpose
Pilocytic astrocytoma (PA) and pilomyxoid astrocytoma (PMA), classified as grade I and II astrocytic tumors by the World Health Organization, are the most common type of glioma in children and young adults. Although pilomyxoid astrocytoma has unique histopathology and clinical course and outcome, no unique imaging features have been established. This study aims to explore the imaging findings of PA and PMA with emphasis on diffusion-weighted imaging (DWI).

Materials and Methods
We did a retrospective study of PA and PMA under the age 20 years. After exclusions, we reviewed the CT, and MRI imaging findings and pathology for a total of 37 cases (32 cases of PA and five cases of PMA). One of the PMA cases was diagnosed initially with PA, but the diagnosis was changed to PMA by our neuropathologist. We studied the T1, and T2/FLAIR signal, enhancement pattern, presence of necrosis, cystic component, hemorrhage, and calcification, and the anatomical location. We also reviewed the DWI signal and ADC value.

Results
The T1, T2/FLAIR signal, enhancement pattern, presence of necrosis, and cystic component were nonspecific features for either type of astrocytoma. Three of the five (60%) PMA cases were suprasellar in location and two (40%) were cerebellar. On the other hand, two of the 32 (6%) PA cases were suprasellar, and 15 (47%) were cerebellar. Other locations of PA were: cervicomedullary (13%), thalamus (9%), midbrain (6%), tectum (6%), temporal lobe (3%), lateral ventricle (3%), and thoracic cord (3%). Two of the PMA cases showed calcifications (40%), compared to five of the PA cases (16%). Hemorrhage was present in one of the 32 PA cases. None of the five PMA cases showed hemorrhage. The mean apparent diffusion coefficient (ADC) values for the PMA and PA cases were 1457x10-6 mm2/s, and 1674 x 10-6 mm2/s, respectively. Apparent diffusion coefficient values of PA and PMA are generally higher than those in other gliomas, reflecting the proportion of the cellularity, microcystic component, or
more water content in the extracellular matrix such as myxoid matrix in these tumors. The difference between the two groups was $206 \times 10^{-6}$ mm$^2$/s, which was not statistically significant ($P=0.295$). However, we noticed that the range of ADC values for PA cases was significantly wide ($470-2490) \times 10^{-6}$ mm$^2$/s, compared to a narrow range of ADC values in the PMA cases ($1529-1877) \times 10^{-6}$ mm$^2$/s. This histopathologically reflects the variation of the cellularity, microcytic component and water in the extracellular matrix in PA, and homogeneous myxoid matrix in PMA.

Conclusions
Variable findings of pilocytic and pilomyxoid astrocytoma on MRI and other imaging modalities are demonstrated, and correlated with the histopathology. The DWI and ADC map are especially important to differentiate both PA and PMA from other types of astrocytomas.
O-102

Assessment of Pediatric Brain Tumors Utilizing Advanced Diffusion Techniques in MRI

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Purpose
Predicting tumor type and grade and assessing treatment response noninvasively are the ultimate goal of brain tumor imaging. The purpose of this novel study is to evaluate the utility of two advanced diffusion models in the grading of pediatric cerebral neoplasms.

Materials and Methods
Diffusion imaging covering the entire tumor area was acquired on 1.5T and 3.0T magnets with a single shot echo planar sequence using 16 extended b-values (0-3500 s/mm²). A region of interest (ROI) was placed over the solid region of each tumor and the averaged signal intensity at all b-values was measured. Conventional apparent diffusion coefficient (ADC) was calculated based on the mono-exponential model using b=0-1000 s/mm². Extended diffusion parameters were derived from two advanced diffusion models: the anomalous diffusion model and the bi-exponential two-compartment model. Low- and high-grade tumor types were compared using a nonpaired t-test. Comparisons were deemed significant when p<0.01.

Results
A total of 22 patients [mean (±SD) age 6.3±4.6] with biopsy-proven nontreated brain tumors (16 high-grade and 6 low-grade) were imaged. In the anomalous diffusion model, the space constant (µ) was significantly higher, and the complexity parameter (β) was significantly lower in the high-grade tumors corresponding to decreased tissue diffusion and increased tissue heterogeneity respectively. In the two-compartment model, the intracellular diffusion coefficient (Dslow) was significantly lower, and the intracellular fractional volume (Vslow), was significantly higher in high-grade tumors corresponding to decreased intracellular diffusion and increased intracellular volume. The extracellular diffusion coefficient (Dfast) was not significantly different between high-grade and low-grade tumors. The conventional ADC measurement was significantly lower in high-grade tumors (Table 1).

Conclusions
These advanced diffusion techniques accurately distinguish high-grade from low-grade cerebral neoplasms providing more complex tissue characterization than conventional ADC measurements, improving the diagnostic confidence of various pediatric brain tumors and facilitating treatment planning and therapeutic response assessment.

<table>
<thead>
<tr>
<th></th>
<th>Low-grade</th>
<th>High-grade</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>µ</td>
<td>21.3 ± 7.2 μm</td>
<td>64.1 ± 17.1 μm</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>β</td>
<td>0.94 ± 0.02</td>
<td>0.81 ± 0.06</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Dslow</td>
<td>0.87 ± 0.17 x 10⁻³ mm²/s</td>
<td>0.37 ± 0.12 x 10⁻³ mm²/s</td>
<td>p&lt;0.00001</td>
</tr>
<tr>
<td>Vslow</td>
<td>38.8 ± 15.3%</td>
<td>58.3 ± 11.6%</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>ADC</td>
<td>1.5 ± 0.31 x 10⁻³ mm²/s</td>
<td>0.83 ± 0.22 x 10⁻³ mm²/s</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>

(Magnetic Resonance Imaging Characteristics of WNT-subgroup Pediatric Medulloblastoma)

Z Patay¹, L DeSain¹, Y Yuan¹, A Coan², D Ellison¹
¹St. Jude Children's Research Hospital, Memphis, TN, ²St. Jude Children's Research Hospital, Memphis, TN
Purpose
Molecular subgroups of medulloblastoma are recognized to represent distinct developmental and clinical disease entities. Since tumor subtypes associated with specific signaling pathway abnormalities may present with distinctly different imaging manifestations, in this study we sought to describe the MRI features of WNT-subgroup medulloblastomas and to correlate them with embryologic and histopathologic variables.

Materials and Methods
Pre- and postoperative imaging studies of 16 WNT-subgroup medulloblastoma patients were evaluated for tumor location, involvement of surrounding CSF spaces or parenchymal structures, conventional and diffusion-weighted signal properties and surgical damage patterns. Laterality scores were assigned to tumors at each step in the imaging evaluation process. Continuous variables were summarized using descriptive statistics, and the Wilcoxon signed-rank test was performed to compare laterality scores.

Results
WNT-subgroup medulloblastomas were histopathologically "classic". WNT-subgroup medulloblastomas tend to occur in specific sites, with involvement of the foramen of Luschka (75%), the 4th ventricle (69%), the cisterna magna (31%) and the cerebellopontine angle cistern (19%). Laterality scores were low (<2) when pre-operative primary and secondary anatomical features were evaluated separately, but increased (>2) when all pre-operative anatomical features were considered together. Based on anatomical lesion involvement patterns, four location-based subtypes, which represent a continuum, may be distinguished: A.) Midline-intraventricular, B.) Midline-extraventricular, C.) Off-midline-intraventricular and D.) Off-midline-extraventricular (see Figure).

Conclusions
WNT-subgroup medulloblastomas are lateralized, dominantly extraparenchymal tumors arising from brainstem and cerebellar parenchyma around the foramen of Luschka. Our current understanding of the embryological origins and the associated WNT signaling pathway abnormalities are in accordance with the spatial distribution of these tumors.

(Filename: TCT_O-103_Fig.jpg)

O-104

Histogram analysis of diffusion tensor imaging parameters in pediatric cerebellar tumors
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Purpose
Apparent diffusion coefficient (ADC) values have been shown to assist differentiating malignancy grades in pediatric cerebellar tumors. Previous studies have applied different ADC measurements (e.g., within the solid, contrast enhancing tumor component or entire tumor). Here we used 1) histogram derived textural tumor features and 2) calculated not only ADC/MD, but also FA, AD and RD to differentiate low- and high-grade pediatric cerebellar tumors.

Materials and Methods
Presurgical diffusion tensor imaging (DTI) data were analyzed with a region of interest (ROI) approach including the entire tumor. For each tumor, histogram-derived metrics including the 25th percentile, 75th percentile, and skewness were calculated for FA, MD, AD, and RD. The histogram metrics were used as primary predictors of interest in a logistic regression model. Statistical significance levels were set at p<0.01.

Results
The study population included 17 children with pilocytic astrocytoma and 16 with medulloblastoma (mean age, 9.21±5.18 years and 7.66±4.97 years, respectively). Compared to children with medulloblastoma (high grade tumors), in children with pilocytic astrocytoma (low grade tumors) we found higher MD (p=0.003 and p=0.008), AD (p=0.004 and p=0.007), and RD (p=0.003 and p=0.009) values for the 25th and 75th percentile. In addition, histogram skewness showed differences for MD between low and high grade tumors (p=0.008).

Conclusions
Histogram features (25th and 75th percentile of the entire tumor) for MD, AD, and RD facilitate the presurgical differentiation between low and high grade cerebellar tumors in children. These findings suggest an additional diagnostic value of quantitative feature analysis of DTI data in pediatric neuro-oncology.

O-105

Grading of Brain Tumors in Children: A Comparative Study between Diffusion-Weighted Imaging and 1H-MR Spectroscopy.

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¹National cancer institute, Cairo, ²National cancer institute, Cairo, Cairo

Purpose
Accurate initial diagnosis and grading of brain tumors are paramount in affecting the choice of treatment, long term prognosis, and the quality of life in survivors. Conventional MRI has limited accuracy in tumor grading; that role is reserved for histopathologic evaluation. Diffusion-weighted imaging (DWI) and 1H-MRS have been used as noninvasive imaging tools for tumor grading. The purpose of our study was to compare the effectiveness of both techniques.

Materials and Methods
We retrospectively reviewed 100 pediatric brain tumors imaged with conventional MRI, DWI, and 1H-MRS. Apparent diffusion coefficient (ADC) and relative ADC (ratios of ADC of tumor
to ADC of normal tissue) were determined. The Cho, NAA, Cho/NAA ratio and the presence of the lactate peak at intermediate TE were assessed from the spectral maps. All these parameters were compared with the tumor grade based on the World Health Organization (WHO) classification of brain tumors.

Results
Apparent diffusion coefficient value is more accurate than the MRS in grading of brain tumors in children. The ADC value had high probability in the detection of tumor grade, reaching 96.2% with $0.95 \times 10^{-3}$ mm$^2$/sec as the threshold value between the high and low grade tumors, with a sensitivity of 90.9% and specificity 91%. Conversely, the probability of using Ch/NAA ratio and a threshold value of 7.4, to separate low and high grade tumors is 86%, with a specificity of 50% and sensitivity 23%.

Conclusions
Calculated ADC value is more accurate and sensitive than MRS in predicting the brain tumor grade in children.

| Table 3. Significance and correlation of the spectroscopic parameters with the tumor grade |
|-----------------------------------------------|------------------|------------------|
| Grade classification with Ch                  | 0.59             | 0.00             |
| Grade classification with NNA                 | -0.10            | 0.29             |
| Grade classification with Cr                  | 0.36             | 0.00             |
| Grade classification with Ch / NNA            | 0.50             | 0.00             |
| Grade classification with Ch / Cr             | 0.03             | 0.71             |
| Grade classification with NNA / Ch            | -0.38            | 0.00             |
| Grade classification with NNA / Cr            | -0.25            | 0.01             |
| Grade classification with NNA / Ch + Cr       | -0.47            | 0.00             |
| Grade classification with Lactate             | -0.0             | 0.98             |

(Filename: TCT_O-105_Captureaa.PNG)
Table 2. The mean, median, range absolute ADC values in low and high grade tumors

<table>
<thead>
<tr>
<th></th>
<th>Mean ± Std</th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Grade</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADC of lesions x10^{-3} mm²/s</td>
<td>0.71 ± 0.19</td>
<td>0.68</td>
<td>0.4 – 1.2</td>
</tr>
<tr>
<td>Relative ADC</td>
<td>0.89 ± 0.25</td>
<td>0.84</td>
<td>0.49 – 1.71</td>
</tr>
<tr>
<td><strong>Low grade</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADC of lesions x10^{-3} mm²/s</td>
<td>1.508 ± 0.43</td>
<td>1.556</td>
<td>0.6 – 2.9</td>
</tr>
<tr>
<td>Relative ADC</td>
<td>1.84 ± 0.57</td>
<td>1.91</td>
<td>0.86 – 3.85</td>
</tr>
</tbody>
</table>
Mass-like Lesions in the Ipsilateral Optic Nerve and Chiasm in Patients with Morning Glory Disc Anomaly (MGDA)

A Kanfi\textsuperscript{1}, R Ramakrishnaiah\textsuperscript{2}, P Phillips\textsuperscript{3}, S Singh\textsuperscript{4}, S Hegde\textsuperscript{1}, C Glasier\textsuperscript{5}
\textsuperscript{1}Arkansas Children's Hospital, Little Rock, AR, \textsuperscript{2}University of Arkansas for Medical Sciences, Little Rock, AR, \textsuperscript{3}University of Arkansas Medical Center, Little Rock, AR, \textsuperscript{4}Arkansas Children's Hospital, University of Arkansas for Medical Sciences, Little Rock, AR, \textsuperscript{5}Arkansas Children's Hosp., Little Rock, AR

Purpose
Describe the presence of mass-like lesions in the ipsilateral optic nerve and chiasm in children with morning glory disc anomaly (MGDA).

Materials and Methods
Five cases of MGDA were observed in a tertiary care children's hospital over a 5 year period. Imaging findings were reviewed by three pediatric neuroradiologists. MR findings were
correlated with the fundoscopic exam performed by the neuroophthalmologist. Imaging was performed on 1.5T magnets with dedicated brain and orbit protocol.

Results
All five patients had unilateral fundoscopic findings of abnormal cupping and funneling of the optic disc, with elevation of the adjacent retinal surface. Orbital MR findings included thickening and enhancement of the terminal optic nerve, cupping of the optic nerve head and obliteration of the terminal optic nerve sheath CSF fluid space in all five patients. All patients also had tumor-like enlargement without enhancement of the ipsilateral optic chiasm. Intracranial vascular abnormalities included stenosis of the ipsilateral internal carotid artery (1/5) and ipsilateral persistent trigeminal artery (1/5). One patient had an ectopic posterior pituitary gland with a small anterior pituitary gland and shallow sella.

Conclusions
The striking appearance in patients with MGDA of tumor-like thickening and enhancement of the terminal optic nerve with nonenhancing thickening of the ipsilateral optic chiasm is of uncertain significance. Our five patients demonstrated short term stability of the enhancement and thickening of the optic nerve and optic chiasm. Previous authors have suggested that the abnormal thickening and enhancement of the optic nerve and the chiasm is due to dysplastic tissue, however in our opinion longer term studies are required to confirm stability and to exclude neoplasm. Additionally, identification of intracranial vascular anomalies including stenoses or aplasia may be a clinically significant finding.
Figure 1. A. Axial fat-saturated T2WI demonstrates cupping of the right optic disc and retinal elevation (arrow). Abnormal soft tissue thickens and surrounds the distal intraorbital segment of the optic nerve. B. Axial post-contrast T1WI demonstrates ill-defined, mass-like enhancement of the distal right optic nerve (curved arrow). 3D TOF MRA images reveal narrowing of the right carotid terminus (white arrow) and a hypoplastic A1 segment of the anterior cerebral artery. D. In a patient with MGDA, the posterior pituitary is ectopic with a small and anterior pituitary (arrowhead). The sella is slightly flattened. An incidental nasal dermoid is noted (asterisk).
In-vivo detection of brain infiltration by experimental cerebral malaria using high field MRI

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¹University of Heidelberg, Heidelberg, Germany, ²University of Heidelberg and German Cancer Research Center, Heidelberg, Germany

Purpose
The spatiotemporal evolution of experimental cerebral malaria (ECM) is poorly defined. It is also unclear whether microvascular pathology and/or inflammation cause disease manifestation and clinical symptoms.

Materials and Methods
In the Plasmodium berghei ANKA-C57BL/6 murine ECM model, disease progression (assessed by rapid murine coma and behavioral scale) was monitored by high field MRI. Blood-brain barrier disruption (BBBD) was measured by contrast-enhanced T1-weighted imaging, edema development by T2 relaxometry, diffusion- and T2-weighted imaging as well as microvascular pathology by susceptibility-weighted imaging and time of flight angiography. For histological correlation, HE staining and immunohistochemistry for neuroblasts and microglia were obtained.

Results
Blood-brain barrier disruption and edema in ECM initiate in the olfactory bulb and spread from there along the rostral migratory stream to the subventricular zone, the dorsal migratory stream and eventually to the external capsule and the deep gray matter. This pattern of spatiotemporal inflammation progression correlated closely with the evolution of clinical disease severity, resulting in coma after brainstem involvement. Microvascular pathology also increased over time showing hemorrhages, microvascular sequestration and watershed infarcts in severe disease, but correlated clearly less with clinical severity and the temporal course of ECM. Histological analysis confirmed inflammation and hemorrhages.

Conclusions
Inflammation in experimental malaria spreads from the olfactory bulb along the rostral migratory stream and uses this perivascular neurogenic niche to extend into the brain. Our findings may help to explain why children are more vulnerable to cerebral malaria.

MRI findings in patients with elevated intracranial pressure secondary to Lyme disease

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Purpose
To assess the diagnostic value of MRI in otherwise asymptomatic patients presenting with elevated intracranial pressure in the setting of Lyme disease. Rarely, Lyme disease may present
with isolated increased intracranial pressure (ICP) thus making difficult the differential diagnosis with Pseudotumor Cerebri.

Materials and Methods
We retrospectively reviewed cases of children with the discharge diagnosis of Lyme disease presenting with symptoms of ICP. All patients underwent lumbar puncture (LP) and MRI.

Results
Six patients met the inclusion criteria; mean age was 9.5 years (standard deviation 3.7 years); three of six patients were males. Average body mass index (BMI) was 20.1 Kg/m2 (standard deviation 4.3 years). Fever was present in three of six. Three patients had a history of rash consistent with Lyme. All patients were diagnosed to have elevated intracranial pressure on LP (Opening Pressure >28cm H2O), headache and bilateral papilledema. On MRI, all patients had flattening of globes and optic nerve protrusion. Four patients had increased (>4mm) fluid around the optic nerves on at least one side. Five patients had cranial nerves enhancement (III, V and VII). All patients had tentorial enhancement and one patient had meningeal enhancement (Table 1). No empty sella sign was identified.

Conclusions
Lyme disease should be considered in the differential diagnosis of patients presenting with signs of elevated ICP in Lyme-endemic areas. The presence on MRI of tentorial and cranial nerves enhancement and orbital signs of increased ICP can guide the differential diagnosis.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Orbital Findings</th>
<th>Enhancements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flattening of globes</td>
<td>Optic nerve protrusion</td>
</tr>
<tr>
<td>1</td>
<td>(+) bilateral</td>
<td>1mm right 0.9mm left</td>
</tr>
<tr>
<td>2</td>
<td>(+) bilateral</td>
<td>1.8mm right</td>
</tr>
<tr>
<td>3</td>
<td>(+) bilateral</td>
<td>1.4mm right left indeterminate</td>
</tr>
<tr>
<td>4</td>
<td>(+) bilateral</td>
<td>1.4mm right 1.1mm left</td>
</tr>
<tr>
<td>5</td>
<td>(+) bilateral</td>
<td>0.6mm right 0.6mm left</td>
</tr>
<tr>
<td>6</td>
<td>(+) bilateral</td>
<td>Bilateral, indeterminate extent</td>
</tr>
</tbody>
</table>

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Does Subarachnoid/Subdural Hyper-intensity Predict Severe Brain Parenchymal Injury in Children with Meningitis? Qualitative and Quantitative Analysis Based on Diffusion-weighted Magnetic Resonance Imaging

Z. Qiao¹, L. Wang¹
¹Children's Hospital of Fudan University, Shanghai, Shanghai

Purpose
To explore the significance of the subarachnoid/subdural hyperintensity (SAHI) on diffusion-weighted (DW) magnetic resonance imaging (MRI) in predicting inflammatory injury of brain parenchyma in children with meningitis.

Materials and Methods
Sixty-nine children with clinically diagnosed meningitis were enrolled in this study, including 46 boys and 23 girls with age range from 10 days to 12 years old. All of them had MRI examinations during hospitalized. Their MRI datasets were reviewed by two radiologists who were blinded to clinic data. The sign of subarachnoid/subdural hyperintensity (SAHI) was identified on each patient's diffusion-weighted (DW) images. The patients were divided into two groups based on whether or not they had the sign of SAHI, including SAHI positive group (Group A) and SAHI negative group (Group B). The macroscopic inflammatory lesions of brain parenchyma including infarct/hypoxia, abscess, and encephalomalacia were evaluated on T1W, T2W, Tirm and DW images. We further used a Matlab script by implementing the Mann–Whitney U test and False Discovery Rate (FDR) with a cut-off threshold at 0.001 to compare Group A and Group B.

Results
There were 36 patients with positive sign of SAHI (Group A), and 33 patients with negative sign of SAHI (Group B). Twenty-eight of 69 patients (22 in Group A, 6 in Group B) demonstrated macroscopic brain damage including brain infarct/hypoxia (n=10), abscess (n=6) and encephalomalacia (n=7). It showed a significantly higher frequency of macroscopic brain damage in patients in Group A compared to Group B (p < 0.01). Brain areas with significant difference of ADC values between Group A and Group B were obtained (Figure 1). The patients with positive sign of SAHI (Group A) showed significantly lower ADC values in the posterior regions of brain parenchyma compared to those with negative sign of SAHI (Group B).

Conclusions
The subarachnoid/subdural hyperintensity DW image was an important feature in children with meningitis, and may predict much more severe brain parenchyma damage and the reduced water diffusion in the posterior region of cerebral parenchyma.
Peripartum Cerebral Ischemic Injuries Associated with Excessive Uterine Activity

j hunter\textsuperscript{1}, M Murray\textsuperscript{2}, S Ater\textsuperscript{1}\textsuperscript{}\textsuperscript{}

\textsuperscript{1}TCH, Houston, TX, \textsuperscript{2}Central New Mexico Community College, Albuquerque, NM

Fig. 1 The pattern with significant difference of ADC values between Group A and Group B obtained by using Matlab script implementing Mann–Whitney U test and False Discovery Rate (FDR) corrected cut-off threshold at 0.001.

(Filename: TCT_O-109_Fig1.jpg)
Purpose
To investigate parameters of excessive uterine activity (XSUA) and correlate them with clinical and neuroimaging features of perinatal cerebral ischemic injury.

Materials and Methods
A retrospective analysis of electronic fetal monitoring, medical records neurological exam and neuroimaging in 10 forensic patients with cerebral ischemic injury was performed. Comparison was made to normal controls.

Results
Measures of diminished resting intervals (< 60 seconds between uterine contractions), hypertonus (uterine resting tone > 25 mm Hg) and excessive uterine contraction frequency (> 7/15 minute period of labor) were more sensitive predictors of perinatal ischemic cerebral injury than abnormal fetal heart rate (FHR) patterns such as late or variable decelerations that typically developed after prolonged periods of XSUA. Clinical and neuroimaging patterns of perinatal hypoxic ischemic injuries associated with XSUA included prolonged partial asphyxia (PPA), acute near-total asphyxia and mechanical trauma. In addition, a distinct pattern of cerebral injury associated with XSUA involved predominantly cerebral ischemic injuries, often without substantial PPA, acidosis, low Apgar scores, multi-organ dysfunction or obvious brainstem dysfunction. Cerebral dysfunction was present and neuroimaging features included an excess of cortical laminar necrosis versus deep gray nuclear injury, cytotoxic edema on diffusion-weighted MRI, cerebral white matter injuries with or without watershed injuries and ulegyria.

Conclusions
Reduced resting intervals with impaired cerebral reperfusion between uterine contractions correlated with poor neurologic outcome and may have a specific pattern of neuroimaging features.

Monday
3:15PM - 4:45PM
Sheraton Chicago Hotel & Towers, Erie (Level 2)

05H - PARALLEL SCIENTIFIC PAPER SESSION-SOCIOECONOMICS I
O-110

Advanced Neuroimaging for Evaluating Vertigo in the Emergency Department: Impact of Modality on Positivity Rate and Time to Diagnosis.

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Purpose
Dizziness accounts for more than 2 million visits to U.S. emergency departments (ED), approximately 3.3% of all ED chief complaints in awake patients (1). Utilization of computed tomography (CT) for diagnosing central causes of dizziness is increasing with a 10-year increase of 169%. Imaging is considered valuable to establish an objective diagnosis in a timely fashion. Therefore, we compared the effectiveness and time to diagnosis of CT versus magnetic resonance imaging (MRI) in concurrently ordered (within 24 hours) examinations for patients presenting to the ED with symptoms of vertigo, dizziness, and cerebellar symptoms.
Materials and Methods
After a quality improvement waiver from the institutional review board, we retrospectively identified patients presenting to the ED between 12/31/08 and 11/23/13 who received CT/CTA or MRI/magnetic resonance angiography (MRA) of the head and/or neck for vertigo, dizziness, question of cerebellar stroke, or frequent falls within 24 hours. We categorized patients into groups receiving CT/CTA only, MRI/MRA only, and both CT and MRI within a 24-hour period (Figure 1). Patients with a recent neurosurgical history or known neurological pathology were excluded. Radiology reports were reviewed to categorize the results of the imaging studies and images were reviewed when a conclusion could not be drawn from a written report. Computerized records of order entry time, room entry time and room exit time were used to determine order-to-table and examination times.

Results
Between 12/31/08 and 11/23/13, 258 patients had both an MRI and CT within 24 hours. In 166/258 patients (64%) both CT and MR were either normal or showed insignificant pathology. In 27/258 (11%) of cases, CT was negative but MR was positive for findings related to vertigo. In only 3/258 (1.2%), CT could be considered positive for dizziness but MRI was negative. MR imaging was significantly better at showing positive findings related to vertigo, as compared to CT (p<0.0001). Exam Time Analysis: In patients who received CT and MRI, a CT was initiated an average of 1.6 (+/-2.5) hours after being ordered, while an MRI was initiated an average of 6.3 (+/-7.31) hours after being ordered (p<0.0001). The most frequent reason for delay in MRI initiation was obtaining a Choyke questionnaire or excluding the presence of/confirming the compatibility of metal in the patient. A CT was completed in 15 (+/-7) minutes after scanner entry where as an MRI was completed in 35 (+/-17) minutes after scanner entry (p<0.0001).

Conclusions
Requesting an MRI in patients with vertigo can increase sensitivity for posterior fossa pathology and reduce low-value (CT) imaging. However, improvements in pre-MRI workflow are required to reduce the time-to-diagnosis.

(Filename: TCT_O-110_figure1.jpg)
Reliability of Advanced Imaging in the Assessment of Symptoms of Lumbar Central Spinal Stenosis in a Large Multicenter Trial Cohort

F Perez¹, S Quinet¹, Q Nguyen¹, E Aghayev², D Jitjai¹, W Hwang¹, E Jarvik¹, S Nedeljkovic³, A Avins⁴, J Schwalb⁵, F Diehn⁶, T Annaswamy⁷, Z Bauer¹, D Haynor¹, B Comstock¹, J Friedly¹, J Jarvik¹

¹University of Washington, Seattle, WA, ²University of Bern, Bern, Switzerland, ³Brigham and Women’s Hospital, Chestnut Hill, MA, ⁴Kaiser Permanente Northern California, Oakland, CA, ⁵Henry Ford Medical Group, West Bloomfield, MI, ⁶Mayo Clinic, Rochester, MN, ⁷VA North Texas Healthcare System, Dallas, TX

Purpose
Lumbar spinal stenosis is a common cause of low back pain resulting in significant disability and healthcare-related costs. The role of imaging in the management of spinal stenosis remains controversial since the severity of anatomical spinal stenosis may not be concordant with the severity of symptoms. Using data from a large multicenter trial, our objective was to characterize interobserver reliability of lumbar imaging findings as well as their relationship to symptoms.

Materials and Methods
As part of a double-blind, multicenter trial, we evaluated CT or MRI spine studies from 394 subjects with symptoms of moderate to severe leg pain and disability with imaging findings of at least mild lumbar central spinal stenosis (1). A study clinician familiar with the clinical symptoms reviewed the enrollment CT or MRI and graded the severity of central spinal canal stenosis. At the completion of the study, six trained readers not involved in the initial enrollment assessment and without knowledge of clinical status retrospectively performed qualitative and quantitative assessment of central spinal canal stenosis (2). The symptom measures were baseline Roland-Morris Disability Questionnaire (RMDQ) score and leg and back pain scores.
Results
Although interobserver reliability among trained readers was moderate-substantial (kappa=0.60),
there was poor interobserver reliability of qualitative assessment of central spinal stenosis
between the study clinician and trained readers (kappa=0.26). There was no positive correlation
between lumbar stenosis severity and baseline RMDQ score or pain scores (Figure 1).
Conclusions
Among a large cohort of nonsurgical patients with symptoms of lumbar central spinal stenosis,
there was poor interobserver reliability in grading the severity of spinal stenosis on advanced
imaging between clinicians and trained readers. Moreover, patients with more severe spinal
stenosis were not more likely to have worse disability or pain scores.
HEENT Structured Reporting

A Farley¹, K Baugnon¹, P Hudgins¹, A Corey¹, M El-Deiry¹, J Beitler¹, A Aiken¹

¹Emory University School of Medicine, Atlanta, GA
Purpose
The American College of Radiology instituted the Breast Imaging Reporting and Data System (BI-RADS) initiative more than 20 years ago to address the inter-observer variability in mammography reporting (1). The standardization of mammography reports and their accompanying management recommendations improves comprehension of imaging findings, conveys the level of suspicion and guides management recommendations (2). We developed a new Head and Neck Imaging Reporting and Data System (Ni-Rads) for surveillance in Head and Neck cancers. We aim to compare the clinical utility, clarity and overall satisfaction of this surveillance template versus a conventional (free form) report.

Materials and Methods
A multidisciplinary team convened to develop a standardized template for the surveillance of post-treatment head and neck malignancies. The impression includes a numerical level of suspicion for the primary site and the neck. The primary tumor and lymph node imaging findings are assigned to one of four categories linked to a specific surveillance recommendation. (see Table.) It is becoming standard of care to perform positron emission tomography/computed tomography (PET/CT) for first post-treatment surveillance. As such, separate templates were developed for surveillance using contrast-enhanced computed tomography (CECT) alone and PET/CT. Nine months after implementing the structured Ni-Rads templates, a survey was distributed to the multidisciplinary head and neck tumor board to evaluate their initial feedback.

Results
The survey response rate was 57% (8/14). Seventy-five percent preferred our new standardized template over a free form dictation. Overall, the majority reported being satisfied (2) or strongly satisfied (4), whereas only one clinician was dissatisfied and one neutral. Seventy-five percent agree or strongly agree with the following statements about our structured surveillance report: 1) more clear and understandable than freeform, 2) decreases ambiguity of reports and forces radiologists to commit to a level of suspicion which is clearly defined, and 3) will improve consistency and clarity for direct patient reporting. Regarding the numerical imaging scores being linked to specific management strategies, 75% agree that the linked imaging, follow-up and biopsy recommendations were in line with their own management paradigms and find the numerical rating helpful to guide their management.

Conclusions
Most referring clinicians are satisfied with our novel surveillance template and agree that it increases clarity and clinical utility compared to conventional reports. This is a realistic look at the early development of a Ni-Rads reporting system and it will likely continue to evolve. Our surveillance template has the potential to reduce inter-reader variability, standardize management algorithms and facilitate research and correlate with long term outcomes.
Comparison of Emergency Pediatric Head CT Scans at a Children's Hospital and Community Hospitals: Dose and Technical Factors

R Mhapsekar¹, M Siegel¹, R McKinstry¹

¹Mallinckrodt Institute of Radiology, St. Louis, MO

Purpose
To compare the technical factors, particularly tube current and voltage, and resultant radiation exposure in emergency head CT scans performed at a children's hospital and general community hospitals.

Materials and Methods
Emergency head CT scans performed between January 2013 and December 2013 at adult-focused community hospital emergency departments (EDs) were reviewed retrospectively and compared with routine low dose head CT scans performed at a children's hospital for kilovoltage
(kV), milliamperage (mAs), CT dose index volume (CTDIvol) and Dose Length Product (DLP). The number of contrast phase scans also was assessed. Differences were tested with nonparametric statistical analysis.

Results
One hundred seventy-one emergency head CTs were performed at adult-focused community hospitals and 155 were performed at a children's hospital. Median patient age for adult-focused CT scans was 9 years and for the children's hospital CT scans was 6 years. At adult-focused hospitals, 80% of head CTs were performed at 120 kV, 17% using 100 kV, and 3% using 140 kV. Automated kV selection technology was used at the children's hospital and all pediatric head CTs were performed at 100 kV. Median mAs for CTs at adult focused hospitals and the children's hospital were 288 mAs and 90 mAs respectively (p < 0.05). Median CTDIvol for CTs at adult-focused hospitals was 45.4 mAs and at the children's hospital was 8.2 mAs (p < 0.05). Median DLP for pediatric head CTs at adult-focused hospitals and the children's hospital was 742 mGy.cm and 146 mGy.cm respectively (p < 0.05). At adult-focused hospitals, there were eight multiphasic studies while there were no multiphasic studies at the children's hospital.

Conclusions
The results of this study suggest that a large proportion of children undergoing emergency head CT scanning at adult-focused community hospitals receive relatively higher radiation doses than at a children's hospital, which appears related to higher technical parameters.
MRI in low back pain: Identification of Core Diagnostic Information and its location across various sequences.

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¹Mallinckrodt Institute of Radiology, Saint Louis, MO, ²Mallinckrodt Institute of Radiology, St Louis, MO

Purpose
MR imaging (MRI) of lumbar spine often is utilized in management of patients with low back pain. However, given the overlap of various imaging findings in asymptomatic and symptomatic population, exact significance of imaging findings in management of these patients is unclear. Our aim was to clearly identify the diagnostic information provided by MRI in low back pain management and to evaluate the adequacy of various sequences in providing this core diagnostic information.

Materials and Methods
Thirty-three consecutive patients (15 males, 33 females; age 50.2 ± 17.9 years) undergoing a noncontrast lumbar spine MRI for the indication of "low back pain" in absence of back surgery, malignancy, or signs of infection, for whom complete medical notes around the time of MRI were available were included. Medical charts and imaging were reviewed to determine both the diagnostic information provided by the MRI (categorized into degenerative and nondegenerative categories) as well as the clinical impact of the information generated by MRI (categorized into conservative treatment/ nondirected intervention, targeted percutaneous intervention, and targeted surgical intervention). Keeping in view both these factors, core diagnostic information (CDI) provided by MRI was defined and imaging reviewed to assess the contribution of each sequence to provide the core diagnostic information (CDI) on a 6-point scale ranging from a score of one for sequence providing incomplete diagnostic information to a score of six for sequences providing complete and nonredundant diagnostic information.

Results
Only nondegenerative disease identified was in one case (3%) of T10 fracture. Detailed delineation of segmental degenerative disease was not used in 25/33 (75.7%) patients who were treated conservatively or with nontargeted interventions such as epidural steroid injection that were directed by clinical presentation rather than imaging findings. Targeted percutaneous interventions were utilized in six (18.2%) cases and targeted surgery was performed in one (3.0%). MR scans had been performed utilizing an average of 5.76 ± 1.16 sequences obtained over a mean duration of 20.8 ± 5.92 minutes. In 32/33 cases, individual sequences were assigned a score of two or three indicating a high level of redundancy within the MR scan. Sagittal T2-weighted TSE and sagittal STIR sequences had the highest mean scores (2.8 ± 0.8 and 2.5 ± 0.5 respectively) indicating their value in providing CDI. Sagittal STIR was the only sequence receiving a score of six in one patient.

Conclusions
Utilization of MRI in patients with low back pain (LBP) suggests that MRI often serves to exclude nondegenerative causes of back pain rather than to delineate the exact nature of spinal
Core diagnostic information provided by lumbar spine MRI is often in the form of redundant information that could be extracted from an abbreviated scan.

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**O-115**

3:55PM - 4:03PM

**Cost-effectiveness of Angiographic Imaging in Isolated Perimesencephalic Subarachnoid Hemorrhage**

X Wu¹, D Durand¹, V Kalra¹, H Forman¹, A Malhotra¹

¹Yale University School of Medicine, New Haven, CT

**Purpose**

CT angiography (CTA) and digital subtraction angiography (DSA) have both been used for initial angiographic evaluation for perimesencephalic subarachnoid hemorrhage (pSAH) on initial noncontrast CT. CT angiography and DSA both have been used for initial angiographic evaluation. The type (CTA versus DSA) and number of follow-up angiographic studies performed have cost implications amenable to a cost-effectiveness study. The purpose of this study is to perform a comprehensive cost-effectiveness analysis of all possible permutations of CTA and DSA imaging strategies for initial diagnosis and follow-up imaging in pSAH patients.

**Materials and Methods**

Each of the 12 possible imaging strategy was evaluated in a decision tree created with TreeAge Pro Suite 2014, with parameters derived from a meta-analysis of 40 studies and literature values. Base case and sensitivity analyses were performed to assess the cost-effectiveness of each strategy. A Monte Carlo simulation was conducted with distributional variables to evaluate the robustness of the optimal strategy.

**Results**

The base case scenario showed performing initial CTA with no follow-up angiographic studies in pSAH patients to be the most cost-effective strategy [$4,221/Quality Adjusted Life Year (QALY)]. Using a willingness-to-pay (WTP) threshold of $50,000/QALY, the most cost-effective strategy based on net monetary benefit is CTA with no follow up when the sensitivity of initial CTA is above 97.9%, and CTA with CTA follow up otherwise. The Monte Carlo simulation reported CTA with no follow up to be the optimal strategy at WTP of $50,000 in 99.99% of the iterations. Digital subtraction angiography, whether at initial diagnosis or as part of follow-up imaging, is never the optimal strategy in our model.

**Conclusions**

CT angiography without follow-up imaging is the optimal strategy for evaluation of pSAH patients when modern CT scanners and a strict definition of pSAH are employed. Digital subtraction angiography and follow-up imaging are not optimal as they carry complications and associated costs.
Cost-Effectiveness Analysis

Cost, $

Effectiveness

Both+Both  Both+CTA  Both+DSA  Both+No FU  CTA+Both  CTA+CTA  CTA+DSA
DSA+Both  DSA+CTA  DSA+DSA  DSA+No FU
dominated  undominated

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Cost-Effectiveness Analysis of Follow-up Strategies for Thunderclap Headache Patients with Negative Non-Contrast CT

X Wu¹, D Durand¹, V Kalra¹, J Schindler¹, A Malhotra¹
¹Yale University School of Medicine, New Haven, CT

Purpose
Severe headache remains a common cause for presentation to the Emergency Department (ED) and exclusion of subarachnoid hemorrhage (SAH) in these patients is a critical part of the work-
Accurate diagnosis of acute SAH is critical in thunderclap headache patients to avoid increased mortality and morbidity in false negative cases. The objective of this study was to determine the utility of CT angiography (CTA) in managing patients with acute, severe headaches and assess the cost-effectiveness of three different screening strategies.

Materials and Methods
Institutional review was performed to assess the frequency and utility of CTA in screening patients with negative noncontrast CT under Institutional Review Board approval. A modeling-based economic evaluation was performed using TreeAge Pro Suite 2014 over a time horizon of 1 year for thunderclap headache patients in the Emergency Department with negative noncontrast CT for SAH. Sensitivity analyses were performed to determine the effect of sensitivity of CT and the prevalence of SAH on cost-effectiveness.

Results
Institutional review demonstrates that CTA yields no positive results for SAH in 128 patients over a 2-year period. LP follow up has the lowest cost and the highest utility in the mathematical model. The Monte Carlo simulation shows CT with LP to be the most cost-effective strategy in 86.7% of all cases even at a $10 million/QALY willingness-to-pay. Sensitivity analyses demonstrate that LP follow up should be performed, except for cases with a very high CT sensitivity (above 99.3%) and a low SAH prevalence (below 2.7%), where no follow up may be considered.

Conclusions
Although CTA is increasingly used for evaluation of thunderclap headache patients, its utility is not clearly defined. LP follow up is shown to be the most cost-effective strategy for evaluation of thunderclap headache patients. No follow up is an effective strategy only when the sensitivity of noncontrast CT is near perfect.
Sensitivity Analysis (WTP=50,000)

Net Monetary Benefit

pSen_CT

- CTA
- LP
- Observation

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Sensitivity Analysis (WTP=50,000)

Net Monetary Benefit vs. pSAH

CTA, LP, Observation

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Screening for Blunt Cerebrovascular Injury: Review of Literature and a Cost-Effectiveness Analysis

X Wu, V Kalra, J Schindler, C Matouk, H Forman, A Malhotra

Yale University School of Medicine, New Haven, CT

Purpose
Screening for blunt cerebrovascular injury (BCVI) has been a topic of immense controversy with wide variations in recommendations regarding the need for screening and the optimal imaging modality. Digital subtraction angiography (DSA) has been considered the reference standard for
BCVI detection, but increasingly CT angiography (CTA) is being used in Emergency Departments to screen patients. We review the literature and determine the most cost-effective strategy of screening for BCVI in trauma patients.

Materials and Methods

Comprehensive literature review was performed with data extracted to create a decision-tree analysis for five different strategies – anticoagulation for high-risk patients, DSA or CTA for only high-risk patients, and DSA or CTA for all trauma patients. The economic evaluation was based on a societal perspective over a one-year horizon, using Medicare costs when possible and literature values otherwise. Statistical analyses, including Monte Carlo simulations and sensitivity analyses, were performed to test the robustness of the results. The cost-effectiveness was compared through two main indicators, incremental cost-effectiveness ratio (ICER) and net monetary benefit (NMB).

Results

Selective anticoagulation was shown to be the most cost-effective strategy, with the lowest cost and greatest effectiveness. Selective CTA has comparable utility and only a slightly higher cost. Digital subtraction angiography, whether performed selectively or for all, was not optimal from both the cost and utility perspective. Extensive sensitivity analyses demonstrated these results to be robust over a wide range of parameter values. Digital subtraction angiography is not an optimal strategy even assuming a low sensitivity of CTA in our model.

Conclusions

Selective CTA in high-risk patients is the optimal and cost-effective imaging strategy. It remains the dominant strategy over DSA, even assuming a low CTA sensitivity and irrespective of the proportion of patients at high-risk amongst all trauma admissions, and the incidence of BCVI in high-risk patients.
Incremental Cost-Effectiveness, Selective DSA v. Selective CTA

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Sensitivity Analysis (WTP=50,000)
Sensitivity Analysis (WTP=50,000)

Net Monetary Benefit vs. pBCVI_routine

CTA for a
△ DSA for a
☆ Selective
★ Selective
Gray Selective

(Filename: TCT_O-117_Figure3.jpg)
Neuroradiology "M & M": Misses and Misdiagnoses

C Stanton\textsuperscript{1}, S Patel\textsuperscript{1}
\textsuperscript{1}NYU Langone Medical Center, New York, NY

Purpose
As part of an ongoing Practice Quality Improvement (PQI) initiative, the neuroradiology division at our institution collects and analyzes errors in diagnostic neuroradiology reports. The purpose of this study is to analyze our series of diagnostic neuroradiology error cases in order to elucidate potential trends, recurring blind spots, and biases in neuroradiology.
Materials and Methods
Diagnostic neuroradiology exams with reports that contained errors were gathered between 05/2009 – 12/2014. These exams usually were identified in the course of evaluating follow-up imaging, during clinical consultation or conference, or during final attending signature of fellow preliminary reports. All cases were gathered in a central database for further analysis. Diagnostic errors were classified broadly into perceptual errors and cognitive errors. Perceptual errors included those in which a relevant imaging finding was not detected. Cognitive errors included those in which a finding was detected but misinterpreted or inappropriately addressed. The errors also were categorized with respect to modality, anatomical distribution, pathology, and level of reader training. When ascertainable, the day and time when the report was rendered also were recorded. When applicable, errors were classified with respect to cognitive bias(es) that were contributory. Errors with the potential to impact patient management or outcome were designated as "major".

Results
A total of 113 cases were encountered with a total of 121 errors. There were 92 perceptual errors and 29 cognitive errors. Fifty-five errors were deemed to be major. The most frequently missed pathology was neoplastic (n=45), which included a variety of minor and major findings such as small incidental meningiomas (n=4) and leptomeningeal metastatic disease (n=6). The most common anatomical distribution was vascular (Figure 1), with the most frequent vascular pathology being aneurysms (n=11). The most frequent modality was MR imaging (MRI) (Figure 2). Errors most frequently occurred on Thursdays and Fridays and during the afternoon to early evening period (Figures 3 and 4). Numerous cognitive biases were deemed to be contributory, including search satisfaction (n=21), framing bias (n=16), attribution bias (n=13).

Conclusions
Analysis of a large cohort of error cases in diagnostic neuroradiology reveals several interesting trends with respect to blind-spots, cognitive biases, and systemic factors. Recognition of common sources of error in diagnostic neuroradiology may allow greater vigilance and preparedness amongst clinical neuroradiologists.
Lean 6 Sigma Methodology for QI Projects in Neuroradiology: Overview of the Process with an Example Project on Reduction of Head CT in Children with Hydrocephalus

A Tekes\textsuperscript{1}, E Jackson\textsuperscript{2}, G Jallo\textsuperscript{3}, J Ogborn\textsuperscript{3}, T Huisman\textsuperscript{1}

\textsuperscript{1}The Johns Hopkins University School of Medicine, Baltimore, MD, \textsuperscript{2}JHH, BALTIMORE, MD, \textsuperscript{3}JHH, Baltimore, MD

\textbf{Purpose}

Quality and safety are recognized increasingly in delivery of healthcare in the last decades. Radiologists are required to deliver high quality, radiation free imaging, especially in children. Our objective is to describe Lean Sigma Methodology as applied in neuroradiology demonstrating a project where we worked on reduction of Head CTs in imaging of hydrocephalus in children.
Materials and Methods
Our goal was to reduce head CT order by 50% in 6 months 24/7 from all referring departments. We followed five step Lean approach: Define, Measure, Analyze, Interventions, and Control (DMAIC) in a tertiary care academic children's center. We formed a multidisciplinary team comprised of pediatric neuroradiologists, neurosurgeons, emergency department physicians, radiology chief technologists/managers (MRI, CT, and US), administrators and an analyst. Existing hydrocephalus imaging modalities were defined (head CT, head US, ultrafast brain MRI, routine brain MRI). Three-month baseline data were analyzed as percentage of each modality per ordering department, exam time (day time, after hours, weekends), and ordering physician rank. The existing baseline imaging practice was outlined in a flowchart. Then interventions were discussed and applied. An improved workflow to incorporate an optimized ultrafast brain MRI protocol and Head US (children less than 6 months) was created and distributed to all involved parties. Postintervention data were collected for 3 months followed by 3-month control phase data collection.

Results
We have reduced our head CT order by 75%, surpassing our goal. There was a statistically significant difference in head CT percentage between baseline and postintervention phases (z test, P value: 0.0001).

Conclusions
Using Lean 6 Sigma methodology and a multidisciplinary approach, we have significantly reduced head CT orders and replaced them by radiation free, no anesthesia/no sedation Ultrafast brain MRI protocol. Although factors may vary by each hospital, similar methodology could yield positive results at other institutions.

Impact of a Radiology Benefit Management (RBM) Program - Does the Specialty of the Referring Provider Matter?

D Friedman¹, N Smith¹, K Talekar¹
¹Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, PA

Purpose
To evaluate the impact of a radiology benefit management (RBM) program on disposition of cases based upon specialty of the referring provider.

Materials and Methods
Using evidence-based guidelines, an RBM company (HealthHelp, LLC) provides real time, peer to peer decision support for providers ordering high cost, outpatient imaging studies on patients enrolled in national and local health plans. After consultation between RBM personnel (tier I, customer service representative; tier II, nurse) and the provider's staff, studies not meeting appropriateness criteria are referred to a radiologist (tier III) for further review. The radiologist can approve the study based upon electronic chart review, or call the provider's office for more information; determination of appropriateness then is made. If a suitable individual cannot take the call, and there is "no callback" within 48 hours, the study is administratively withdrawn. Studies are not denied. Based upon provider specialty, we analyzed rates of (1) study approved by consensus, (2) study changed by consensus, (3) study withdrawn by consensus, (4) study
approved, but no consensus, and (5) study withdrawn due to "no callback". Aggregated data for all specialties enabled comparison to results for each specialty. Combined rate of "study changed" and "study withdrawn" by consensus assessed the effect of provider-radiologist collaboration; rate of "no callback" assessed the sentinel effect. Together, these assessed the overall impact of the RBM program. Project period was 5 years (7/2009-6/2014). Studies ordered by cardiologists were excluded, as many were reviewed at tier III by cardiologists, not radiologists.

Results
A total of 168,915 studies were ordered by all specialties: 98,925 (58.6%) were approved, 11,508 (6.8%) were changed, and 22,731 (13.5%) were withdrawn by consensus; 10,068 (6.0%) were approved without consensus; 25,683 (15.2%) were withdrawn due to "no callback". Hence, 59,922 (35.5%) studies initially ordered were not performed at that time. Among specialties, family practice (FP) (25.3%) and internal medicine (IM) (23.8%) had the highest rates of procedure changed/withdrawn by consensus; thoracic surgery (13.3%), neurosurgery (NS) (11.2%), and orthopedic surgery (OS) (9.3%) had the lowest rates. Internal medicine (18.0%), neurology (17.7%) and FP (17.4%) had the highest rates of "procedure withdrawn due to no callback"; pediatrics (7.1%) and ophthalmology (7.3%) had the lowest rates. The overall impact of the RBM was greatest for FP (42.7%), IM (41.8%), and neurology (33.4%), and lowest for OS (22.8%) and NS (24.0%). Pediatrics (10.3%), FP (8.2%), and IM (6.6%) had the highest rates of "no consensus".

Conclusions
This RBM program had a substantial impact upon the performance of studies, regardless of provider specialty; however, the impact was greatest upon primary care specialties that are heavy users of radiology, and least upon some surgical specialties. Most primary care specialists are less likely to return the radiologist's call; light users of radiology are more likely. Primary care providers are less likely to follow the radiologist's advice.
Disposition of Cases by Specialty of Pr

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Monday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)

06B - INTERNATIONAL SESSION: ESNR: WHITE MATTER DISEASE: DIFFUSE DISEASE, NEW PROBLEMS

06B-1
Expanded Imaging Spectrum of Neuromyelitis Optica (NMO): Where to Look

Thurnher, M.
Medical University Of Vienna
Vienna

06B-2

Therapy Related Complications in Multiple Sclerosis

Yousry, T.
UCL Institute of Neurology
London

06B-3

ADEM: The Usual and Unusual

Rossi, A.
G. Gaslini Children's Hospital
Genova

06B-4

Toxic and Metabolic White Matter Disease

Van Goethem, J.
University Hospital Antwerp
Antwerp

Monday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

06C - YOUNG PROFESSIONAL III: PRACTICE POST-TREATMENT NEUROIMAGING

06C-1

Post Treatment Brain
Cha, S.
University of California San Francisco
San Francisco, CA

06C-2
Post Treatment Neck
5:25PM - 5:50PM

Williams, III, D.
Wake Forest University School of Medicine
Winston-Salem, NC

06C-3
Post Treatment Spine
5:50PM - 6:15PM

Shah, L.
University of Utah
Salt Lake City, UT

06C-4
Discussion
6:15PM - 6:30PM

Monday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)

06D - HEALTH POLICY COMMITTEE: PATIENT ENGAGEMENT, TRANSPARENCY AND POPULATION HEALTH

06D-1
Introduction to Population Health
5:00PM - 5:30PM

Ruth, J.
Sparrow Health System, Inc.
Lansing, MI
06D-2

Future of Neuroradiology in the Era of Population Health

Mukherji, S.
Michigan State University
Ann Arbor, MI

06D-3

Public Disclosure and Patient Engagement from the Radiologist Perspective

Seidenwurm, D.
Sutter Medical Group
Sacramento, CA

Monday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

06E - LEGAL SEMINAR: LEGAL EAGLES: INSIDE AND OUTSIDE THE COURTROOM

06E-1

Cognitive Errors and Missing Cases

Srinivasan, A.
University of Michigan Health System
Ann Arbor, MI

06E-2

Mitigation of Litigation: How to Avoid Being Sued

Yousem, D.
Johns Hopkins Medical Institution
Baltimore, MD

06E-3

Guidelines for the Expert Witness

5:00PM - 6:00PM

5:00PM - 5:20PM

5:40PM - 6:00PM

5:00PM - 6:30PM

5:00PM - 5:20PM

5:20PM - 5:40PM

5:40PM - 6:00PM
Reassessing the Anatomic Origin of the Juvenile Nasopharyngeal Angiofibroma

C McKnight¹, H Parmar¹, K Watcharotone¹, S Mukherji²
¹University of Michigan, Ann Arbor, MI, ²Michigan State University, Ann Arbor, MI

Purpose
Current literature lacks a modern, image-based assessment of the anatomical origin of the juvenile nasopharyngeal angiofibroma (JNA) lesion. A comprehensive review which takes advantage of the numerous recent advances in modern CT and MR imaging is necessary to further define the anatomical origin of the JNA lesion.

Materials and Methods
Following IRB approval, a search from January 1998 to January 2013 yielded 33 patients with pathologically proven JNA lesions with CT and/or MR imaging obtained prior to any intervention. Juvenile nasopharyngeal angiofibroma involvement was assessed in the following regions: Sphenopalatine foramen, pterygopalatine fossa, vidian canal, nasopharynx, nasal cavity, sphenoid sinus, choana, pterygomaxillary fissure/masticator space, orbit and sphenoid bone. Degree of involvement was defined: 0 = no involvement, 1 = < 1/3 involvement, 2 = > 1/3 involvement and < 2/3 involvement, 3 = > 2/3 involvement, 4 = expansion and/or extensive bone remodeling. Lesion volume was estimated by using a standard prolate ellipse formula (AP x TR x CC x 0.5233). Ordinal logistic regression was used to assess the extent to which tumor volume predicted the level of involvement within each region.

Results
Involvement and expansion of the choana was present in 32 out of 33 individuals. The
nasopharynx was involved in all 33 cases. In contrast, only 22 lesions involved the pterygopalantine fossa, 24 lesions involved the sphenopalatine and 28 lesions involved the vidian canal. Estimated tumor volume predicts the extent of involvement most substantially in the sphenopalatine foramen (p = 0.007) and pterygopalantine fossa (p = 0.002).

Conclusions
The origin of the JNA lesion is most likely in the region of the choana and nasopharynx. Tumor enlargement results in expansion into the pterygopalatine fossa and sphenopalatine foramen. This challenges the commonly held notion that the JNA lesion originates within the pterygoplantine fossa or sphenopalatine foramen.
MR Imaging Evaluation of Cranial Defect Reconstruction following craniopharyngioma resection via Endoscopic endonasal approach

K Shekdar¹, N Adappa², P Storm³, L Bilaniuk³


Purpose
Endoscopic endonasal approach (EEA) is evolving as the surgical approach of choice in pediatric patients for resection of craniopharyngiomas. Successful endoscopic closure of the surgically created cranial defect necessitates multilayer reconstruction utilizing inlay free grafts (fat packing, collagen matrix dural graft, and/or fascia lata) and mucosal onlay pedicled nasoseptal flap (NSF) based on the sphenopalatine artery. This study aims to evaluate the normal temporal evolution of imaging appearance of skull base reconstruction utilizing NSFs and free grafts.

Materials and Methods
We retrospectively reviewed unenhanced and enhanced serial brain MRIs of patients following EEA for resection of craniopharyngiomas and multilayer skull base reconstructions utilizing NSFs, and free grafts, performed between 2011 and 2013. The grafts were evaluated for temporal changes in signal, enhancement, thickness, and configuration.

Results
Twelve patients with reconstructions were evaluated and had follow-up MRIs (2-24 months). All 12 reconstructions retracted into the skull base defects. All intracranial fat grafts showed progressive resorption with 50% reduction in the fat by 6 months and near complete resorption by 14 months. By 3-6 months, all inlay fascia lata and onlay NSFs demonstrated mature imaging features with little or no further change on subsequent imaging. The initial enhancement of viable NSFs persisted but the flap thickness decreased by 20-30%. The distinct C-shaped arc and vascular pedicle leading toward the sphenopalatine foramen seen on immediate postoperative imaging became progressively less defined due to incorporation.

Conclusions
A definite pattern of MR imaging changes was observed over time in patients who had undergone craniopharyngioma resection via EEA and multilayer endoscopic skull base reconstruction corresponding to maturation of the grafts. An understanding of the normal evolution and appearance of NSFs and free graft reconstructions is essential for accurate image interpretation and to avoid its misinterpretation for neoplasm.
Purpose
To investigate the detectability of the petroclival segment of the abducens nerve in its entire course and to evaluate the role of the size of the petroclival venous sinus in the visibility of the abducens nerve using contrast-enhanced FIESTA magnetic resonance imaging (MRI).

Materials and Methods
We retrospectively evaluated the contrast-enhanced FIESTA images of 237 patients (F:M ratio, 127:110; mean age, 49.04±14.66 years) with temporal MRI. Two radiologists, working collaboratively, divided the imaging findings of the petroclival segments of the abducens nerves into three groups: 0 (not visualized), 1 (partially visualized), and 2 (completely visualized). A third radiologist, blinded to the classification data, measured the anteroposterior dimension between the clival bony surface and the inner layer of dura at the same level as the cisternal segment of the abducens nerve pierces the dura to enter the venous sinus. Analysis of variance was used to test differences between groups. Dunnett's test was used for multiple comparisons in One-Way ANOVA. A cut-off measurement value was determined using receiver operating characteristic (ROC) curve analysis for the discrimination between the group 0 and group 2.

Results
Among 474 abducens nerves, 76 were classified as group 0 (76/474, 16.03 %), 100 were classified as group 1 (100/474, 21.10 %) and 298 were classified as group 2 (298/474, 62.87 %). There was significant difference in mean anteroposterior diameters of the petroclival venous sinus for each group (0.95 mm for group 0; 1.80 mm for group 1; 2.51 mm for group 2) (p<0.001). The cut-off value in the differentiation of group 0 and group 2 was found as 1.74 mm (AUC=0.929, p=0.0001).

Conclusions
Abducens nerve in its petroclival segment can be identified reliably using contrast-enhanced FIESTA MRI. The efficiency of this imaging technique in the visualization of the entire petroclival course of the abducens nerve increases in patients with a greater anteroposterior dimension of the petroclival venous sinus.

O-124

Imaging findings predictive of successful microvascular decompression for trigeminal neuralgia

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Purpose
Trigeminal neuralgia (TN) is a debilitating facial pain disorder. While TN has many etiologies, vascular compression of the cisternal portion of the trigeminal nerve is a treatable cause (1). The centrally myelinated proximal portion of the nerve is more susceptible to vascular compression than the peripherally myelinated distal segment of the nerve (2). Success rates for microvascular decompression (MVD) depend on a number of clinical features: paroxysmal pain, the presence
of trigger points, and a positive response to carbamazepine all portend a good outcome \((3,4)\). Imaging markers that predict response to MVD have not been described well. The purpose of the study is to identify imaging markers predictive of MVD success.

**Materials and Methods**

Twenty patients with TN being considered for MVD underwent a preoperative MRI delineating the trigeminal nerve and adjacent vessels. Our MVD protocol includes 4 mm multiplanar steady state free precession (SSFP) sequences performed on a 3T magnet. Images were reviewed retrospectively to identify presence of vascular contact of the trigeminal nerve, whether the contacting vessel was an artery or vein, specific artery name, general point of contact (proximal/posterior versus distal/anterior), specific point of contact (distance from pons in mm), compression of the nerve, deviation of the course of the nerve, and presence of multiple contacting vessels. Compression of the nerve is defined as visible deformity of the nerve. All patients underwent a MVD by a single neurosurgeon specializing in cranial nerve disorders, who has performed over 500 MVDs for TN. Pain status following MVD was the outcome measure, quantified utilizing a four point pain scoring system \((1=\text{pain free}, 2=\text{pain free with medication}, 3=\text{some relief}, 4=\text{no relief})\) based on patient interviews. Univariate correlation of the imaging findings with the pain score was performed with a Spearman's rank correlation.

**Results**

The presence of compression of the nerve on imaging correlated significantly with a lower postoperative pain score \((p=0.01)\). Deviation of the nerve on imaging also correlated with a lower postoperative pain score, which trended towards statistical significance \((p=0.08)\). The remaining imaging findings did not correlate with the postoperative pain score.

**Conclusions**

Visible compression of the trigeminal nerve identified on dedicated thin section SSFP sequences significantly correlated with improved outcome following MVD for TN. This finding may help select TN patients who will benefit from MVD.

**O-125**

5:32PM - 5:40PM

**Diagnostic value of high resolution ultrasound in detection of nasal bone fractures compared with CT scan.**

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**Purpose**

This study was designed to compare usefulness of sonography for detection of nasal fractures in trauma patients as a first-line imaging modality in comparison to CT scan as a gold standard.

**Materials and Methods**

During a 24-month period we prospectively analyzed 40 patients with recent trauma to their nose referred to a head and neck trauma center. Nasal CT scan and sonography were done in all of these patients. Two radiologists reported the CT scans and performed the sonographies respectively and were blind to the results of the other study. CT scans were performed in axial plane and then coronal reformat images were taken. The sonographies were done using a 10
MHZ frequency linear transducer in transverse and longitudinal directions for dorsum and two lateral nasal bones.

Results
CT scan detected a total of 45 fractures in dorsum and two lateral nasal bones. Of these, 38 fractures were detected by sonography. The sensitivities of sonography in detection of dorsal and lateral nasal bone fractures were 76.9% and 85.6% respectively and the specificities were 92% and 93.8% respectively. Totally the sensitivity and specificity of sonography in detection of nasal fractures were 83.9% and 93.2% respectively.

Conclusions
Our study showed that sonography has high sensitivity and specificity for detection of nasal fracture and is a cost-effective, safe, available and fast method for detecting nasal fractures.

O-127
5:48PM - 5:56PM

Craniocervical Hyperpneumatization: Estimation of Prevalence and Imaging of Treatment Response

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Purpose
To determine the prevalence of accessory pneumatization of the occipital condyle and the frequency with which this finding is associated with extension into the upper cervical spine.

Materials and Methods
This HIPAA-compliant study was approved by the Institutional Review Board, and the need for informed consent was waived. The electronic medical record was queried to identify CT reports containing keywords that referenced pneumatization and the anatomical regions of the posterior skull base and cervical spine between May 1995 and December 2014. These reports were evaluated to identify potential cases of pneumatization of the occipital condyle and cervical spine, which were ultimately confirmed by CT review, and the extent of aberrant pneumatization was documented. The Radiology Information System was searched to determine the total number of relevant CT scans (i.e., head, face, temporal bone, cervical spine, neck) performed during this time period to estimate prevalence.

Results
Nine subjects (5 men, 4 women; age 56.9 +/- 16.3 years) were identified with occipital condyle pneumatization, and this was unilateral in most instances (4 right, 4 left) with only one bilateral case. The latter subject with bilateral condylar pneumatization was the only one to exhibit associated pneumatization of C1 (Figure 1A). Given the 193,982 related CT studies included in the search, this translates into an estimated prevalence of 0.0046% and 0.0005% for occipital condyle and C1 pneumatization respectively. No cases of cervical pneumatization were identified in the absence of a pneumatized occipital condyle. The single patient with C1 hyperpneumatization was symptomatic (headache, conductive hearing loss, vertigo) and was therefore treated with pressure-equalization tubes. Post-treatment CT demonstrated resolution of skull base and C1 pneumatization (Figure 1B), and MRI performed 3 years later documented return of normal marrow signal in the previously pneumatized bones (Figure 1C).
Conclusions
The occipital condyle is an uncommon site of accessory skull base pneumatization. In rare instances, this is associated with acquired craniocervical hyperpneumatization which, when treated with middle ear pressure-equalization, can revert to normal bone marrow.

1A 1B 1C

(Filename: TCT_O-127_SkullbasePneumAbstractFigure.jpg)

O-128

CT Appearances of Sigmoid Sinus Diverticulum or Dehiscence: An Important and Treatable Cause of Tinnitus

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Purpose
The purpose of this retrospective review is to describe imaging findings of sigmoid sinus dehiscence/diverticulum (SSDD) on temporal bone CT or CT Angiography/Venography (CTA/V) in patients with pulsatile tinnitus (PT). A subset of patients underwent surgery for repair of the diverticulum.

Materials and Methods
After IRB approval, we searched our imaging database for temporal bone CT/CTA/Vs performed for objective tinnitus, ICD-9 code 388.32. Images were reviewed by two neuroradiologists, and SSDD side, size, and contour were recorded. Clinical data including age, gender, body mass index (BMI), surgery and outcome were documented.

Results
Thirty-two patients with PT (F:M = 28:4, average age 41.25 years) and SSDD were diagnosed over a 12-year period. Average BMI was 31.81. Of the 32, 4/32 underwent temporal bone CT, 27/32 had CTA/CTV and one patient underwent both. Seventeen of 32 were on left, 14/32 were right, and 1/32 had bilateral dehiscence. All had bony dehiscence, and 20/32 had a diverticulum associated with the defect. Defects ranged from 3-12 mm, and some were multifocal. Diverticula
were entirely intraosseous or extended into mastoid air cells. Strongly dominant transverse sinuses and large bulky arachnoid granulations were associated with diverticula. Seventeen of 32 patients underwent surgical repair, with complete resolution of tinnitus in 16/17 patients. A trans-temporal approach was performed in 13/17 patients. Osseous defects were covered with titanium plate and muscle graft, or a calcium-phosphate based bone cement and muscle graft. Postoperative CT was available in one patient.

**Conclusions**

Sigmoid sinus dehiscence/diverticulum should be suspected in obese middle-aged women with PT. Dehiscence may be simple or irregular, multifocal, and associated with a venous diverticulum. With the current epidemic of obesity, it is important to recognize this entity, as it is a treatable cause of PT.
Figure Legend:

A. Axial CTA/V of left sigmoid demonstrates a simple dehiscent diverticulum

B. Axial CTA/V of left sigmoid demonstrates trans-osseous

C. Coronal CTA/V of right demonstrates two separate d
Prevalence of Cavitating Otosclerosis

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Purpose
Otosclerotic lesions typically have groundglass opacity or sclerotic changes on computed tomography (CT) scan of the temporal bone. Cavitating lesions are defined as lesions that are isodense to cerebrospinal fluid (CSF) within the internal auditory canal IAC. The purpose of this study is to evaluate the incidence and distribution of cavitating otosclerosis on CT scan.

Materials and Methods
Temporal bone CT scan of 114 patients with clinical and radiologic diagnosis of otosclerosis were reviewed. The imaging features and distribution of cavitating lesions was assessed by two neuroradiologists.

Results
Cavitating lesions were identified in 21 patients (32 ears). The lesions were bilateral in eight patients, isolated involvement of the left ear in nine patients, and isolated involvement of the right ear in four patients. The lesions were pericochlear in six patients and involved the anterior aspect of the internal auditory canal in 15 patients. There was no evidence of cavitary changes in the fenestral region.

Conclusions
Cavitating otosclerosis commonly is seen in patients with otosclerosis. The majority of the lesions typically are seen involving the IAC.

Topographic distribution of lesions in otosclerosis

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Purpose
Otosclerosis is a primary focal osteodystrophy of the otic capsule with two subtypes fenestral and retrofenestral. Fenestral lesions are seen involving the lateral wall of the otic capsule, including the round and oval windows, and cochlear promontory. The retrofenestral lesions involve the labyrinthine capsule, including the pericochlear region, the semicircular canals, internal auditory canal (IAC), vestibule, and cochlear and vestibular aqueducts. The purpose of this study is to evaluate the topographic distribution of otosclerotic lesions on CT scan.

Materials and Methods
Temporal bone CT scans of 114 patients with clinical and radiologic diagnosis of otosclerosis
were reviewed. The imaging features and distribution of the lesions was assessed by two neuroradiologists.

Results
Bilateral otosclerotic lesions were seen on 93 patients (186 ears), isolated to the left temporal bone in 14 ears and isolated to the right temporal bone in seven ears. The lesions were seen involving the fissula ante fenestrum in 190 ears, the round window in 69 ears, pericochlear in 62 ears, anterior aspect of the IAC in 70 ears and the posterior aspect of the IAC in nine ears. Isolated retrofenestral lesions without evidence of fenestral involvement were seen in nine patients (17 ears), with 12 lesions were seen involving the IAC and five lesions were isolated to the pericochlear region.

Conclusions
The majority of otosclerotic lesions are fenestral. Isolated retrofenestral lesions are uncommon but should be part of the imaging checklist in assessing patients with suspected otosclerosis.

O-131
6:20PM - 6:28PM
Assessment of Anterior Pathology in Symptomatic Patients with Hindbrain Herniation (Chiari I Malformation)

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Purpose
A significant number of Chiari I patients have craniocervical junction (CCJ) instability and ventral brainstem compression from a retroflexed odontoid, basilar invagination, or from congenital or acquired weakness of the superior longitudinal band of the cruciate ligament. Management includes surgical normalization of the craniocervical relationship with craniocervical fusion. While there are ongoing efforts to develop ways to identify this subset of Chiari patients, there is currently no consensus among clinicians on how to evaluate for craniocervical instability radiographically. MR imaging (MRI) has become the standard diagnostic imaging modality in defining Chiari pathology and more specifically, measurements of the pB-C2 line (Grabb line) and clivoaxial angle (CXA) are important in identifying craniocervical junction instability. The purpose of this study was to determine the inter and intrarater reliability of these measurements among different readers and explore the efficacy of intra-operative reduction in producing normal radiographic craniocervical relationships.

Materials and Methods
We conducted a retrospective review of patients treated at a single institution from 2011 to 2012. We analyzed two different measurements of the pB-C2 (Grabb line) and Clivo-Axial angle (CXA) on pre and postoperative T1 and T2 MRI sequences of MR imaging to assess the effectiveness of surgery. The measurements were repeated by four different raters; including a neurosurgeon, a neuroradiologist, a neurologist and a neurosurgery resident. Inter- and intrarater reliability on these measurements from T1 and T2 MRI sequences were compared.

Results
There was a total of 24 patients (17 females, 7 males) with a mean age of 25.9 years (age range between 9 to 52 years). All patients had a diagnosis of Chiari I malformation and underwent
intra-operative reduction and craniocervical fusion. The values between pre and postoperative imaging findings were significantly different (p<0.005 respectively). We also found the CXA to be a consistent measurement on both T1 and T2 imaging. The pB-C2 line was shown to be a more reliable measurement on T2 imaging.

Conclusions
Intra-operative reduction with craniocervical fusion was effective in normalizing radiographic relationships of craniocervical junction instability in Chiari I patients. The CXA measurement using the T1 sequences of MR imaging can be used as a screening tool by the radiologist to capture patients at risk for craniocervical instability. When the CXA is found to be abnormal and the pB-C2 equivocal, further MR imaging that includes T2 sequences will be helpful. Patients meeting abnormal criteria for CXA and pB-C2 should receive a referral to a neurosurgeon for evaluation.

Figure 1. Craniocervical junction measurements. A. Clivoaxial angle, eg T1: A degrees. The angle is measured between two lines. The first extends from the dorsal clival cortex to the posterior most dural margin at the craniocervical second is a line from the posterior most dural margin to the inferior posterio corticomedullary junction (2). B. pB-C2, eg T2: Abnormal if ≥ 8mm. This represents the perpendicular distance from the posteriormost dural edge at the craniocervical junction drawn from the most posterior inferior point of the basion to the infradensity corticomedullary junction (4).
Figure 2. Intraoperative reduction with craniocervical fusion was effective in radiographic relationships of craniocervical junction. A. Preoperative CXA: 135°, pB-C2: 1.2 cm B. After craniocervical fusion, CXA: 169 degrees pB-C2: 0.6 cm

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Deep Neck Fibromatosis Following Cervical Fusion and Discectomy: Case Series and Review of the Literature

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Purpose
The purpose of this series is to describe deep fibromatosis as a rare cause of neck mass following cervical spine surgery.

Materials and Methods
Patient 1: A 48-year-old male developed a right neck mass 5 years following anterior cervical spine fusion. Core biopsy followed by resection showed a spindle cell lesion consistent with fibromatosis. Patient 2: A 53-year-old male presented with a posterior neck mass 1 year following cervical spine fusion performed after spine trauma. Core biopsies and resection demonstrated low grade spindle cell neoplasm, consistent with fibromatosis. Patient 3: A 25-year-old male presented with a right posterior neck mass 1 year following discectomy and C4-C7 fusion performed after spine trauma. Resection of the 13cm mass demonstrated slender, spindle cells consistent with "desmoid-type fibromatosis". Patient 4: A 59-year-old male presented with...
a right hypopharyngeal neck mass of 6 months duration following anterior cervical spine fusion. Based on experience with prior cases, fibromatosis was suggested as probable diagnosis. Final pathology demonstrated abscess with acute and chronic inflammation.

Results
Computed tomography (CT) demonstrated a well circumscribed, nonenhancing mass in patient 1. In all cases, MRI shows the lesions were predominantly T2 hyperintense but heterogeneous, adjacent to surgical hardware, with variable enhancement patterns with gadolinium. The masses ranged from 3 cm to 13 cm in greatest dimension.

Conclusions
Fibromatosis is an uncommon head and neck mass in postoperative cervical spine fusion patients, with few cases reported in the literature. The diagnosis can be suggested when CT or MRI show large heterogeneous masses in a patient with prior cervical spine surgery. Complete surgical extirpation is treatment of choice. Postoperative hematoma, infection, a reactive process such as myositis ossificans, and sarcoma are almost always additional considerations. Although rare, deep fibromatosis should be considered in a patient with a painful neck mass and a prior history of cervical spine surgery.
Figure 1.

A. Axial contrast-enhanced CT shows a well-circumscribed nonenhancing mass in the prevertebral portion of the spinal space, inseparable from the right prevertebral musculature.

B. T2-weighted axial image shows the mass is heterogeneous with central marked hypointensity.
Infected Tracheal Diverticulum Presenting as a Right Paratracheal Mass in a Patient Requiring Surgical Resection.

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Purpose
Tracheal diverticula have a classic location in the right tracheoesophageal groove and are associated with chronic obstructive lung disease. They usually are incidental, but rarely become infected and present as a painful neck mass. We present a case of an infected tracheal diverticulum mimicking a necrotic right paratracheal mass in a patient with cystic fibrosis.

Materials and Methods
A 34-year-old female with a history of cystic fibrosis and chronic cough presented to her provider with cough and right neck pain. An initial CT revealed a complex right paratracheal mass containing gas and fluid. The differential provided included a necrotic mass or lymph node, or soft tissue abscess. Biopsy of the mass was indeterminate. She was treated conservatively and failed to improve. Repeat imaging a few months later demonstrated a persistent complex right paratracheal mass containing foci of gas. The mass had not increased in size or complexity. There was no clear connection with the trachea at CT, but the location of the mass was classic for a tracheal diverticulum. Given the patient's history of chronic cough and pain, an infected diverticulum was suspected. She then was referred for surgical consultation. She underwent operative laryngoscopy, bronchoscopy, and esophagoscopy, all of which were unremarkable. She then was prepped for surgical resection of the mass. At surgery, a firm cystic mass was identified and dissected off of the right lateral aspect of the trachea and esophagus. The mass was connected by a small stalk, but it was uncertain whether the origin was from the trachea or esophagus. Therefore, the stalk was sutured, ligated, and dissected flush with the tracheoesophageal groove. The cyst was violated gently and purulent fluid was expressed. The cyst wall was over sewn and sent for pathology. Results of the intraoperative frozen section were consistent with a cyst lined by respiratory epithelium and inflammatory cells consistent with an infected tracheal diverticulum.

Results
A tracheal diverticulum is a benign cyst which usually is asymptomatic and therefore usually incidentally discovered (1, 5). They project posteriorly, most commonly from the right tracheoesophageal groove at the thoracic inlet, where the cartilage rings are deficient and there is no support of the paratracheal tissue from the esophagus. A direct connection with the trachea is sometimes visible on CT (2, 5). The diverticulum can accumulate respiratory secretions that become infected and lead to cough, as in this case, or tracheobronchitis. Once infected, the cyst can develop secondary signs of infection, wall thickening, associated fat stranding/phlegmon, central high attenuation secretions mixed with air, and reactive lymphadenopathy (3, 4).

Conclusions
This case illustrates a tracheal diverticulum mimicking a necrotic right neck mass in a symptomatic patient with chronic cough. It is important for the radiologist to recognize this
entity with a classic location along the right tracheoesophageal groove and to include it among the list of diagnostic considerations.

Infected Tracheal Diverticulum

![Infected Tracheal Diverticulum](TCT_E-34_Trachealdiverticulumasnr.gif)

Axial CT with contrast, on soft tissue windows (above, left) and lung windows (below, left), and coronal patient demonstrates a complex right paratracheal collection with foci of gas displacing the trachea. No definite connection to the trachea. This was interpreted as a possible necrotic mass/lymph node or nicely demonstrates classic imaging stigmata of cystic fibrosis in the upper lobes.

(Filename: TCT_E-34_Trachealdiverticulumasnr.gif)

E-35

Optic nerve glioblastoma multiforme masked by suspected optic neuritis and central retinal vein occlusion.

A Kalnins¹, M Penta¹, N Fischbein¹, M Iv¹
Purpose
We present the clinical and radiographic manifestations of primary glioblastoma multiforme (GBM) of the optic nerve to highlight the clinical and diagnostic challenge of this rare entity.

Materials and Methods
A 72-year-old female with history of Waldenstrom's macroglobulinemia woke up with new onset left orbital pain and vision loss. Left optic disc swelling and visual field defect were found on exam and diagnosed as optic neuritis. MR imaging of the orbits was interpreted as normal (Figure 1). The patient's vision worsened over the next 3 months, and neuro-ophthalmologist exam led to the diagnosis of ischemic optic neuropathy from central retinal vein occlusion (CRVO). Review of the initial MRI showed subtle enhancement of the left optic nerve, consistent with the clinical diagnosis. The patient developed left eye blindness after 1 month, and repeat MRI (Figure 2) showed diffuse left optic nerve enhancement, likely secondary to anterograde optic nerve degeneration following CRVO, but lymphoma, optic neuritis, and pseudotumor were considered. The patient was referred for biopsy and follow-up MRI. While biopsy of the optic nerve sheath was unremarkable, repeat orbital MRI (Figure 3) demonstrated new nodular enhancement within the prechiasmatic left optic nerve. The patient progressed to contralateral vision loss after 2 months, and repeat imaging (Figure 4) showed progression of mass-like enhancement of the left optic nerve and chiasm, with areas of necrosis, interpreted as optic nerve GBM, confirmed by optic nerve biopsy.

Results
Figure 1 (4/9/14): Cor T1WI+ orbits shows enhancement within the superior aspect of the left optic nerve. Figure 2 (8/6/14): Ax T1WI+ orbits shows abnormal enhancement and enlargement of the left optic nerve. Enhancement extends from the posterior globe to the distal prechiasmatic segment. Figure 3 (8/28/14): Ax T1WI+ orbits shows increased extent of enhancement of the left optic nerve, which now appears somewhat nodular in the prechiasmatic segment. Figure 4 (10/28/14): Ax T1WI+ orbits shows marked progression of disease with increased size of the left optic nerve lesion now involving the chiasm with increased mass-like enhancement and necrosis.

Conclusions
Malignant optic gliomas such as anaplastic astrocytoma or GBM are very rare and more commonly present in older adults, with no gender predilection and mean age at diagnosis of 54 years (1-3). These carry a grim prognosis, with rapid vision loss often worsened by chiasmatic spread of tumor and death occurring between 6 and 12 months of onset (1, 2). Treatment may consist of radiation, chemotherapy, or both. Early imaging findings may overlap with other causes of unilateral optic nerve enlargement and enhancement, notably optic neuritis or infiltrative disorders such as sarcoidosis and lymphoma. Confirmation of the diagnosis depends on the combination of clinical presentation, response to treatment, biopsy, and serial imaging findings (4). In this case, the focal nature of the initial enhancement, rapid progression and extent of nerve enlargement were important clues to the diagnosis of optic nerve GBM.
Simultaneous development of Graves-like orbitopathy and hypophysitis related to ipilimumab

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Purpose
Ipilimumab is a humanized monoclonal antibody targeting the CTLA-4 receptor, which enhances destruction of malignant cells, through activation of CD8 killer lymphocytes. It has been shown to extend patient survival in metastatic melanoma; however it also is associated with a variety of immune-related adverse events.

Materials and Methods
A 40-year-old female with stage III melanoma on the left side of her back was started on ipilimumab; however after receiving three doses of ipilimumab, she developed ocular symptoms, which started as eye pain followed by swelling of both eyes, diplopia and blurry vision. On physical examination she had proptosis and diffuse limitation of eye movements, conjunctival injection and chemosis. Brain and orbit MRI was consistent with graves-like orbitopathy. In addition, there was diffuse enlargement of pituitary gland consistent with hypophysitis. Patient subsequently was treated with steroid.

Results
MR imaging of brain and orbit demonstrated bilateral marked enlargement of extraocular muscles consistent with graves-like orbitopathy. In addition, there was diffuse enlargement of pituitary gland consistent with hypophysitis. Follow-up MRI after steroid treatment demonstrated resolution of above-mentioned findings.

Conclusions
This is the first report of simultaneous occurrence of graves-like orbitopathy and hypophysitis in the setting of ipilimumab treatment. Familiarity of radiologists with these entities and immediate initiation of treatment are mandatory to reduce the risk of adverse sequelae.
Extraosseous Nasopharyngeal Chordoma Mimicking Large Thornwaldt Cyst

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Purpose
To report a case and to review the clinical and imaging findings of extra osseous, nasopharyngeal chordoma, a lesion easily misinterpreted as a Thornwaldt cyst.

Materials and Methods
A 32-year-old female patient who presented with chronic bilateral nasal congestion. Endoscopy
demonstrated a lobulated, flesh-colored mass filling the entire nasopharynx, with irregular surface and firm consistency. Endoscopic biopsy of this mass was performed.

Results
CT demonstrated a round, 2 cm midline posterior nasopharyngeal mass, situated between the longus colli muscles. The lesion was hypodense on CT, without calcification or enhancement. There was no bony erosion. The lesion appeared hypointense on T1 and hyperintense on T2 imaging with mild heterogeneous enhancement. No clival sinus tract was seen.

Conclusions
Extraosseous nasopharyngeal chordoma is a rare entity, as most chordomas arise in the clivus or sacrum. The differential diagnosis of this lesion includes Thornwaldt cyst and nasopharyngeal carcinoma. In particular, a midline T1 hypointense, T2 hyperintense lesion in the nasopharynx between the longus colli muscles easily could be misinterpreted as a Thornwaldt cyst, especially on CT and in the absence of IV contrast. There are several distinguishing features of extraosseous chordoma. These include internal calcifications, bone scalloping, internal enhancement, and presence of a soft tissue tract through the clivus. A Thornwaldt cyst should not demonstrate any of these features. Interestingly, our case demonstrated only one of these features, internal enhancement on MR.
Eagles syndrome and facial nerve paralysis: A rare clinical entity

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Purpose
We describe a rare case of Eagle's syndrome presenting with acute facial nerve paralysis, which improved after surgery.

Materials and Methods
A 56-year-old male presented with progressive dysphagia and neck pain referable to the ear. Physical examination revealed a tender left neck mass. CT showed enlarged bilateral styloid processes with asymmetric thickened and ossified left stylohyoid ligament. The patient was scheduled for resection of the left styloid process and ossified stylohyoid ligament. Three weeks later, patient presented with acute left facial paralysis. The patient was treated acutely with steroids. The patient was scheduled for an open parapharyngeal space dissection, facial nerve decompression and styloid process resection. At the time of surgery, there was edema of the facial nerve with evidence of impingement at and just above the stylomastoid foramen.

Results
CT scan revealed exuberant ossification of the left stylohyoid ligament along its entire length extending up to its articulation with the hyoid bone. The left facial nerve canal at the level of stylomastoid foramen was narrowed consistent with clinical impression of facial nerve impingement.

Conclusions
Eagle syndrome is a rare clinical entity associated with elongated styloid process, with a reported incidence of about 4%. It is diagnosed only when the patient is symptomatic which occurs in about 0.16% of general population. Patients usually present with atypical symptoms including dysphagia, pain on rotation of neck, headaches, change in voice or hypersalivation. While Eagle syndrome is rare in itself, there has been only one case reported of Bell's palsy associated with Eagle's syndrome. The patient underwent an open surgical approach, removing the left styloid process and ossified styloid ligament with improvement of the facial nerve paralysis.
Trigeminal Trophic Syndrome - A Less Known Entity in Neuroradiology. Imaging Evolution and Histopathology Correlation.

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Purpose
To highlight the salient clinical features, imaging evolution and histopathology correlation of trigeminal trophic syndrome (TTS).

Materials and Methods
A 70-year-old male presented with progressive par-aesthesia and right hemifacial numbness with ulceration of the right nasal ala. There was no history of diabetes or trauma. He was operated for right cerebellopontine angle cistern meningioma 2 years ago. Clinical examination revealed right hemifacial asymmetry and numbness. Crescentic ulceration of the right nasal ala was noted with relative sparing of the tip. Biopsy was negative for malignancy, Wegener's granulomatosis, syphilis, leprosy and tuberculosis. Trigeminal trophic syndrome, also referred to as trigeminal trophic ulceration, is a rare entity that is associated with damage to the central or peripheral trigeminal nerve pathway. The etiologies of trigeminal nerve damage leading to TTS include: treatment for trigeminal neuralgia (such as alcohol injection of the Gasserian ganglion), tumors (meningioma, schwannoma, astrocytoma), infectious processes (herpes, syphilis, leprosy), cerebrovascular accidents, syringobulbia, and trauma. Clinically, TTS manifests as a triad of ulceration of the nasal ala, paresthesia, and anesthesia. The mechanism of ulceration is thought to be due to repetitive self-mutilation in an attempt to relieve the paresthesias experienced by the patient following trigeminal nerve injury. The ulcers frequently are unilateral (right side affected two times more commonly than the left side), crescent-shaped, and involve nasal ala. Ulceration also can involve the forehead, cheek, jaw and ear. A distinct feature of the ulceration is sparing of the tip nose, which is referred to as 'ulceration en arc', due to innervation by the anterior ethmoidal nerve.

Results
MR imaging revealed focal soft tissue defect along the right nasal ala. Encephalomalacic changes were noted along right hemipons and involving the trajectory of trigeminal nucleus. Diffuse atrophy of the right side muscles of mastication was noted and clinically correlated with the facial asymmetry.

Conclusions
1) Trigeminal trophic syndrome is a rare condition that occurs following damage to the trigeminal nerve pathway. Nonspecific findings on microbiology and histopathology evaluation and negative biopsy for infectious-inflammatory and neoplastic pathologies are important for diagnosing this entity. 2) Trigeminal trophic syndrome as a complication of cerebellopontine angle surgery is a less known entity in neuroradiology literature. 3) The syndrome is a well-described entity in ENT and dermatology literature. However, the complete imaging evolution and clinicopathological correlation has not been described well in neuroradiology literature.
A Rare Case of a Primary Carcinoid Tumour of the Postnasal Space: Pathological-radiological Correlation and Literature Review

S Gregson¹, R Bhalla², K Gnanalingham³, C Hilditch¹, G Potter⁴
Purpose
To demonstrate a rare case of primary carcinoid tumor within the postnasal space and review existing literature.

Materials and Methods
A 58-year-old lady was referred as an out-patient to ENT with symptoms of difficulty breathing through the left side of the nose and intermittent episodes of choking. Past medical history included tonsillectomy. Physical examination was unremarkable. CT of the paranasal sinuses showed a soft tissue density lesion centered in the postnasal space, extending into the posterior nasal cavity and sphenoid sinus. Subsequent MRI demonstrated a T1- and T2-isointense mass with avid, homogeneous enhancement. There was no intracranial extension. Biopsy showed carcinoid tumor. Pituitary function tests and urine and serum tests for 5-HT were normal. The patient underwent resection of the lesion with a joint ENT and neurosurgical approach.

Results
Axial noncontrast CT sinuses (top left) demonstrated a well defined mass in the postnasal space extending into the sphenoid sinus and posterior nasal cavities with remodelling of the posterior nasal septum and body of sphenoid. There was no aggressive bony destruction. On MRI, the mass was isointense on T1 MRI (bottom left) and mildly T2-hyperintense (not shown) with avid, homogeneous enhancement (T1+C, top right). Corresponding high uptake was seen on SPECT imaging (bottom right, coronal view). SPECT imaging was otherwise normal, with no evidence of distant metastases.

Conclusions
We present a rare case of primary, nonmetastatic postnasal space carcinoid tumor demonstrated on CT and MR imaging with surgical resection of the lesion. Appropriate multidisciplinary clinical, biochemical and imaging assessment provides the optimum setting for appropriate management of these unusual cases.
Parotid Region Tumor Recurrence Associated with Great Auricular Perineural Tumor Spread and Intraspinal Extension Along Multiple Cervical Nerve Roots

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¹University of Texas MD Anderson Cancer Center, Houston, TX, ²M.D. Anderson Cancer Ctr., Houston, TX

Purpose
Perineural spread from the skin to cervical spinal nerve roots is extremely rare. We present a case involving the great auricular nerve (GAN), and illustrate the anatomy of the cervical plexus. The cervical plexus is composed of ventral rami of C1-C3 nerve roots; it gives rise to the great auricular, lesser occipital, transverse cutaneous and supraclavicular nerves. The GAN provides sensory innervation to the skin overlying the parotid and periauricular region.
Materials and Methods
A 72-year-old man with multiple recurrent skin cancer was treated initially in 2010. His cancer was stable until October 2014 when he presented with a draining fistula near the left ear. Contrast-enhanced CT demonstrated progression of tumor and new perineural spread along the GAN. He currently is undergoing palliative radiation treatment.

Results
Axial postcontrast CT images are shown in the Figure. A) Infiltrative tumor in the left deep parotid, extending to the skin (asterisk). B) Necrotic nodal metastasis at the left parotid tail (n). C) Perineural spread within the left C2-3 neural foramen extending intraspinally (black arrow). Perineural spread along the left great auricular nerve (white arrow). D) Perineural spread within the left C3-4 neural foramen extending intraspinally (black arrow). Perineural spread along the left C4 root between the paraspinous musculature and sternocleidomastoid muscle (white arrow).

Conclusions
A patient with a long history of perineural spread, treated with chemoradiation, developed a massive recurrence that included perineural spread along the great auricular nerve, the cervical plexus and the C4 nerve root with extension into the spinal canal through multiple cervical foramina. Knowledge of the complex anatomy of the cervical plexus and great auricular nerve is necessary to understanding the imaging findings.
Sinonasal Phosphaturic Mesenchymal Tumor: A rare oncogenic cause of osteomalacia.

V Trinh¹, C Geannette¹, B Salehi¹, A Sepahdari², R Venkatesh³
¹UCLA, Los Angeles, CA, ²Univ. of California, Los Angeles, Los Angeles, CA, ³UCLA Medical Center, Los Angeles, CA

Purpose
Illustrate a rare tumor that may occur in the sinonasal region that mediates biochemical factors to cause osteomalacia and rickets.

Materials and Methods
A 29-year-old man with h/o osteomalacia of unclear etiology presents with right proptosis x1 month, HA, and R blurry vision. Initial labs showed ↑ALKphos and hyperphosphatemia. Imaging of the sinuses found an aggressive right sided sinonasal tumor invading into the right orbit and skull base. The patient underwent surgical resection with pathology indicative of a phosphaturic mesenchymal tumor. Subsequent to the surgery, the alkaline phosphatase levels gradually decreased.

Results
CT: Aggressive solid and cystic right sinonasal mass with invasion into the right orbit and skull base. MRI: Cystic areas contain fluid-fluid levels. Postcontrast images confirm enhancing septations and nodular components consistent with a complex cystic mass.

Conclusions
Phosphaturic mesenchymal tumors are rare tumors that have been described to mediate and induce osteomalacia and rickets. We describe a rare case of this tumor occurring in the sinonasal region. Awareness of this tumor and its associated biochemical changes will help broaden the differential diagnosis in difficult cases.
Ruptured Trigeminal Nerve Dermoid Cyst
Purpose
We present a case of a rare dermoid cyst occurring at the trigeminal semilunar ganglion.

Materials and Methods
A 32-year-old male presented with a 3-month intermittent history of abnormal bitter taste and vertigo. Neurologic exam was otherwise normal. CT and contrast-enhanced MRI revealed a fat density (on CT) extra-axial mass occurring along the expected path of the trigeminal nerve, centered at the trigeminal cistern. Precontrasted MR images revealed T1 signal intensity similar to subcutaneous fat with homogeneous suppression on fat saturated sequences, and additional T1 hyperintense foci scattered throughout the basal cisterns. Surgical pathology following elective resection revealed a dermoid cyst.

Results
Noncontrast CT demonstrates a mass lesion with fat attenuation occurring along the expected course of the trigeminal nerve. MR imaging revealed a T1 hyperintense, T2 hyperintense lesion extending from the trigeminal nerve root entry zone anteriorly through the trigeminal (Meckel) cave and into the cavernous sinus, with complete fat suppression of the lesion on postcontrast fat saturated images. Additional T1 hyperintense, T2 hyperintense foci were scattered throughout the basal cisterns. There was no intralesional restricted diffusion.

Conclusions
Dermoid cysts are rare non-neoplastic ectodermal inclusion cysts which must be distinguished from neoplastic fat containing lesions such as teratomas and lipomas. The presence of intrinsically T1 hyperintense foci within the basal cisterns suggests prior dermoid cyst rupture.

Figure Legend. A. Axial noncontrast CT demonstrates a fat-attenuating lesion anterior and medial to the right foramen of ovale. B. Coronal T2-weighted fat-suppressed image demonstrates uniform fat suppression of the mass within the right trigeminal (Meckel) cave. C. Axial T1-weighted noncontrast image demonstrates a T1 hyperintense lesion within the right trigeminal nerve root entry zone with signal intensity similar to the subcutaneous fat. D. Axial T1-weighted noncontrast image demonstrates multiple punctate T1 hyperintense foci within the basal cisterns with signal intensity similar to the subcutaneous fat.
Rare Malignant Transformation of Cerebellopontine Angle Epidermoid to Squamous Cell Carcinoma with Leptomeningeal Spread and Drop Metastases to the Spinal Cord

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¹University of Utah Department of Diagnostic and Interventional Imaging, Salt Lake City, UT, ²University of Utah, Salt Lake City, UT, ³University Of Utah, Salt Lake City, UT

Purpose
We present a case of malignant transformation of a cerebellopontine epidermoid to squamous cell carcinoma with leptomeningeal spread of disease and drop metastases to the spinal cord.

Materials and Methods
A 37-year-old female presented with progressive horizontal diplopia, hearing loss and facial weakness. Physical exam revealed bilateral seventh and eighth nerve palsies and unilateral third and sixth nerve palsies. Contrast-enhanced MRI revealed a left prepontine lesion with nodular enhancement along its anterior margin, and foci of nodular leptomeningeal enhancement involving multiple cranial nerves, as well as the thoracic and lumbar spine. Biopsy of the prepontine lesion revealed epidermoid. Biopsy of nodular enhancement along the fifth cranial nerve revealed squamous cell carcinoma. Immunohistochemical staining was positive for markers suggestive of squamous origin.

Results
MR images revealed a T1 hypointense, T2 hyperintense lesion at the left cerebellopontine angle with restricted diffusion, compatible with epidermoid cyst. At the anterior margin of the epidermoid cyst, a focus of nodular enhancement was identified. Additional foci of nodular enhancement were present within the internal auditory canals and coating multiple cranial nerves, representing leptomeningeal spread of disease. MR imaging of the thoracic and lumbar spine demonstrated nodular leptomeningeal enhancement compatible with drop metastases.

Conclusions
Although exceedingly rare, malignant transformation of an epidermoid cyst should be considered in patients with intracranial squamous carcinoma and no known extracranial primary tumor. Additional considerations in our patient with extensive leptomeningeal disease included lymphoma and sarcoid. Careful attention should be directed toward the development of enhancing components within an epidermoid cyst as this may signify malignant transformation and prompt early biopsy and excision. Figure Legend: (A) Postcontrast MR demonstrates a nonenhancing T1 hypointense, prepontine epidermoid cyst (white arrow) with nodular enhancement at its anterior margin (black arrow) and bilateral IACs (black curved), indicating biopsy proven squamous cell carcinoma. (B) The nonenhancing prepontine epidermoid cyst demonstrates restricted diffusion (black arrow). (C) Nodular leptomeningeal enhancement (white arrow) representing drop metastases is present (C). (D) Immunostaining of leptomeningeal disease shows focal P63 positivity, compatible with squamous origin.
Case Report of a Sellar Spine Mimicking a Pituitary Adenoma

C Geannette1, V Trinh1, B Yoo1, N Salamon1

1David Geffen School of Medicine at UCLA, Los Angeles, CA

Purpose
Sellar spine is a rare entity characterized by a projection of bone from the dorsum sellae extending into the pituitary fossa. The spine can produce a diagnostic dilemma as it can mimic a pituitary adenoma. This case report highlights imaging findings of this entity.

Materials and Methods
A 23-year-old woman with history of pituitary surgery at outside institution in 2009 was referred to our institution for bilateral hemianopsia, oligomenorrhea, and galactorrhea in 2014. MR imaging demonstrated a hypoenhancing pituitary mass suggesting residual/recurrent adenoma. No laboratory endocrine abnormalities were present. She subsequently underwent endoscopic pituitary surgery with plan for tumor resection. However, an exploration of the pituitary gland revealed no tumor, and biopsy yielded normal pituitary tissue. The patient's symptoms persisted. A follow-up MRI was unchanged, again demonstrating a hypoenhancing pituitary mass. A CT of the brain demonstrated a spike of bone projecting anteriorly from the anterior aspect of the dorsum sellae, extending into the pituitary fossa and abutting the optic chiasm, consistent with a sellar spine. This corresponded to the hypoenhancing structure seen on MRI. The sellar spine then was resected, with relief of mass effect on the optic chiasm and complete resolution of patient's symptoms.

Results
Coronal T1-weighted postcontrast sequence demonstrates a hypoenhancing structure within the left side of the sella, with mass effect on the optic chiasm. CT demonstrates a spike of bone projecting left of midline from the anterior aspect of the dorsum sellae with extension into the pituitary fossa. The bone abuts the inferior aspect of the optic chiasm and elevates the pituitary gland. Subsequent MRI and CT demonstrate interval resection of the sellar spine with relief of mass effect on the optic chiasm.

Conclusions
Although rare, neuroradiologists should be aware of the sellar spine as a potential mimic of pituitary region masses.
High-resolution Flat-panel CT in the Post-operative Evaluation of Stapes Implants

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¹Johns Hopkins University, Highland, MD, ²Johns Hopkins Hospital, Baltimore, MD, ³Johns Hopkins University School of Medicine, Baltimore, MD
Purpose
Flat-panel CT (FPCT) has been shown to provide high resolution postoperative information with minimal streak artifact for both stapes (1) and cochlear (2) implants with radiation exposure less than 0.5 mSv (1). This information can be helpful to evaluate postoperative hearing outcomes. We describe the use of FPCT with high-resolution secondary reconstructions in the postoperative evaluation of stapes implants.

Materials and Methods
Case 1: A 26-year-old man with a history of bilateral hearing loss and otosclerosis underwent right-sided stapes surgery at an outside hospital. He experienced minimal improvement in his hearing and was referred for evaluation of his prosthesis. Case 2: A 47-year-old woman with a 7-year history of hearing loss, pain, and tinnitus in the right ear underwent placement of a right stapes prosthesis (Grace Medical Eclipse 4.75 mm x0.5 mm) without complications. She was diagnosed with bilateral otosclerosis. In both cases, a collimated 20-second FPCT of the head was performed using 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 prosthesis and surrounding ossicles, voxel size 0.07 mm - 0.08 mm, 512 x 512 matrix, Hounsfield units (HU) kernel type, and sharp image characteristic.

Results
Secondary reconstructions of FPCT datasets in both patients produced high resolution images (slice thickness 0.1 mm) with no streak artifact. Other associated findings including fenestral otosclerosis (Fig. 1A, arrow) were depicted clearly. The stapes implants (Figs. 1 B-D) were seen in their entirety and their relationship around the incus could be assessed. Both implants were intact without evidence of loosening or uncoupling. The courses of the prostheses were visualized as well as their relationship to the oval window, vestibule and facial nerve.

Conclusions
Flat-panel CT is a promising imaging tool for the evaluation of patients with stapes implants. Secondary reconstructions produce higher resolution images of both the implant and surrounding anatomical structures with no streak artifact and low radiation exposure.
A Unique Case of Conductive Hearing Loss: Intralabyrinthine Cholesteatoma with Middle Ear Invasion

V Ruparelia¹, S Patel¹, B Griffith²
¹Henry Ford Hospital, Detroit, MI, ²Henry Ford Health System, Detroit, MI

Purpose
Cholesteatoma is a benign proliferative lesion arising from stratified squamous epithelial cells, which typically occurs due to a retraction or perforation of the tympanic membrane typically in the middle ear cavity. The purpose of this exhibit is to present a unique case of an intralabyrinthine cholesteatoma with invasion of the middle ear ossicles, describing its unique imaging and clinical features. In addition, the exhibit will discuss various additional etiologies, which may have similar presentation and potential features for differentiating these entities.

Materials and Methods
We present the case of a 39-year-old female with progressive conductive left-sided hearing loss for several months. CT and MRI imaging was performed, demonstrating an intrala byrinthine mass. The patient underwent a radical mastoidectomy with facial nerve monitoring, which demonstrated a cholesteatoma eroding into the anterior limb of the lateral semicircular canal. There was extension in the attic extending deep to the anterio r epitympanum. There also was partial erosion of the stapes, with sparing of the head and posterior crus. Pathology revealed foreign body-type giant cell reaction to keratinaceous debris, consistent with a cholesteatoma. At three-month follow up, the patient had stable conductive hearing loss of the left ear.

Results
Initial temporal bone CT demonstrated a soft tissue lesion replacing the left vestibular bony island with destruction of the lateral semicircular canal and extension into the attic of the middle ear. A subsequent MRI was performed which showed extension along the tympanic and labyrinthine segments of the facial nerve.

Conclusions
Cholesteatomas most commonly present as a soft tissue mass arising from the tympanic membrane epithelium. Rarely, they can arise from the inner ear cavity, which raises clinical concern for a possible congenital etiology. This exhibit will discuss intralabyrinthine cholesteatoma and potential mimicking lesions of the head and neck, including facial nerve venous malformation (previously known as ossifying hemangioma), intralabyrinthine schwannoma, and Langerhans histiocytosis. When possible, potential distinguishing features, both clinical and radiologic, will be emphasized.
Jugular Bulb Dehiscence Leading to Conductive Hearing Loss

R Rios¹, E Gulko¹, J Bello¹, K Shifteh¹
¹Montefiore Medical Center, Bronx, NY

Purpose
Jugular bulb dehiscence (JD) can lead to conductive hearing loss. Loss of conduction may result from the following scenarios: interference with the ossicular chain, specifically the incudostapedial joint or manubrium, contact with the tympanic membrane, or obstruction of the round window niche. Though infrequent, the presence of high jugular bulbs as a cause of conductive hearing loss and pulsatile tinnitus has been reported in the literature (1). Failure to recognize this pathology may have dramatic implications including incidental perforation during myringotomy or middle ear procedures. We report a case of conductive hearing loss attributed to jugular bulb dehiscence resulting in obstruction of the round window niche in a 16-year-old female.

Materials and Methods
A 16-year-old female presented to her otolaryngologist with complaints of otologia and decreased hearing. Her prior medical history consisted of sickle cell disease, developmental delay, tonsillectomy, and placement of bilateral myringotomy tubes. She had multiple episodes of otitis media without mastoiditis. Audiogram results revealed conductive hearing loss. On physical exam, she was noted to have bilateral otorrhea. After suction and clearance, the bilateral myringotomy tubes were patent. The patient was placed on antibiotics. A CT of the temporal...
bones was ordered to evaluate for possible chronic otitis media despite patent appearing myringotomy tubes, and for evaluation of conductive hearing loss.

Results
Images revealed dehiscence of the boney covering separating the right jugular bulb from the middle ear cavity. The jugular bulb bulged into the middle ear cavity obstructing the round window niche which was opacified. There was no contact with the ossicular chain or tympanic membrane, and no soft tissue thickening within the right middle ear cavity.

Conclusions
A high jugular bulb whether dehiscent or not, may result in varying degrees of conductive hearing loss. Mechanisms involve interference with the ossicular chain, tympanic membrane or obstruction of the round window niche. High resolution CT is the modality of choice for evaluating this anomaly. Failure to recognize this pathology may have dramatic implications including incidental perforation during myringotomy or middle ear procedures. While treatment decisions vary among clinicians, management tends to be conservative. Periodic follow up may be recommended with serial imaging (high resolution CT temporal bone) every few years to identify progression. Jugular vein ligation also has been reported to relieve symptoms in certain cases; however this carries the potential neurologic risk of pseudotumor cerebri.
Anaplastic Thyroid Cancer Masquerading as Thyroid Abscesses: Case Report and Imaging Findings

Y Chen¹, P Jabehdar Maralani²
¹University of Toronto, Toronto, Ontario, ²University of Toronto and Sunnybrook Health Sciences Centre, Toronto, ON

Purpose
Anaplastic thyroid cancer (ATC) is a rare aggressive tumor arising from the thyroid follicular epithelium. It accounts for less than one percent of all thyroid cancers but has universally poor
prognosis. Imaging findings of ATC are nonspecific, and include a rapidly enlarging thyroid mass with or without involvement of adjacent soft tissue and lymph nodes. We present an unusual presentation of ATC masquerading as intrathyroid abscesses in an elderly woman.

Materials and Methods
A 64-year-old woman underwent a fine needle aspiration (FNA) of a complex cystic right thyroid nodule. Three days after the nondiagnostic FNA, she developed right anterior neck erythema and swelling, and was treated with clindamycin with initial improvement. However, symptoms recurred 1 month later, with high fevers, worsening right-sided neck swelling, hoarseness and palpable cervical lymphadenopathy. Repeat FNA of the enlarged cystic right thyroid lesion was performed, which showed atypical cells on a background of acute inflammation, but grew no organisms. Leukocytes, free T3 and T4 were elevated. A working diagnosis of acute suppurative thyroiditis with right intrathyroid abscess was made based on clinical and imaging findings, which was treated with vancomycin and incision and drainage. The purulent drainage grew no organisms. Despite ongoing antibiotics treatment, she developed left-sided neck swelling 1 week later. Ultrasound-guided core biopsy of the bilateral intrathyroid "abscesses" and cervical lymph nodes was performed, and revealed ATC. The patient subsequently underwent extensive surgical resection and palliative radiation.

Results
A CT neck scan post-initial FNA showed a partially calcified right thyroid cystic lesion (A), and fat stranding in the right anterior neck corresponding to skin erythema on clinical exam. Repeat CT neck scan following recurrent right neck erythema and swelling showed increased low-density fluid collection in the right thyroid lesion (B). A third CT neck scan 1 week later following the development of left neck swelling revealed interval complete liquefaction of the left thyroid gland (C), and multiple cystic right jugular chain lymph nodes (D).

Conclusions
This unique case describes the diagnostic challenge in differentiating between aggressive thyroid neoplasm and superinfective low-grade thyroid malignancy. The presentation of ATC may mimick acute suppurative thyroiditis, especially when biased with a history of instrumentation. Both entities can present with painful neck swelling, hoarseness, skin erythema, high fevers, as well as laboratory findings of leukocytosis and hyperthyroidism (1, 2). Although the diagnosis of ATC can be accurately made with FNA, a small proportion of samples will show nonspecific inflammation (3), such as the case in our patient. Therefore, when encountered with a rapidly enlarging intrathyroid "abscess" in an elderly female not responding to antibiotics treatment, clinicians and radiologists must consider the differential diagnosis of ATC and pursue further evaluation with large bore or surgical biopsy.
Migration of Ocular Silicone Oil to the Ventricles and Optic Tract: A Case Report

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¹Santa Clara Valley Medical Center, San Jose, CA

Purpose
Intravitreous silicone injection is a procedure typically utilized by ophthalmologists to treat complex or recurrent retinal detachments. The purpose of this case report is to describe the intracranial migration of silicone oil, which is a rare sequela of this ophthalmologic treatment.

Materials and Methods
A 68-year-old male with a history of poorly controlled diabetes presents with altered mental status (AMS) to the ED. Approximately 8 years ago, the patient received left ocular silicone injection as treatment for recurrent retinal detachment. As part of the work-up for AMS, he receives a noncontrast head CT. Findings on the CT result in a follow-up MRI of the brain. Imaging findings are described below.

Results
Figure 1 is an axial noncontrast CT image demonstrating high density silicone material in the left
globe, as well as the left optic nerve (arrow) and optic chiasm. Figure 2 is a sagittal noncontrast CT image showing the same high density silicone in the left optic nerve (arrow), optic chiasm, and left optic tract (arrowhead). Figure 3 is an axial T2-weighted MR image which shows silicone material in the nondependent portion of the frontal horns of the bilateral lateral ventricles. The silicone in the left lateral ventricle exhibits chemical shift artifact. Figure 4 is an axial GRE MR image demonstrating blooming along the left optic tract, consistent with migrated silicone material.

Conclusions
Due to its high surface tension, silicone may be used as treatment for recurrent or complex retinal detachment. In certain patients, this silicone material may undergo intracranial migration and subsequently be seen on cross-sectional imaging in the optic nerve, optic chiasm, optic tract, or lateral ventricles, as described in this case report. It is important to be able to correctly identify imaging findings of silicone migration, as the appearance may resemble intracranial hemorrhage. Though the pathophysiology of the phenomenon is not understood completely, ophthalmology literature posits a "pseudo-Schnabel's cavernous degeneration" of the optic nerve as a likely cause. The cystic spaces in the optic nerve formed as a result of the cavernous degeneration then are occupied by silicone oil, which then may migrate further.
Tuesday
7:30AM - 8:30AM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

07A - SAM SESSION: PEDIATRICS CASE BASED (AR) (SAM)
07A-1

Pediatric Spine
07A-2

**Head and Neck**

Mirsky, D.
Children's Hospital Colorado
Aurora, CO

07A-3

**Pediatric Brain**

Poussaint, T.
Boston Children's Hospital/Harvard Medical School
Boston, MA

**Tuesday**

8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

**08A - ASHNR: CAN YOU HEAR ME? EVALUATING SENSORINEURAL HEARING LOSS**

08A-1

**Central Lesions Causing Hearing Loss**

Hamilton, B.
Oregon Health and Science University
Portland, OR

08A-2

**To Gad?**

Dillon, W.
University of California, San Francisco
San Francisco, CA
08A-3

Or Not to Gad?

Lane, J.
Mayo Clinic
Rochester, MN

08A-4

Surgical Approaches to Vestibular Schwannomas

Parsa, A.
Northwestern University Feinberg School of Medicine
Chicago, IL

08A-5

Patient

Tuesday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)

08B - SYMPOSIUM: EMERGENCY ROOM TRIAGE: TRAUMARAMA AND OTHER URGENCIES: PART I: PEDIATRIC EMERGENCIES: NEED TO KNOWS (AR) (SAM)

08B-1

Imaging of Acute Focal Neurologic Deficit

Vossough, A.
Children's Hospital of Philadelphia and Hospital of the University of Pennsylvania
Philadelphia, PA

08B-2

8:45AM - 9:00AM
Acute Altered Mental Status: Etiologies and Best Practices for Evaluation

Murnick, J.
Children’s National Medical Center
Washington, DC

08B-3
9:00AM - 9:15AM

Traumatic Brain Injury: Spectrum of Relevant and Non-Relevant Imaging Findings

Silvera, V.
Boston Children's Hospital
Boston, MA

08B-4
9:15AM - 9:30AM

The Acute Pediatric Spine

Hayes, L.
Children's Healthcare of Atlanta
Atlanta, GA

08B-5
9:30AM - 10:00AM

Questions and Answers

Tuesday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

08C - YOUNG PROFESSIONALS 4: RESEARCH SYMPOSIUM
08C-1
8:30AM - 8:35AM

Introduction

Foerster, B.
University of Michigan
Ann Arbor, MI
08C-2

Advanced Imaging Methods to Study Cancer & Neurological Diseases

Pomper, M.
Johns Hopkins University
Baltimore, MD

08C-3

Bridging the Gap Between Imaging and Outcomes Through Health Sciences Research

Jarvik, J.
Univ of Washington
Seattle, WA

08C-4

Getting Personal – Better Imaging Care Through Computing - A Chair’s Perspective

Bryan, R.
University of Pennsylvania
Philadelphia, PA

08C-5

How to Get There From Here: A Junior Faculty’s Perspective

Petrou, M.
University of Michigan
Ann Arbor, MI

08C-6

Discussion
Tuesday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)

08D - SYMPOSIUM: CONNECTOME AND GENOMICS: OMICS AND BIG DATA FOR NEURORADIOLOGY: SESSION I: OMICS AND BIG DATA FOR BRAIN DEVELOPMENT AND NEURODEGENERATIVE DISORDERS

08D-1
Quantitative Neuroimaging / QIBA

8:30AM - 8:45AM
Petrella, J.
Duke University Medical Center
Durham, NC

08D-2
Neuroimaging in ADNI

8:45AM - 9:00AM
Van Horn, J.
Kerk School of Medicine of USC
Los Angeles, CA

08D-3
Processing Pipelines

9:00AM - 9:15AM
Maldjian, J.
Wake Forest University School of Medicine
Winston-Salem, NC

08D-4

9:15AM - 9:30AM
Schmitt, J.
University of Pennsylvania
Philadelphia, PA

08D-5
9:30AM - 9:45AM

Alzheimer’s Disease Imaging Biomarkers: From Big Data to the Individual Patient

Kantarci, K.
May Clinic Minnesota
Rochester, MN

08D-6

9:45AM - 10:00AM

Panel Discussion: Should I Report About Hippocampal Volume in my Patients with Alzheimer’s Disease?

Tuesday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

08E - HEALTH POLICY COMMITTEE – PAYMENT/REGULATORY UPDATE (2015–J. ARLISS POLLOCK MEMORIAL LECTURE)
08E-2

8:30AM - 8:55AM


Tu, R.
Progressive Radiology
Washington, DC

08E-3

8:55AM - 9:20AM

Quality Initiatives 2015- These are not your Father’s Quality Initiatives

Nicola, G.
Hackensack Radiology Group
River Edge, NJ

08E-1

9:20AM - 9:30AM

Presentation of the Pollock Award
Barr, R.
Mecklenburg Radiology Associates, P.A.
Charlotte, NC

08E-4
9:30AM - 10:00AM
"2015 J. Arliss Pollock Memorial Lecture": Bundled Payments in Radiology: Stop Debating Whether the Glass is Half Full or Half Empty and Just Pour the Water

Duszak, R.
Emory University School of Medicine
Atlanta, GA

Tuesday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Michigan AB (Level 2)

08F - INTERNATIONAL SESSION- ASNR/SILAN: PERSONALIZED NEURORADIOLOGY ACROSS THE CONTINENTS

08F-1
8:30AM - 8:50AM
The Neuroradiologist: A Key Member of the Neuroscience Team in Patient Care

Gonzalez-Toledo, E.
LSU School of Medicine
Shreveport, LA

08F-2
8:50AM - 9:10AM
Neuroimaging in Trauma: Special Considerations in Geriatric Patients

Nunez, D.
Yale-New Haven Hospital, Saint Raphel Campus
New Haven, CT

08F-3
9:10AM - 9:30AM
Neuro-interventional Radiology in Latin America, How to Establish a State-of- the-Art Service in a Developing Country
Low, not high, permeability predicts hemorrhagic transformation after reperfusion therapy

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Purpose
To determine whether Ktrans maps calculated from first pass PCT data can predict the hemorrhagic transformation (HT) in acute ischemic stroke after thrombolysis.

Materials and Methods
Consecutive patients with acute occlusion of the M1 segment of middle cerebral artery (MCA) or internal carotid (ICA), or M1 plus ICA, who received endovascular treatment were enrolled. Ktrans values of HT regions and nonhemorrhage (non-HT) regions were measured by two neurologists for three times. For all 41 patients, their mean Ktrans values of HT regions and non-HT regions were compared using Wilcoxon Rank Sum Test. And a receiver operating characteristic (ROC) curve for Ktrans value was calculated for predicting the HT risk. Mean Ktrans values among these four groups, HI, PH, non-HT, and normal regions, were compared using Kruskal-Wallis Rank Sum Test. Spatial correlation between permeability changing and the possibility of HT also was assessed.

Results
Forty-one patients were included. HI was found in 26 patients (63.4%) and PH in 15 patients (36.6%). And the mean permeability value of HT region of all 41 patients was 0.26±0.21/min, which was significantly lower than non-HT regions (0.78±0.64/min) (P<0.001). Lower value of
ischemic region than Ktrans threshold 0.334/min would more likely have the occurrence of HT. The sensitivity was 0.951 and the specificity was 0.732.

Conclusions
Ktrans maps deduced from standard first-pass perfusion CT could assess the risk of HT for acute proximal arterial occlusion after intra-arterial (IA) reperfusion. Those ischemic regions with lower permeability value are more likely involved in HT.
Isolated hyperdense basal ganglia on post-procedure CT scan following mechanical thrombectomy as a prognostic factor for symptomatic intracranial hemorrhage

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Purpose
CT scans following mechanical thrombectomy of an acute ICA/MCA occlusion frequently demonstrate hyperdense lesions in the basal ganglia (BG). Usually they are followed up closely as they may represent an early hemorrhagic transformation. We aimed to evaluate the likelihood of these isolated hyperdense BG lesions predisposing to symptomatic intracranial hemorrhage (ICH).

Materials and Methods
We retrospectively evaluated the CT and MR scans on all the patients with acute ICA/MCA occlusion who underwent mechanical thrombectomy between Aug 2010 and Nov 2014. All of the patients who had new hyperdense lesions in the BG on immediate postprocedure CT scans were included in this analysis. The immediate postprocedure CT should have been done in the first 24 hours with a second follow-up CT in the next 3-5 days to assess for any change in the BG lesions.

Results
Eighty-three patients underwent mechanical thrombectomy for an acute ICA/MCA occlusion between Aug 2010 and Nov 2014. Forty-four patients (52%) were found to have new hyperdense lesions in the BG on immediate postprocedure CT scans. Only 13 patients had isolated hyperdense lesions in the BG with no other changes in the rest of the brain. All of these patients demonstrated resolution or decrease in the BG density on the follow-up CT with 0% having a symptomatic ICH. Thirty-one BG. Fourteen patients had a significant increase in the hyperdense lesions on follow-up CT, with seven of those developing massive ICH. Sixteen patients had demonstrated resolution or decrease in the density of these hyperdense areas on the follow-up CT.

Conclusions
Our data show that isolated hyperdense lesions in the BG seen on immediate postprocedure CT scans following mechanical thrombectomy of an acute ICA/MCA occlusion are benign findings and are not precursor for significant hemorrhagic transformation.
Purpose
Hemorrhagic transformation (HT) is a potential devastating complication of thrombolysis in patients with acute ischemic stroke (AIS). The purpose of this study was to evaluate the predictive role of MR perfusion biomarkers including increased microvascular permeability and decreased cerebral blood volume (CBV) in the infarction core to predict the risk of HT in a cohort of patients with AIS who received thrombolysis.

Materials and Methods
In this retrospective study, patients were included if they: had AIS, received thrombolysis, had pretreatment MRI including dynamic susceptibility contrast (DSC) perfusion and had follow-up MRI for evaluation of HT within 7 days. MR perfusion data were processed employing a Bayesian probabilistic method\(^1\) to generate CBV and permeability coefficient (K2)\(^2\) maps. Using coregistered images, voxel-based K2 and rCBV values were obtained in the region of infarction (defined by ADC < 600 \(10^{-6}\) mm \(^2\)/s)\(^3\) and compared in patients with and without HT. Receiver operating characteristic (ROC) analysis was performed to determine the optimal parameter/s and threshold for predicting HT.

Results
Forty-eight patients met study criteria: mean (SD) age was 67.5 ± 15, median baseline NIHSS was nine (IQR: 5-24) and mean infarct volume of 34 ± 18 ml (range 11-78 ml). Thirty percent of patients (14/48) had HT. The mean K2 value was significantly (p< .0001) higher in patients with HT (0.24 ± 0.17) versus patients without HT (0.08 ± 0.03). Mean rCBV was significantly (p=0.0001) lower in patients with HT (0.21 ± 0.02) compared to patients without HT (1.28 ± 0.66). Receiver operating characteristic analysis showed a threshold and corresponding sensitivity/specificity of 0.104, 94%/84% for K2 and 0.38, 94/97% for rCBV. The combination of K2 and rCBV resulted in a higher discriminative power with an AUC of 0.97, sensitivity of 94% and specificity of 100%. In a multivariable logistic regression model that included NIHSS and infarct volume, the combined K2-rCBV classifier was an independent predictor of HT.

Conclusions
Combined increased permeability and decreased CBV derived from MR perfusion have improved sensitivity and specificity, compared to either measure alone, for prediction of HT following thrombolysis. A larger clinical study is required to validate our results in an independent cohort.

O-135
Variable Patterns of Intracranial Hemorrhage after Intra-Arterial Infusion of Different-Osmolar Iodinated Contrast Media in a MCA Occlusion / Reperfusion Model: MRI and Pathologic Correlation

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Purpose
Decreased area of cortical intracranial hemorrhage (ICH) occurs following MCA occlusion and intra-arterial (IA) iso-osmolar iohexol infusion compared to low-osmolar iopamidol. We
postulate that the characteristics of hemorrhagic transformation (HT) and MR signal changes may differ after IA injection of different osmolar iodinated contrast media (ICM) as well.

Materials and Methods
Infarct was induced in 30 rats by a validated method of MCA suture occlusion. Reperfusion was performed after 5 hours with either iodixanol (n=9), iopamidol (n=12) or saline (n=9). MR images were obtained immediately after reperfusion and at 24 hours. Rats were sacrificed at 24 hours. Iodinated contrast media type on cut brain slices were recorded. MR imaging signal changes consistent with ICH (hypo intense areas within the infarction on T2-WI or GRE at 6 hours and 24 hours) were recorded by two blinded neuroradiologists, and compared to ICH on cut brain slices. Statistical analysis was performed with SPSS software. Chi-square, or Exact's tests were used as appropriate.

Results
Two types of ICH were noted on brain slices post-mortem: a customary confluent > 0.2 mm petechial hemorrhagic (PeH) area (76%) or well defined <= 0.2 mm hemorrhagic focus (HF) (24%). No parenchymal hematoma was noted. Hemorrhagic focus was more common in the ICM group and PeH was least common in the iodixanol group (Table, p<0.02). Readers exhibited good agreement identifying and classifying MR findings (k=0.69). Positive GRE-24h with negative MRI findings at 6 hours was the most common finding in the saline group (44%); less common in the iodixanol (21%) and iopamidol subgroups (28%), correlating with ICH in 75% of saline group. Positive T2 and negative GRE at 6 hours was the most common finding in the ICM subgroups, iodixanol (47%) and iopamidol (33%), as compared with saline (7%). Its presence in the iodixanol and iopamidol subgroups correlated with ICH in 44% and 66% of cases, respectively. There were variable values of sensitivity (range of 28-61%, highest for T2-6h in the saline group) and specificity (range of 37-100%, highest for GRE-6h in the iodixanol group) for the detection of hemorrhage in the different groups/sequences.

Conclusions
Variability exists in ICH type and MR signal changes in the iodixanol, iopamidol and saline groups. Hemorrhagic focus was significantly more common after ICM infusion, perhaps a deleterious effect; while PeH was least common after iodixanol infusion, suggesting a protective effect as compared with iopamidol or saline. Areas of T2-WI hypo-intensity with no GRE hypo-intensity at 6 hours, more commonly seen in the ICM groups, likely reflect ICM deposition. These area were related more frequently to later ICH in the iopamidol group. Hypo intensities on GRE at 24 hours with no definite earlier abnormalities, more commonly seen in the saline group, are consistent with late ICH unrelated to ICM deposition. The above-described variability may reflect a direct or indirect pathophysiologic effect of ICM deposition on the BBB and parenchyma, and serve not only as a baseline for future laboratory and clinical research in reperfusion therapy, but also in interpretation of MR findings in stroke patients.
TABLE. Incidence and Type of Intracranial Hemorrhage in a MCA occlusion/reperfusion model *

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Hemorrhagic Lesions</th>
<th>Petechial area &gt; 0.2 mm (n, %)</th>
<th>Focus &lt;= 0.2 mm (n, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saline</td>
<td>28</td>
<td>26 (92.9)</td>
<td>2 (7.1)</td>
</tr>
<tr>
<td>Iopamidol</td>
<td>42</td>
<td>31 (74)</td>
<td>11 (26)</td>
</tr>
<tr>
<td>Iodixanol</td>
<td>20</td>
<td>11 (55)</td>
<td>9 (45)</td>
</tr>
</tbody>
</table>

* All animals demonstrated petechial hemorrhagic areas; in some cases there were also associated tiny foci (¥), which were usually seen in the cortex and in the iodinated contrast subgroups.

O-136

11:02AM - 11:10AM

**Perfusion CT-derived Blood-Brain Barrier Permeability Strongly Predicts Low Risk of Hemorrhagic Transformation after Intravenous Thrombolysis in Acute Stroke**

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**Purpose**

Hemorrhagic transformation (HT) is one of the most frightening complications of acute stroke. Blood-brain barrier (BBB) permeability has been proposed as an imaging predictor of HT after tissue plasminogen activator (tPA) administration; however, perfusion computed tomography (PCT) permeability imaging has not been established yet as a part of the standard of care, in part due to concerns regarding its sensitivity and specificity. We aimed to determine the predictive power of different thresholds of permeability surface derived from PCT acquired at admission in predicting HT after tPA to treat acute stroke.

**Materials and Methods**

We retrospectively studied consecutive patients with acute middle cerebral artery stroke treated...
with tPA. We used delayed-acquisition to calculate admission PCT-derived BBB permeability surface. Nine volume thresholds were applied (from 3 to 7 mL/100g/min, every 0.5 units). Hemorrhagic transformation was graded according to the European-Australasian Acute Stroke Study II criteria. Receiver operating characteristic (ROC) curves selected optimal volume threshold, and multivariate logistic regression analysis identified independent predictors of HT.

Results
Of 68 patients, 18 (26.4%) developed HT (4 PH1 and 9 PH2). None of the permeability surface volume thresholds was better than the others at predicting HT. Permeability surface > 618.958 mm2 at 3-mL threshold yielded sensitivity, specificity, and positive and negative predictive values 44.4%, 90.4%, 72.7% and 82.5%, respectively, for HT (AUC 0.686, CI 0.526-0.845) and 55.6%, 89.9%, 45.5% and 93%, respectively, for PH2 (AUC 0.718, CI 0.503-0.932). The volume threshold of 3-mL was the only independent predictor of PH2 (OR 1.30; AUC 0.72, CI 1.04-1.63, P=0.016).

Conclusions
Lower PCT-derived BBB permeability surface predicts lower risk of HT after thrombolysis in acute stroke patients. This approach could help identify patients with less important BBB abnormalities who might safely undergo tPA beyond the current 4.5-hour window.

Figure. Boxplots of PS in ischemic regions according HT. In each box, median, 95% CI, and fir are illustrated.

(Filename: TCT_O-136_Figure.jpg)

O-137

Distance to thrombus on magnetic resonance angiography predicts outcome after middle cerebral artery occlusion treated by IV thrombolysis

M Gawlitza¹, B Friedrich¹, U Quäschling¹, D Fritzsch¹, C Hobohm¹, S Schob¹, K Hoffmann¹, D Lobsien¹
Purpose
Our group recently proposed that the distance-to-thrombus (DT) on CT angiography might be a predictor of outcome in patients treated by intravenous thrombolysis (IVT) for stroke due to acute occlusion of the middle cerebral artery (MCA) (Friedrich B, Gawlitza M, Schob S, Hobohm C, Raviolo M, Hoffmann K-T, Lobsien D; unpublished data, 2014). The purpose of the present study was to validate its use and prognostic value on contrast-enhanced magnetic resonance angiography (CE MRA).

Materials and Methods
Patients with acute MCA occlusions treated by IVT with recombinant tissue plasminogen activator and diagnosed with magnetic resonance imaging (MRI) were included. Distance-to-thrombus was defined as the distance from the carotid T to the thrombus in the MCA [see Figure 1 - an example of a rather short (A – 11 mm) and a long DT (B - 42 mm, measured on 15 mm thick slab MIP reconstructions]. Infarct volumes were calculated semiautomatically. Clinical status was determined using the initial NIH stroke scale (NIHSS) and 90-day modified Rankin Scale (90d mRS).

Results
Of 605 patients with acute stroke, 61 showed a lesion on a diffusion-weighted magnetic resonance image and an occlusion of the MCA on CE MRA. The mean DT was 17.3 ± 9.9 mm (median 14.0 mm, range 3–52 mm). We found a significant inverse correlation between DT and NIHSS scores at admission ($\rho = -0.29; P=0.02$) and between DT and mRS at 90 days ($\rho = -0.29; P=0.04$). No significant correlations between DT and patient age, diffusion-weighted imaging (DWI) lesion volumes or time from symptom onset to IVT were evident. The DT was significantly larger in patients with a favorable compared with those with an unfavorable outcome (19.8 ± 10.3 mm versus 15.5 ± 9.3 mm; $P=0.03$). Aside from DT, only patient age and NIHSS score at admission showed significant differences between patients with favorable and unfavorable outcomes. Receiver operating characteristic (ROC) analysis of DT for the prediction of favorable patient outcome revealed an area under the curve (AUC) of 0.67 ($P=0.03$) in comparison to an AUC of 0.54 ($P=0.63$) for baseline DWI lesion volume. For a DT <22 mm the likelihood of an unfavorable outcome (90d mRS 3-6 or NIHSS score improvement of $\leq$10 points at discharge) was >50% (see Figure 2 - logarithmic regression graph).

Conclusions
Distance-to-thrombus measured on CE-MRA proved to be a predictor of clinical outcome in patients with acute occlusion of the MCA treated by IVT. These results have to be confirmed in larger patient groups. The easy to apply measurement of DT on MRA can be used for exact localization of the MCA occlusion site. If it may assist in the decision-making process for individual patients should be investigated. Presumably it may be helpful in patients with proximal occlusions in whom a benefit from IVT is unlikely, but in whom mechanical thrombectomy offers good recanalization rates.
Distance to thrombus in acute MCA occlusion: a predictor of outcome after intravenous thrombolysis for acute ischemic stroke

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Purpose
In patients with acute middle cerebral artery (MCA) stroke, therapeutic decisions are influenced
by the location of the occlusion. This study aimed to analyze clinical outcomes in patients with acute ischemic MCA stroke treated with systemic intravenous thrombolysis using recombinant tissue plasminogen activator (IVT), according to the location of the occlusion.

Materials and Methods
Of 621 patients screened, 136 with acute stroke and MCA occlusion confirmed by CT angiography were included retrospectively in this study. The distance from the carotid T to the thrombus (DT) on coronal maximum intensity projection images and the thrombus length were measured. The correlation between DT and the modified Rankin Scale (mRS) score at 90 days (90d-mRS) was analyzed.

Results
The distance from the carotid T to the thrombus was an independent predictor of clinical outcome in stroke patients treated with IVT. A long DT was correlated significantly with a good clinical outcome (90d-mRS ≤2). A poor clinical outcome was exponentially more likely than a good outcome when the DT was <16 mm (p<0.001). The thrombus length was not correlated with 90d-mRS. A long thrombus (>8 mm) occurred significantly more often in the proximal MCA than the distal MCA (p<0.001).

Conclusions
The distance from the carotid T to the thrombus is an independent predictor of clinical outcome in patients with acute MCA occlusion treated with IVT. In acute stroke with MCA occlusion confirmed by CT angiography and DT <16 mm, the likelihood of a good clinical outcome after treatment with IVT was exponentially <50%. It should be considered carefully whether IVT is the ideal therapy in these patients.
Hyperdense basal ganglia on post-procedure CT scans and correlation with susceptibility weighted MRI
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Purpose
Immediate postprocedure CT scans on patients after mechanical thrombectomy of an acute ICA/MCA occlusion, frequently demonstrate hyperdense lesions in the basal ganglia (BG). The question of whether this represents contrast enhancement versus an early hemorrhagic transformation is an important one, as this will impact early antiplatelet/anticoagulation plans. We aimed to evaluate the true nature of these hyperdense BG lesions utilizing susceptibility-weighted imaging (SWI).

Materials and Methods
We retrospectively evaluated postprocedure CT and MR scans on all patients with acute ICA/MCA occlusion who underwent mechanical thrombectomy between Aug 2010 and Nov 2014. All of the patients who had new hyperdense lesions in the BG on postprocedure CT scans and underwent MRI scans with SWI were included in this analysis. The postprocedure CT and MRI should have been done in the first 48 hours after mechanical thrombectomy. To evaluate whether iodinated contrast media could be accounting for the decreased signal on the SWI images, we scanned the contrast media (CM) ex vivo in vials, utilizing SWI.

Results
Eighty-three patients underwent mechanical thrombectomy for an acute ICA/MCA occlusion between Aug 2010 and Nov 2014. Forty-four patients (52%) were found to have new hyperdense lesions in the BG on their initial postprocedure CT scan. Only 29 patients underwent MRI brain imaging with SWI. All the 29 patients demonstrated susceptibility artifact in the corresponding location of the hyperdense lesions in the BG on the follow-up CT. The ex vivo SWI images of the CM did not demonstrate any susceptibility artifact.

Conclusions
Our data show that hyperdense lesions in the BG postmechanical thrombectomy of an acute ICA/MCA occlusion seen on the postprocedure CT scan are not simply contrast staining from entrapment in the infarcted areas. While this may represent a component of the imaging findings, there also are associated microhemorrhages or micro-emboli. This may have an impact on postprocedure medical therapy.

O-140

Comparison of oSVD-based Deconvolution Time to Maximum Residue Function (Tmax) and Bayesian-based Deconvolution Arterial Tissue Delay (ATD) for Determination of Ischemic Penumbra in Asymptomatic Patients With Cerebrovascular Occlusion.

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Purpose
The identification and quantification of oligemic cerebral parenchyma at risk for infarction (penumbra) is a clinical challenge. Single Value Decomposition (SVD)-determined time-to-maximum residue function (Tmax) has been proposed as an imaging marker of penumbra, but is
strongly influenced by other parameters including image noise, abnormalities of mean transit time (MTT), delay and dispersion. The Bayesian model to determine time-to-maximum residue function, arterial tissue delay (ATD) is theoretically superior by allowing for a more accurate determination. We tested this hypothesis by comparing both methods with clinical cases specifically chosen to address the issue.

Materials and Methods
Five patients with imaging proven ICA and/or MCA occlusion or near occlusion were identified retrospectively. All patients were asymptomatic without diffusion-weighted imaging (DWI) evidence for infarction; consequently no penumbra was expected. All patients underwent CT (n=4) or MR (n=1) cerebral perfusion. Source images were postprocessed on a single software platform (Sphere 2.3, Olea Medical) using delay-insensitive oscillation index SVD (oSVD) and Bayesian deconvolution to generate both Tmax and ATD maps. Penumbra was determined using literature derived best values of Tmax>6 seconds and the Bayesian equivalent ATD>6 seconds. Areas beyond the hemisphere of interest and the ventricles were removed to avoid erroneous results. Volumes of penumbra were compared as percentage of the ipsilateral hemisphere. Mean±SD values are reported.

Results
oSVD-Tmax generates an erroneous penumbra of 10.607 ± 7.99% (47.483 ± 36.443 cc) whereas Bayesian-ATD generates 0.356 ± 0.68% (1.354 ± 2.454 cc). Based on a paired Student's T-test, this difference is statistically significant (p=0.039) (Figure 1).

Conclusions
Literature review indicates this is the first clinical demonstration that Bayesian ATD mitigates the erroneous results provided by oSVD Tmax for the determination of ischemic penumbra. It merits further consideration as a more accurate index of ischemia for diagnostic and treatment decisions in patients with acute ischemic stroke.
Student t-test: p<0.05

The Natural History of Penumbra Over Time: An Exploratory Analysis of the EPITHET Trial
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Purpose
The natural fate of ischemic penumbra is understudied. Our objective is to determine how time from stroke onset to imaging affects penumbral salvage in untreated stroke patients. We hypothesize that, as time from stroke onset to imaging increases, baseline penumbra will be less likely to become infarction due to collateral sustenance.

Materials and Methods
We analyzed the placebo arm of EPITHET trial acquired from the Stroke Imaging Repository Consortium. Baseline MRI (3-6 hour after stroke onset) was assessed for ischemic core (diffusion lesion volume) and penumbra volume [Tmax >6 second on perfusion-weighted imaging (PWI)]. Final infarct volume was measured on Day 5 FLAIR imaging. Penumbra salvage was defined as Penumbra \( \text{-} \) (Final Infarct Volume \( \text{-} \) Ischemic Core). Associations were assessed between penumbral salvage and time from onset to imaging, penumbra volumes, and good outcome (90-day mRS \( \leq 2 \)). We secondarily explored the presence of a mismatch pattern (PWI/DWI>1.8) instead of penumbra volume, collateral grade (baseline MRA), and delayed recanalization status (Day 5 MRA).

Results
Among 48 placebo subjects, three had nondiagnostic perfusion studies. Among 45 remaining subjects, mean age was 71 years, median NIHSS was 10, and median (range) time from stroke onset to baseline imaging was 249 (135-343) minutes. The median (range) of ischemic core was 20.6 (0.01-196.7), penumbra 68.3 (0-345.6), final infarct 61.5(0.8-155.9), and salvaged penumbra was 33.3 (0-155.9) ml. Mismatch was observed in 26 subjects. No significant correlation between salvaged penumbra and time from onset to imaging was observed (r=-0.16; p=0.30). Good (versus poor) outcome was associated with smaller baseline penumbral volume (39 versus 116 ml; p=0.01), but not with salvaged penumbra (30 versus 36 ml; p=0.44). Better collaterals were not associated with larger salvaged penumbra (r=-0.13; p=0.40). Subjects with mismatch (versus no mismatch) had more penumbral salvage (median 45 versus 17 ml, p=0.02), better collaterals (median 3 versus 1; p=0.01), and comparable good outcome (46% versus 32%; p=0.32). Regression models for penumbral salvage and outcomes were limited by small sample sizes, but an interaction between recanalization status and salvaged penumbra in predicting good outcome was not seen.

Conclusions
In this small cohort of untreated patients, we did not demonstrate a correlation between time to imaging and penumbral salvage within the 3-6 hour window. Further study of the natural history of penumbra is needed.

O-142
11:50AM - 11:58AM

Treatment for symptomatic intracranial arterial stenosis by using self-expanding Enterprise stent system: a single center experience of 29 cases with clinical and angiographic outcome
Purpose
Using self-expanding stent as endovascular treatment for symptomatic high degree intracranial arterial stenosis remains investigational. In this study, we retrospectively reported and analyzed the clinical and angiographic outcome of 29 cases with endovascular procedures by using a lower radial force and self-expanding Enterprise stent in one institution.

Materials and Methods
Twenty-nine symptomatic patients (23 male and 6 female) with total 35 intracranial arterial stenotic lesions over than 70% luminal narrowing refractory to dual anti-platelet medication underwent angioplasty and Enterprise stenting between January 2013 and August 2014. Lesion locations included internal carotid artery, middle cerebral artery, vertebral artery and basilar artery. Follow-up angiographic examination was performed by dual-energy computed tomographic angiography. The data were reviewed retrospectively including age, gender, characteristic of stenotic lesion, in-stent restenosis rate, procedural-related complication, and initial and 3-month follow-up modified Rankin Score.

Results
Stent deployments were achieved in all patients with 100% technical success rate. Median prestent and poststent stenosis degree was 81 ± 11.3% and 18 ± 6.8%. Periprocedural complications included severe intracranial hemorrhage (n=1), complete in-stent thrombosis (n=1) and ischemic stroke (n=3). The 3-month follow up showed 19 of 29 patients (65.6%) had a good clinical outcome (modified Rankin Score 0 to 2). Computed tomographic angiography studies were available for 16 of 29 patients with total 18 lesions at 6 to 18 months after stenting (mean 11.4 months). In-stent restenosis over more than 50% narrowing were observed in 2 of 18 follow-up lesions (11.1%) with asymptomatic status.

Conclusions
Enterprise stenting for patient with high-degree symptomatic intracranial arterial stenosis showed favorable neurologic outcome after 3 months procedure and relatively low in-stent restenosis rate in comparison to previous similar studies. This low radial force self-expanding stent may be considered as an alternative strategy for high degree stenosis in symptomatic patient.
<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Modified Rankin Scale Pre-</th>
<th>Age / Gender</th>
<th>Location</th>
<th>Pre-stent stenosis degree</th>
<th>Post-stent stenosis degree</th>
<th>Enterprise stent size</th>
<th>Periprocedural Complication</th>
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<tr>
<td></td>
<td>stent 30 days</td>
<td></td>
<td></td>
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<td>1</td>
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<td>55/M</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RMCA</td>
<td>70%</td>
<td>15%</td>
<td>4.5 x 22 mm</td>
<td>None</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>76/M</td>
<td>RICA</td>
<td>80%</td>
<td>35%</td>
<td>4.5 x 22 mm</td>
<td>None</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>66/F</td>
<td>LMCA</td>
<td>70%</td>
<td>10%</td>
<td>4.5 x 22 mm</td>
<td>None</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>66/M</td>
<td>LMCA</td>
<td>70%</td>
<td>20%</td>
<td>4.5 x 22 mm</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RVA</td>
<td>99%</td>
<td>10%</td>
<td>4.5 x 28 mm</td>
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</tr>
<tr>
<td>12</td>
<td>2</td>
<td>75/F</td>
<td>LICA</td>
<td>70%</td>
<td>20%</td>
<td>4.5 x 22 mm</td>
<td>None</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>73/F</td>
<td>LVA</td>
<td>99%</td>
<td>30%</td>
<td>4.5 x 22 mm</td>
<td>Ischemic stroke (1 day)</td>
</tr>
<tr>
<td>14</td>
<td>5</td>
<td>83/M</td>
<td>BA</td>
<td>80%</td>
<td>25%</td>
<td>4.5 x 22 mm</td>
<td>None</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>49/M</td>
<td>RVA</td>
<td>99%</td>
<td>20%</td>
<td>4.5 x 37 mm</td>
<td>None</td>
</tr>
<tr>
<td>16</td>
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<td>55/F</td>
<td>RMCA</td>
<td>99%</td>
<td>20%</td>
<td>4.5 x 22 mm</td>
<td>Stent rethrombosis (2 day)</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>72/M</td>
<td>LVA</td>
<td>99%</td>
<td>30%</td>
<td>4.5 x 22 mm</td>
<td>Ischemic stroke (1 day)</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>86/M</td>
<td>BA</td>
<td>70%</td>
<td>15%</td>
<td>4.5 x 22 mm</td>
<td>None</td>
</tr>
<tr>
<td>19</td>
<td>3</td>
<td>56/F</td>
<td>LMCA</td>
<td>80%</td>
<td>20%</td>
<td>4.5 x 22 mm</td>
<td>None</td>
</tr>
<tr>
<td>20</td>
<td>3</td>
<td>90/M</td>
<td>BA</td>
<td>70%</td>
<td>20%</td>
<td>4.5 x 22 mm</td>
<td>None</td>
</tr>
<tr>
<td>21</td>
<td>5</td>
<td>50/F</td>
<td>RMCA</td>
<td>70%</td>
<td>10%</td>
<td>4.5 x 22 mm</td>
<td>Ischemic stroke (3 day)</td>
</tr>
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(Filename: TCT_O-142_Table11.jpg)
<p>| | | | | | | |</p>
<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>0</td>
<td>0</td>
<td>56/M</td>
<td>RMCA</td>
<td>99%</td>
<td>20%</td>
</tr>
<tr>
<td>24</td>
<td>0</td>
<td>0</td>
<td>60/M</td>
<td>RICA</td>
<td>80%</td>
<td>25%</td>
</tr>
<tr>
<td>25</td>
<td>2</td>
<td>0</td>
<td>65/M</td>
<td>RICA</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>26</td>
<td>1</td>
<td>1</td>
<td>56/M</td>
<td>RICA</td>
<td>70%</td>
<td>10%</td>
</tr>
<tr>
<td>27</td>
<td>4</td>
<td>6</td>
<td>43/M</td>
<td>RMCA</td>
<td>99%</td>
<td>10%</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
<td>0</td>
<td>65/M</td>
<td>RVA</td>
<td>70%</td>
<td>20%</td>
</tr>
<tr>
<td>29</td>
<td>3</td>
<td>3</td>
<td>58/M</td>
<td>RVA</td>
<td>80%</td>
<td>25%</td>
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</tbody>
</table>

(Filename: TCT_O-142_Table12.jpg)
Table 2: Measures of the patient's characteristic, clinical and angiographic outcome

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patient</td>
<td>29</td>
</tr>
<tr>
<td>Age average (range)</td>
<td>64 (43-90)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>23 (79.3%)</td>
</tr>
<tr>
<td>Female</td>
<td>6 (20.7%)</td>
</tr>
<tr>
<td>Total treated vessels</td>
<td>35</td>
</tr>
<tr>
<td>ICA</td>
<td>6 (17.1%)</td>
</tr>
<tr>
<td>MCA</td>
<td>15 (42.8%)</td>
</tr>
<tr>
<td>BA</td>
<td>4 (11.4%)</td>
</tr>
<tr>
<td>VA</td>
<td>10 (28.5%)</td>
</tr>
<tr>
<td>Stent size</td>
<td></td>
</tr>
<tr>
<td>Diameter (mm)</td>
<td>4.5 (mm)</td>
</tr>
<tr>
<td>Length (mm)</td>
<td>23 ± 4.4 (mm)</td>
</tr>
<tr>
<td>Lesion characteristic</td>
<td></td>
</tr>
<tr>
<td>Mean pre-treatment stenosis degree</td>
<td>81 ± 11.3 %</td>
</tr>
<tr>
<td>Mean post-treatment stenosis degree</td>
<td>18 ± 0.8 %</td>
</tr>
<tr>
<td>Complication</td>
<td></td>
</tr>
<tr>
<td>Infarction or TIA</td>
<td>3 (10.3%)</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>1 (3.4%)</td>
</tr>
<tr>
<td>Stent rethrombosis</td>
<td>1 (3.4%)</td>
</tr>
<tr>
<td>Modified Rankin Score at 3 months post-stenting</td>
<td></td>
</tr>
<tr>
<td>Good (0-2)</td>
<td>19 (65.6%)</td>
</tr>
<tr>
<td>Moderate (3)</td>
<td>3 (10.3%)</td>
</tr>
<tr>
<td>Poor (4-6)</td>
<td>6 (20.6%)</td>
</tr>
<tr>
<td>Available vessels with CTA follow-up</td>
<td>18</td>
</tr>
<tr>
<td>In-stent restenosis</td>
<td>2 (11.1%)</td>
</tr>
<tr>
<td>Average F/U period (month)</td>
<td>11.4 (6-18)</td>
</tr>
</tbody>
</table>
Tuesday 
10:30AM - 12:00PM 
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)

09B - SYMPOSIUM: EMERGENCY ROOM TRIAGE: TRAUMARAMA AND OTHER URGENCIES: PART II: PAIN IN THE NECK: MODERN IMAGING OF HEAD AND NECK EMERGENCIES (AR) (SAM)

09B-1 
Facial Trauma: Pointers and Pitfalls

Mohan, S. 
University of Pennsylvania
Philadelphia, PA

09B-2 
Temporal Bone Trauma

Gentry, L. 
University of Wisconsin Hospital
Madison, WI

09B-3 
Evaluating and Treating Vascular Emergencies of the Neck and Skull Base: Endovascular Management of Cervicocerebral Vascular Trauma

Hetts, S. 
University of California, San Francisco
San Francisco, CA

09B-4 
Infections in the Head and Neck

Kelly, H. 
Massachusetts General Hospital
Boston, MA
Intravoxel incoherent motion MR imaging in the head and neck: correlation with conventional diffusion-weighted imaging and dynamic contrast-enhanced MR imaging

X Xu¹, Y Choi², J Lee³
¹The First Affiliated Hospital of Nanjing Medical University, Nanjing, Jiangsu, ²Ulsan College of Medicine, Asan Medical Center, Seoul, Korea, Seoul, Seoul, ³University of Ulsan College of Medicine, Asan Medical Center, Seoul, Seoul

Purpose
To investigate the correlation between diffusion- and perfusion-related parameters from intravoxel incoherent motion (IVIM) and those from conventional diffusion-weighted imaging (DWI) and dynamic contrast-enhanced MR imaging (DCE MRI) in head and neck tumors.

Materials and Methods
We enrolled 22 patients with head and neck tumors from June 2014 to November 2014 with MR imaging performed using a 3-T MR scanner. Tissue diffusivity (D), pseudo-diffusion coefficient (D*) and perfusion fraction (f) were derived from bi-exponential fitting of IVIM data obtained with 14 different b-values in three orthogonal directions. We investigated the correlation between D, f and D* and apparent diffusion coefficient (ADC) value and model-free perfusion parameters obtained from DCE MRI (wash-in, Tmax, Emax, initial AUC60, and whole AUC) in the tumor and normal masticator muscle using whole volume-of-interest approach. Pearson's correlation test was used for statistical analysis.

Results
Apparent diffusion coefficient was correlated significantly D in tumors and normal musculature despite its significantly higher value than D (P < 0.05). The difference between ADC and D showed good correlation with f in tumors and musculature (Table 1), but no correlation with D*. No correlation was found between f or D* and all perfusion parameters from DCE MRI in all patients (Table 2) or in eight patients with head and neck squamous cell carcinoma.

Conclusions
Intravoxel incoherent motion was feasible for the analysis of diffusivity in both tumors and
normal musculature, but showed no significant correlation with model-free perfusion parameters derived from DCE MRI.
Table 1 Correlation of the difference between ADC and D with the perfusion parameters from IVIM

<table>
<thead>
<tr>
<th></th>
<th>Tumor</th>
<th></th>
<th>Muscle</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>P</td>
<td>r</td>
<td>P</td>
</tr>
<tr>
<td>f</td>
<td>0.604</td>
<td>0.003</td>
<td>0.634</td>
<td>0.002</td>
</tr>
<tr>
<td>D*</td>
<td>-0.208</td>
<td>0.353</td>
<td>-0.148</td>
<td>0.511</td>
</tr>
</tbody>
</table>

Note: ADC, apparent diffusion coefficient; f, perfusion fraction; D*, pseudo-diffusion coefficient

Table 2 Correlation between perfusion parameters from IVIM and from DCE-MRI in tumors and normal musculature

<table>
<thead>
<tr>
<th></th>
<th>Tumor</th>
<th></th>
<th>Muscle</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>P</td>
<td>r</td>
<td>P</td>
</tr>
<tr>
<td>f</td>
<td>-0.05</td>
<td>0.83</td>
<td>-0.24</td>
<td>0.29</td>
</tr>
<tr>
<td>D*</td>
<td>0.05</td>
<td>0.99</td>
<td>0.09</td>
<td>0.71</td>
</tr>
<tr>
<td>f</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.93</td>
</tr>
<tr>
<td>D*</td>
<td>0.29</td>
<td>0.29</td>
<td>0.19</td>
<td>0.19</td>
</tr>
<tr>
<td>Emax</td>
<td>0.40</td>
<td>0.21</td>
<td>0.35</td>
<td>0.29</td>
</tr>
<tr>
<td>Tmax</td>
<td>0.71</td>
<td>0.31</td>
<td>0.31</td>
<td>0.28</td>
</tr>
<tr>
<td>IAUC60</td>
<td>0.30</td>
<td>0.18</td>
<td>0.20</td>
<td>0.37</td>
</tr>
<tr>
<td>WAUC</td>
<td>0.23</td>
<td>0.31</td>
<td>0.26</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Note: Emax was defined as follow: Emax = (SI_{max} - SI_{pre}) / SI_{pre}, where SI_{max} was the signal intensity at the maximum contrast enhancement, and SI_{pre} was the baseline signal. Tmax was defined as the time at which Emax occurred. Wash-in was defined as follows: Wash-in = CI_{max} - CI_{pre} / Tmax. The AUC60 was obtained by using trapezoidal integration of the CI with time over 60 seconds after contrast agent arrival in the enhancing voxels of interest. WAUC was defined as the area under the whole of the enhancement curve.
Impact of T1 Mapping on Quantitative Analysis of Dynamic Contrast Enhanced MRI of Head and Neck Tumors

B Quiney¹, Y Anzai¹
¹University of Washington, Seattle, WA

Purpose
Dynamic contrast-enhanced (DCE) MR imaging has the potential to assess tumor microvascular environment and evaluate response to anti-angiogenesis treatment for head and neck cancers. However, the technique of DCE MRI for head and neck cancer lacks standardization. Many previous reports were conducted without measurements of native T1 (T10 map) values. The purpose of this study is to evaluate the impact of T1 mapping on the quantitative assessment of DCE parameters.

Materials and Methods
Among 22 patients who underwent DCE MRI, 13 patients had variable flip angle T1 mapping included in their study. Three patients were excluded from the analysis due to technical reasons (coverage of T10 map was different from the DCE MRI sequence). Seven patients had a measurable tumor visible on DCE MRI. Regions of interest (ROIs) were placed manually over these tumors. In the absence of visible tumor, normal muscle was evaluated. Dynamic contrast-enhanced MRI was analyzed using the extended Toft’s model (Olea Medical, Sphere 3.0). Dynamic contrast-enhanced MRI parameters, Ktrans (volume transfer constant between plasma and extracellular, extracellular space, EES), Kep (rate transfer constant between EES to plasma), and Ve (extravascular, extracellular volume) were measured both with and without T1 maps. Intraclass correlation coefficient was performed to address the degree of agreement.

Results
The average ratio of variables without T1 map to with T1 map was: 2.95 +/- 2.8 for Ktrans, 2.47 +/- 2.4 for Kep, and 2.04 +/- 1.66 for Ve. The intraclass correlation coefficient for Ktrans, Kep and Ve respectively was: -0.104 (-0.665, 0.531), 0.775 (0.324, 0.939) and -0.294 (-0.781, 0.413).

Conclusions
Dynamic contrast-enhanced parameters were overestimated by approximately 2-3 times without measurement of native T1 values (see Figure 1). There was no intraclass correlation between either approach for Ktrans and Ve with a moderate correlation for Kep. In order to use quantitative values for clinical decision-making, it is essential to perform accurate T1 measurements.
Assessment of pediatrics neck masses by diffusion MR imaging

A youssef¹, A Baiomy², T Rafaat³, A Refaat³
¹National cancer institute, Cairo, ²National cancer institute, Cairo, ³National cancer institute, Cairo

Purpose
Head and neck masses in children represent a spectrum of malignant tumors and benign lesions that are sometimes difficult to differentiated by conventional imaging techniques. Our objective was to determine whether diffusion-weight imaging (DWI) and calculated apparent diffusion coefficient (ADC) value correlates with pathological diagnosis of pediatric head and neck tumors and therefore allows more accurate tumor characterization.

Materials and Methods
One hundred pediatric pediatrics patients with recently diagnosed head and neck tumors who underwent preoperative conventional MRI and DWI were included in this study. The average...
ADC obtained from each tumor was compared with the hematological diagnosis benign, locally malignant or malignant.

Results
We found a significant negative correlation between average ADC and tumor histopathologic diagnosis (P < 0.001, r = -0.54): The mean ADC values of the malignant tumors, locally malignant masses and benign lesions were (0.83±0.23) ×10⁻³, (1.43±0.17) ×10⁻³ and (1.65±0.58)×10⁻³ mm² s⁻¹, respectively. Cut off value ≤ 1.19 ×10⁻³ mm² s⁻¹ was used for differentiation between benign and malignant pediatric head and neck masses with a sensitivity of 97.3%, specificity of 80.0%, and positive predictive value of 94.7% and negative predictive value of 88.9%.

Conclusions
Diffusion MRI study is a significant, accurate, fast, non invasive and nonenhanced technique that can be used for characterization of malignant lesions of the head and neck region and to differentiate it from benign lesions relying on calculated ACD value.
Differences in dual energy CT derived parameters between FDG-PET avid and non-avid neck lymph nodes of patients with head and neck squamous cell carcinoma

M Metkees\textsuperscript{1}, C McKnight\textsuperscript{2}, A Srinivasan\textsuperscript{2}

\textsuperscript{1}National research center, Egypt, Cairo, Egypt, \textsuperscript{2}University of Michigan, Ann Arbor, MI

Purpose
To evaluate differences in dual energy CT (DECT) derived parameters in FDG-PET avid and nonavid lymph nodes of patients with head and neck squamous cell carcinoma.

Materials and Methods
This was an IRB approved retrospective study. All pretherapeutic DECT neck scans performed at our institution from 2010-2014 in patients with path proven head and neck squamous cell carcinoma were included for analysis if the patients also had a FDG-PET scan within a 1-month interval of the DECT. Scans with significant motion artifact or suboptimal contrast bolus were excluded. One reader placed multiple regions of interest (ROIs) within the neck lymph nodes identified as avid on FDG-PET qualitatively and also within other normal lymph nodes within the same patient without any FDG avidity. Spectral HU at 40 keV, at 70 keV, iodine concentration and effective Z were generated for each lymph node. The lymph nodes then were divided into FDG avid and nonavid groups with comparison of each dual energy parameter performed between the groups using independent samples t test. P value of <0.05 was considered significant.

Results
Fifty-one lymph nodes were identified in six patients for final analysis for applying the inclusion and exclusion criteria of which 15 showed FDG avidity on PET and 36 did not. The average long and short axis diameters of the lymph nodes in the FDG avid and nonavid groups were 8.5 x 5.8 mm and 5.9 x 4.1 mm respectively. Significant differences (all p values <0.000) were seen between the FDG avid and nonavid lymph nodes in all dual energy CT measurements (SHU40:
224 versus 115, SHU70:81 versus 40, Effective Z: 9.03 versus 8.33 and iodine concentration: 25.3 versus 12.1 respectively. The area under the curve on receiver operating characteristic (ROC) analysis for the above parameters was 0.91, 0.91, 0.90 and 0.90 respectively.

Conclusions
Dual energy CT derived parameters are significantly different between FDG avid and nonavid neck lymph nodes of patients with head and neck squamous cell carcinoma, suggesting that this technique may have utility in predicting presence of neck nodal metastatic disease.

O-147

Using texture analysis of head CT images to differentiate osteoporosis from normal bone density

Y Kawashima¹, A Fujita², K Buch², B Li², T Kaneda³, O Sakai²
¹Boston Medical Center, Boston University, Boston, MA, ²Boston Medical Center, Boston University School of Medicine, Boston, MA, ³Nihon University School of Dentistry at Matsudo, Matsudo, Chiba

Purpose
Texture analysis is playing an increasing role in radiology as it is a noninvasive, postprocessing step which can detect subtle changes in pixel intensities. The purpose of this study was to investigate the use of a texture analysis for detecting patients with osteoporosis on head CT and to explore the best region to evaluate the trabecular architecture in the maxillofacial bones.

Materials and Methods
Following IRB approval, 38 patients who underwent noncontrast head CT between April 2007 and July 2014 with a dual energy x-ray absorptiometry scan within 12 months of the CT scan were included in this study. Segmentation of five osseous regions: clivus, both sides of sphenoid triangles and mandibular condyles were manually contoured and imported into an in-house developed texture analysis software and 42 texture features were calculated for each of the five locations. Patients were stratified by bone densitometry and basic descriptive statistics were used to differentiate patients with normal bone density compared to those with osteoporosis. The t-test was used and P values less than 0.05 was considered significant.

Results
The study cohort was comprised of 18 patients with normal bone density and 20 patients with osteoporosis. A total of 26 texture features demonstrated statistically significant differences (P<0.01) between normal bone density and osteoporosis in the clivus including six histogram features, two gray level co-occurrence matrix features, nine gray level run length features, and nine Law's features. Numerous texture features were demonstrated statistically significant in other regions such as: 24 in the left sphenoid, 15 in the right sphenoid, 15 in the right condyle, and 11 in the left condyle (P<0.05). The mean and median, which were categorized as histogram features, showed statistically significant differences in all regions.

Conclusions
Several texture features demonstrated statistically significant differences between normal and osteoporosis patients in various regions of the craniofacial bones. With texture analysis, head CT may be used to identify patients with osteoporosis without additional examination or cost.
Using texture analysis of neck CT images to differentiate hyperparathyroidism from normal controls

Y Kawashima¹, A Fujita², K Buch², B Li³, T Kaneda⁴, O Sakai²

¹Boston Medical Center, Boston University School of Medicine, Boston, MA, ²Boston Medical Center, Boston University School of Medicine, Boston, MA, ³Boston Medical Center, Boston University, Boston, MA, ⁴Nihon University School of Dentistry at Matsudo, Matsudo, Chiba

Purpose
Texture analysis is a noninvasive, postprocessing method to evaluate variations in the spatial location and signal intensity characteristics of fundamental structural elements in digital images. The purpose of this study was to investigate the use of a texture analysis to detect osseous changes associated with hyperparathyroidism on neck CT and to explore the best region to evaluate the trabecular architecture in the head and neck bones.

Materials and Methods
Following IRB approval, 16 patients who underwent a 4D neck CT between January 2011 and November 2014 were included in this study. Segmentation of eight osseous regions: bilateral mandibular condyles, bilateral mandibular bodies, C4 vertebral body, sternum, and bilateral proximal clavicles were manually contoured only including trabeculae structure. Segmented images were imported into an in-house developed texture analysis software and 42 texture features were calculated for each of the eight locations. Patients were compared to 17 age- and gender-matched normal controls. The T tests were used and P values less than 0.05 were considered significant.

Results
A total of 32 texture features demonstrated statistically significant (P<0.01) differences between controls and patients with hyperparathyroidism in the sternum including seven histogram features, five gray level co-occurrence matrix features, five gray level run length features, 11 Law's features, and four gray level gradient matrix. Numerous texture features were demonstrated statistically significant in other regions such as: 29 in the right mandibular body, 15 in the right clavicle, 13 in the left clavicle, seven in the left mandibular body, six in the right condyle, five in the C4 vertebral body, and three in the left condyle (P<0.01).

Conclusions
Numerous texture features were able to demonstrate statistically significant differences between osseous changes associated with hyperparathyroidism compared to normal controls in multiple osseous regions in the neck. Given the noninvasive, postprocessing, multimodality applications of the texture analysis, it potentially may be able to detect early stage hyperparathyroidism by CT.

Novel Orbital Findings of Intracranial Hypotension

J Holbrook¹, A Saindane¹

¹Emory University, Atlanta, GA
Intracranial hypotension (IH) is an increasingly recognized etiology of headache related to low intracranial pressure and is characterized clinically by positional headaches. While intracranial imaging findings of IH are well described, findings in the orbit may have value for suggesting the presence of IH. This study evaluated whether imaging findings in the orbit on routine brain MRI can be used to differentiate IH from controls.

**Materials and Methods**

Nineteen patients meeting diagnostic criteria for IH including recent opening pressure confirmation, and 60 age, sex, and body mass index (BMI)-matched controls with normal brain MRI and lacking headache or visual disturbance were identified. All patients underwent contrast-enhanced MRI including an axial T2-weighted sequence and a postcontrast 3D-T1-weighted dataset from which sagittal oblique reformats along the course of the optic nerve sheath were generated. Two readers blinded to the IH or control status initially evaluated axial T2-weighted images to evaluate the amount of cerebrospinal fluid (CSF) in the ONS graded on a 4-point scale: 0=no CSF, 1=trace CSF, 2=normal CSF, and 3=increased CSF. Next, the readers evaluated the postcontrast 3D-T1-weighted images for retraction of the posterior sclera, distention of the superior ophthalmic vein (SOV), and optic nerve angle (ONA) as a measure of intra-orbital optic nerve straightening in an oblique sagittal plane along the course of the optic nerve. MR imaging findings were compared between the two groups using a t-test for continuous variables and Fisher exact test for categorical variables.

**Results**

Patients with IH demonstrated significantly decreased CSF in the ONS (higher frequency of no or trace CSF) compared with controls (p<0.0001). Average ONA in the IH group was 165.7 degrees (left) and 165.2 degrees (right), and average ONA in the control group was 159.7 degrees (left) and 160.4 degrees (right); both ONAs were significantly higher in the IH group compared to controls (p=0.006 and p=0.017, respectively). Retraction of the posterior sclera was significantly more frequent in IH (p=0.001 on the left and 0.0027 on the right) than in controls, as was distention of the SOV, which was more common in IH (p=0.043). The figure illustrates absence of CSF in the ONS (A) and straightening of the ONA (C) in a patient with IH relative to a control (B,D).

**Conclusions**

Orbital findings of diminished/absent optic nerve sheath CSF, straightening of the ONA, posterior scleral retraction, and distention of the SOV are significantly more common in the setting of IH and may be useful signs for identifying patients with IH.
Accuracy of Diffusion Weighted Imaging in the Differential Diagnosis of Orbital Masses

L Politi¹, J Milesi², C Godi¹, S Bianchi³, A Ferreri², A Giordano Resti², A Falini¹
¹San Raffaele Scientific Institute, Vita-Salute San Raffaele University, Milan, Italy, ²San Raffaele Scientific Institute, Milan, Italy, ³IRCCS Istituto Auxologico, Milan, Italy

Purpose
To retrospectively assess the accuracy of apparent diffusion coefficient (ADC) values in: 1) discriminating benign versus malignant orbital masses; 2) distinguishing inflammatory lesions from lymphomas and from malignant neoplastic masses; 3) identifying orbital lymphomas.

Materials and Methods
All patients who underwent biopsy or surgery for orbital masses in our Institution between September 2006 and July 2014 and who had also undergone a pre-operative orbital MRI study with diffusion-weighted imaging (DWI) sequences (axial and coronal single-shot SE-EPI; b=0,
700; thickness 3 mm) were included retrospectively in the analysis. In all patients, regions of interest (ROIs) including all the masses were located manually on b0 images and were transposed automatically on the ADC maps to obtain the lesional mean ADC values. Lesions were grouped into benign and malignant categories and also clustered into seven subgroups (neoplastic benign lesions, lymphomas, primitive neoplastic malignant lesions other than lymphomas, inflammatory lesions, vascular masses, metastasis and meningiomas) according to pathology. Descriptive statistics, ANOVA, Student-t tests, and receiver operator characteristic (ROC) were performed. Sensitivity and specificity of various ADC thresholds were determined. Results

One hundred sixty-four patients with both pre-operative orbit MRI with DWI sequences and pathology were identified and included in the analyses. Fifty-three lymphomas (mean ADC=676 x 10-6 mm2/sec ±73), 29 inflammatory lesions (1320 x 10-6 mm2/sec ± 317), 27 primitive malignant masses other than lymphomas (958 x 10-6 mm2/sec ± 321), 22 vascular malformations (1457 x 10-6 mm2/sec ± 409), 17 neoplastic benign lesions (1683 x 10-6 mm2/sec ± 617), nine metastasis (1145 x 10-6 mm2/sec ± 227) and seven meningiomas (965 x 10-6 mm2/sec ± 103) were observed, and grouped in 96 malignant and 68 benign masses. The ADC threshold of 966 x 10-6 sec/mm2 showed 71% sensitivity, 95% specificity and and overall accuracy of 92% in discriminating benign versus malignant orbital masses. An ADC threshold of more than 830 x 10-6 sec/mm2 distinguished lymphoma from inflammation with 100% sensitivity, 100% specificity and 100% accuracy. The ADC threshold of 1180 x 10-6 sec/mm2 showed 95% sensitivity, 88% specificity and accuracy of 94% in discriminating inflammatory from malignant orbital masses. An ADC value of less than 808 x 10-6 sec/mm2 distinguished lymphomas from all other lesions with sensitivity and specificity of 93%, and an accuracy of 97%.

Conclusions

Apparent deficient coefficient values are highly accurate in distinguishing benign from malignant orbital masses, in discriminating inflammatory lesions from malignant ones and in identifying orbital lymphomas. Therefore, DWI sequences should be included in the MRI protocol for the orbit and ADC values should be employed in routine clinical activity for aiding in lesion characterization.
High Rate of Sampling Adequacy in Thyroid Nodule Fine Needle Aspiration Using a Combination of Single-Pass Technique and ThinPrep Evaluation of Cytology Specimens

C Huang¹, I Corcuera-Solano², A Doshi³
¹Mount Sinai Medical Center, New York, NY, ²Icahn School of Medicine at Mount Sinai, New York, NY, ³Mount Sinai Hospital, New York, NY

Purpose
Ultrasound-guided fine-needle aspiration (FNA) often is performed for a more definitive evaluation of nodules within the thyroid gland. Current FNA techniques require multiple passes into the thyroid nodule with a fine needle to obtain tissue adequacy, which often is confirmed by an on-site cytopathologist or the cytopathology lab. ThinPrep is an alternate method used to evaluate cytology specimens potentially reducing the need for immediate evaluation. The purpose of this study is to assess a new approach to sampling thyroid gland nodules. We
retrospectively evaluated the ability to obtain adequate thyroid nodule tissue using a single pass technique with a 20-gauge needle and evaluation of specimens with ThinPrep.

Materials and Methods
Our radiology database was queried retrospectively to identify patients who underwent thyroid ultrasound-guided FNA from May 2012 to August 2013. We reviewed the radiologic and pathologist reports of 225 consecutive patients and we selected those cases whose FNA was performed with a 20-gauge needle technique with samples sent to the cytopathology laboratory for analysis by ThinPrep and was based on the single pass. One hundred fifty patients were excluded due to one or more of the following: use of a 25- or 27-gauge needle, more than one FNA pass, use of conventional smear technique to assess adequacy. A total of 75 patients with 130 nodules finally were included. All examinations included in this study were performed as part of patients' routine clinical care. Patients were evaluated for surveillance of known thyroid nodules.

Results
Of the 130 nodules included, 123 specimens were considered adequate for cytologic diagnosis (94.61%). On the basis of the cytopathology evaluation 109 were benign (83.84%), eight demonstrated atypia of undetermined significance (6.15%), six were malignant (4.61%) and seven were nondiagnostic or unsatisfactory (5.38%).

Conclusions
We describe an FNA technique that provides a high rate of sampling adequacy without the need for immediate cytopathologic evaluation.

O-152
Detection of bone marrow edema of the pig mandible with Dual-Energy CT derived Virtual Non-Calcium images.

A Postma¹, A Stadler², R Böckmann², F Hoebers³, P Kessler², L Poort²
¹MUMC, Maastricht, Netherlands, ²MUMC+, Maastricht, Netherlands, ³Maastro clinic, Maastricht, Netherlands

Purpose
To investigate the accuracy of dual energy CT (DE CT) derived virtual noncalcium images for detection of bone marrow edema of the mandible after previous irradiation and surgery. Radiation-induced changes can be depicted at MRI, demonstrating an increase in water content. However, cortical disruption is easier depicted at CT. When CT is able to demonstrate an increase in bone marrow edema, it has the potential for one-stop-shop-imaging.

Materials and Methods
This study was part of a larger study concerning the development of osteoradionecrosis of the mandible in pigs. Fifteen adult 18 month-old Göttingen mini-pigs received irradiation with an equivalent dose of 0, 25, 50 or 70 Gy. At 13 weeks tooth extraction and placement of four implants was performed in the left mandible. Six months postradiation therapy all animals underwent DE CT (Siemens Definition Flash, Erlangen, Germany) and MRI of the mandible (Phillips intera 1,5T, Best, The Netherlands). Coronal T2-SPIR (TR/TE 3700/80 ms) was used for grading of bone marrow edema (0-3). Dual energy CT with simultaneous imaging at 80 kVp and Sn140 kVp was performed of the mandible and forehead. Postprocessing with reconstruction
of virtual noncalcium images with a 3-material decomposition algorithm was done on a dedicated workstation and send to a PACS system. Hounsfield units (HU) were measured at four regions of interest (ROIs) in the virtual noncalcium images by two observers. Hounsfield units of bone marrow and cortex were compared to grading of T2-SPIR images. All procedures (imaging, irradiation and surgery) were done under general anesthesia. The experiment was performed in accordance with Dutch and European Community guidelines for protection of (laboratory) animals. Permission was obtained from the Animal Ethical Committee (DEC 2011-127).

Results
Hounsfield unit measurements between both observers had a good comparability. Mean HU value of the virtual noncalcium images of the left-sided (L) was higher than right-sided (R) (marrow: L -66.6; R -73.6; p> 0.05) (cortex : L 63.6; R 57.8; p>0.05). MRI T2-SPIR demonstrated increased signal intensity in higher radiation groups. An increase of signal intensity at T2-SPIR was accompanied by an increase in HU at virtual noncalcium images in the bone marrow (R=0.59, p<0.05), but not at the cortex (R=0.27, p>0.05).

Conclusions
Virtual noncalcium images derived from DE CT are able to demonstrate bone marrow edema in radiation-induced bone changes in the pig mandible. This findings open up for DE CT as one-stop-shop-imaging modality for mandibular pathology with CT. Further research in humans is necessary.
Shimony, J.
Washington University School of Medicine
Saint Louis, MO

09D-2
10:45AM - 11:00AM

Human Connectome

Hagmann, P.
Batiment Hospitalier
Lausanne, France

09D-3
11:00AM - 11:15AM


Verma, R.
University of Pennsylvania
Philadelphia, PA

09D-4
11:15AM - 11:30AM

Normative Databases and Machine Learning: Does it Matter for Neuroradiology?

Whitlow, C.
Wake Forest School of Medicine
Winston-Salem, NC

09D-5
11:30AM - 11:45AM

Traumatic Brain Injury (TBI): The TBI Track Study and Best Practices for Genetics and Proteomics in TBI

Manley, G.
University of California at San Francisco
San Francisco, CA
09D-6

Psychiatric Disorders: The Human Disconnectome?

Williams, L.
Stanford School of Medicine
Stanford, CA

09D-7

Panel Discussion How Will Big Data be Used in Routine Practice in 5-10 Years?

Tuesday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

09E - PARALLEL SCIENTIFIC PAPER SESSION-INTERVENTIONAL: AVM's/FISTULAE

O-153

Outcomes Associated with Treatment of Unruptured Cerebral Arteriovenous Malformations

J. Tejada^1, G Bosh^2, M Crosby^1, N Supakul^3

^1Indiana University School of Medicine, Indianapolis, IN, ^2Indiana University, Indianapolis, IN, ^3Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

Purpose
In early 2013, patient enrollment in a randomized trial of unruptured brain arteriovenous malformations (ARUBA) was discontinued earlier than planned after an interim analysis revealed statistically significant outcome differences between the treatment groups. At 33 months, it was reported that the incidence of stroke and death was more than three times higher in the intervention group (30.7%) than the nonintervention group (10.1%). In light of the preliminary findings of ARUBA, a retrospective analysis was performed to determine the rates of stroke and death in the population of patients that underwent treatment for unruptured arteriovenous malformations (AVMs) at Indiana University since 2001.

Materials and Methods
A multi-institutional, retrospective search of radiology reports from Indiana University and its affiliated institutions generated between 2001 and 2014 was performed to identify all patients with arteriovenous malformations. The following data were collected: initial clinical symptoms,
presence of hemorrhage at presentation, location, size, drainage pattern (superficial versus deep), treatment (medical management only versus endovascular therapy, surgical excision, radiotherapy, or a combination of these interventions), and subsequent stroke/death. For cases in which these data were not available in the dedicated radiology reports, the corresponding images were assessed directly and the patients' electronic medical records were referenced to collect any excluded information. An analysis was performed to determine the rates of stroke and death in the population of patients that underwent treatment for unruptured arteriovenous malformations.

Results
Four hundred thirty-nine AVMs were identified, 150 (34%) of which were unruptured at diagnosis. While women comprised 56% of all AVMs identified, they constituted 64% of unruptured AVMs. Of the unruptured AVMs, 61% presented with headache and 20% presented with seizure. Five percent of AVMs were discovered incidentally and 13% presented with nonspecific symptoms such as altered mental status and dizziness. By the Spetzler-Martin Grading Score, 17% of cases were classified as grade I, 31% grade II, 31% grade III, 17% grade IV, and 4% grade V. One hundred twenty of the initially untreated AVMs underwent intervention shortly after diagnosis and 30 were treated with conservative medical management alone. Only four of the medically managed AVMs later ruptured. Of the unruptured AVMs that underwent intervention, 12% were embolized, 12% were treated with radiosurgery, and 7% were surgically resected. The remainder were treated with a combination of the above therapies as seen in Table 2. Following intervention, 13.3% experienced subsequent stroke. No deaths were reported.

Conclusions
The results of this study demonstrate a much lower rate of stroke or death following intervention compared to the results of the ARUBA trial (13.3% versus 30.7%). Complication rates for patients treated with intervention in this study (13.3%) were similar to those treated with medical management alone in ARUBA trial (10.1%). These findings suggest that negative patient outcomes following intervention may not be as extreme as suggested in ARUBA
Table 1: Study population

(Filename: TCT_O-153_HOMEPAGE_1412020835_001.jpg)
The Impact of Angioarchitecture and Embryological Stage of Development on the Brain Organization of Patients with Arteriovenous Malformations: a Resting-State Study.

R La Piana¹, D Klein², X Chai², J Chen², D Tampieri³
¹Montreal Neurological Institute and Hospital, McGill University, Montreal, Quebec, ²Cognitive Neuroscience Unit, Montreal Neurological Institute, McGill University, Montreal, Quebec, C, Montreal, Quebec, ³Montreal Neurological Hospital and Institute, Montreal, Quebec

Purpose
Probably congenital in nature, brain arteriovenous malformations (AVMs) are embedded in the brain tissue and may affect its organization and functions. In this study we evaluated the impact of the angioarchitecture and embryological stage of development on the brain organization of patients with AVMs, as measured by resting-state connectivity.

<table>
<thead>
<tr>
<th>Treatment Types</th>
<th>Count (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embolization</td>
<td>18 (12%)</td>
</tr>
<tr>
<td>Radiation</td>
<td>18 (12%)</td>
</tr>
<tr>
<td>Surgery</td>
<td>10 (7%)</td>
</tr>
<tr>
<td>Embolization and Radiation</td>
<td>22 (15%)</td>
</tr>
<tr>
<td>Embolization and Surgery</td>
<td>38 (25%)</td>
</tr>
<tr>
<td>Radiation and Surgery</td>
<td>4 (3%)</td>
</tr>
<tr>
<td>Embolization, Radiation and Surgery</td>
<td>10 (7%)</td>
</tr>
</tbody>
</table>

Table 2: Treatment Types

<table>
<thead>
<tr>
<th>Stroke Outcome</th>
<th>Count (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death or Stroke</td>
<td>16 (13.3%)</td>
</tr>
<tr>
<td>Stroke</td>
<td>16 (13.3%)</td>
</tr>
<tr>
<td>Hemorrhagic</td>
<td>10 (8.3%)</td>
</tr>
<tr>
<td>Ischemic</td>
<td>6 (5%)</td>
</tr>
<tr>
<td>Death</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

Table 3: Stroke and Mortality After Treatment
Materials and Methods
Thirty-two patients with AVMs (18 males, age range 18-62 years) underwent a resting-state functional MR imaging (fMRI) scan. Arteriovenous malformations were classified according to the venous drainage and the presumptive embryological stage of development. Imaging data were acquired on a 3T TrioTim Siemens scanner. T1-weighted whole brain anatomical images and resting-state functional images were acquired covering the entire brain. Resting-state fMRI data were first preprocessed in SPM8, using standard spatial preprocessing steps. Functional connectivity analysis was performed using a seed-driven approach. We computed seed-to-voxel temporal correlations between the BOLD signal from our a priori regions of interest and that at every brain voxel. We included seeds from the default network and anatomically defined brain regions. We calculated the overall brain wiring efficiency for each participant. We also compared group differences in the default network connectivity and anti-correlations with the attention control network.

Results
Nine AVMs probably originated in early embryological stages and showed both a superficial and deep venous drainage; eight lesions originated presumptively during mid-pregnancy and showed a variable venous drainage; 15 originated later during embryological development and showed a superficial venous drainage. Resting state fMRI showed that functional connectivity is disrupted in AVM patients relative to controls, and connectivity patterns differed among different groups of AVM patients.

Conclusions
Resting state fMRI combined with classification of AVMs that relies on the angioarchitecture and presumed age of embryological development provides more optimal tools to investigate the impact of AVMs on brain organization and function.

O-155

Thermo-Responsive PPCN-Contrast Complex as a Novel Liquid Embolic Agent: An Experimental Study.

S Lee1, J Yang2, J Eliyas-Khader3, M Niekrasz3, C Wardrip3, A Chang4, P Pytel3, G Ameer2
1The University of Chicago, Chicago, IL, 2Northwestern University, Evanston, IL, 3University of Chicago, Chicago, IL, 4Univeristy of Chicago, Chicago, IL

Purpose
Polyethylene glycol citrate-co-N-isopropylacrylamide (PPCN) is a novel, thermo-responsive, biodegradable, anti-oxidative copolymer which remains liquid status until 29 °C but turns into hydrogel status instantaneously above the temperature. In vitro and in vivo experimental evaluations regarding the feasibility of the PPCN as a novel permanent liquid embolic agent were performed.

Materials and Methods
Water soluble iodine contrast agent (Visipaque™ 320, GE Healthcare) was added to provide radio-opacities in three different concentrations (50Vol%, 25Vol% and 12.5Vol% of contrast). Fluoroscopic visibility and injectability through microcatheter of the PPCN-Complexes were evaluated in vitro. In vivo embolic effects were evaluated in end arterial system (Rabbit renal artery, n=8) and non-end arterial system (Swine rete mirabile, n=12). Pre-embolization,
immediate postembolization and follow up angiographies (1 week, 2 weeks and 4 weeks) were obtained in experimental animals. After obtaining follow-up angiographies, experimental animals were euthanized and target organs (rabbit kidney and swine rete mirabile) were harvested and histologic examinations were performed.

Results
Twenty-five Vol% PPCN Complex was used for in vivo experiment which showed 22.7% more radio-opacity than that of 12.5Vol% one. The dynamic modulus (G’, Pa) of 25Vol% PPCN Complex increased from 0 to 120 at the temperature of 29 °C. In rabbit renal artery embolization model, all follow-up angiographies showed no evidence of angiographic recanalization and all histologic examinations demonstrated total ischemic necrosis of embolized renal parenchyma. In swine rete mirabile embolization model, post single embolization angiography showed complete occlusion (n=10), partial occlusion (n=1) and nonocclusive (n=1). On follow up, there was no recanalization (n=10/10) in complete occlusion group, but there was no progressive thrombosis either (n=2/2) in cases with partial or nonocclusis groups. Histology of occluded rete mirabile showed loss of endothelium and intraluminal thrombi indicating sustained luminal occlusion.

Conclusions
The PPCN Complex demonstrated adequate visibility under fluoroscopy, controllability and injectability through microcatheter system as well as sustained in vivo embolic effects. The PPCN complex is a promising novel biodegradable liquid embolic agent for fluoroscopy-guided endovascular embolization.

O-156
10:54AM - 11:02AM

Endovascular Treatment of Dural Arteriovenous Fistulas with a New, Liquid Embolic Agent, the Squid

G Gál1, A Diaz1, G Benndorf2
1University Hospital Odense, Odense, Denmark, 2University of Southern Denmark, Odense M, Denmark

Purpose
To report our experience with a recently developed, Onyx-like liquid embolic agent in the endovascular treatment of dural arteriovenous fistulas.

Materials and Methods
This liquid embolic agent, similar to the Onyx, consists of EVOH copolymer, dissolved in DMSO, mixed with micronized Tantalum powder. The major difference compared to Onyx is the size of the Tantalum particles; that makes it less viscous and its radio-opacity more homogenous during long injections. Between December 2011 and October 2014, 15 dural fistulas in 15 patients were treated with a new liquid embolic agent - the Squid. The clinical presentations were as follows: eight bleeding, three headache, three pulsynchronous bruit and one progressive paraparesis. According to the Cognard classification, one was grade I., one II.a., three II.a+b, three III., six IV., and one V. The locations of the fistulas were as follows: six on the transverse sinus, three at the confluence sinuum, three on the tentorium, two on the superior petrosal sinus, and one spinal, at the Th8 level. Twelve of the fistulas were treated by transarterial embolization, and three of them via the transvenous route, also utilizing detachable coils.
Results
In 14 fistulas we achieved total occlusion, that was confirmed by follow-up angiographies in every case. In one case, we achieved subtotal occlusion, and in this patient, the fistula was surgically extirpated, that also was confirmed by angiography. One microcatheter could not be removed due to significant reflux that was noted and accepted by the operator during the procedure. There was no other complication. All patients had good clinical recovery.

Conclusions
Endovascular treatment of dural fistulas with Squid is feasible, safe and efficient. In the authors' experience, this new embolic agent has some advantages compared to Onyx, like deeper penetration and better visibility on the fluoroscopy during the injection.

O-157
11:02AM - 11:10AM
Endovascular Occlusion of Intracranial Vessels using nBCA Embolization, Controlled by Adenosine Induced Asystole

F Thaher1, M Aguilar2, W Kurre3, C Harmening4, P Kurucz5, O Ganslandt5, H Henkes2
1Neurosurgery/Neuroradiology Klinikum Stuttgart, Stuttgart, Germany, 2Neuroradiology, Klinikum Stuttgart, Stuttgart, Germany, 3Neuroradiology, Klinikum Stuttgart, Stuttgart, Germany, 4Klinik für Anästhesiologie und operative Intensivmedizin, Klinikum Stuttgart, Stuttgart, Germany, 5Neurosurgery, Klinikum Stuttgart, Stuttgart, Germany

Purpose
To evaluate the efficacy and safety of adenosine induced asystole during the intra-arterial injection of nBCA, aiming at controlled endovascular occlusion of intracranial vessels.

Materials and Methods
A retrospective analysis of patient files and procedure documentations was performed. Between August 2010 and July 2014, adenosine induced asystole was applied in 29 consecutive procedures, performed in 24 patients (12 female). A total of 21 AVMs, 4 dural AV fistulas, three intracranial aneurysms and one arterial vessel injury were treated. The procedures were evaluated according to the following criteria: 1) was asystole achieved? 2) was the nBCA injection sufficiently controlled? 3) was a complication of the adenosine injection encountered? 4) did the nBCA embolization cause adverse effects, related to venous passage or arterial displacement?

Results
Asystole was induced in all 29 attempts. The injection and propagation of nBCA was well controlled in all procedures. All patients returned spontaneously to rhythmic cardiac action, without any circulatory issues. No complication related to venous passage or distal arterial migration of nBCA was observed.

Conclusions
Adenosine induced asystole per se is safe. In high-flow arteriovenous shunts and in rare arterial embolizations (e.g., dissecting aneurysm occlusion), nBCA injection is well controlled if performed under cardiac arrest.

O-158
11:10AM - 11:18AM
Head and Neck Endovascular Repair of Vascular Malformations

W Yakes¹, A Yakes¹
¹Vascular Malformation Center, Englewood, CO

Purpose
To determine the efficacy of ethanol embolotherapy of extracranial head and neck vascular malformations of all types, particularly after failure of other endovascular and surgical treatments.

Materials and Methods
One hundred sixty-six patients (64 males, 102 females; mean age: 38 years) presented with extracranial arteriovenous malformations (AVMs) of the head and neck area. Over half of the patients had undergone previous failed therapies. All patients underwent ethanol embolotherapy under general anesthesia. Forty-five patients had AVMs and 121 patients had venous malformations (VM).

Results
Of 45 AVM patients, 36 patients are cured (mean follow up - 2 ½ years); of 121 venous malformation patients, 65 are at end-therapy (mean follow up - 4 ½ years). The remaining patients are not at end-therapy and are being treated for their residual malformations. In AVM follow up, arteriography is the main imaging modality to determine cure or residual AVM as MR is less sensitive in the evaluation of residual AVM. In VM follow up, MR is the main imaging tool, particularly with T-2 fat suppression and/or STIR imaging. All patients demonstrated improvement post-therapy. Complications were 4.5%, to include bleeding (self-limited), partial 7th nerve palsy (with recovery), skin injury (not requiring skin grafts), infection, and pain.

Conclusions
Ethanol has proven its consistent curative potential at long term follow up for high-flow AVMs and low-flow VM lesions at long term follow up as lesions in the periphery. Complication rates remain low. The procedures are tolerated well by the patients and done on an out-patient basis. Prior surgery and embolization procedures can cause difficulty in lesion access, but does not obviate further ethanol endovascular treatment.

O-159

Mandibular AVM Diagnosis and Curative Treatment

W Yakes¹, A Yakes¹
¹Vascular Malformation Center, Englewood, CO

Purpose
To determine optimal management strategies for the treatment of mandibular AVM.

Materials and Methods
Twelve patients (9 females, 3 males), age 9 -14 years; mean age 10 years, underwent endovascular therapy to treat their mandibular AVMs. Nine patients had distinct intra-osseous AVMs. Three had multiple facial and intramaxillary AVMs requiring treatment. Outside institutions recommended massive hemi-facial resections in these patients. Four patients had
prior PVA and gel foam embolization, one patient had a lip graft, and one had prior mandible surgery, all that had failed.

Results
All twelve patients have demonstrated MR and angiographic cure of their AVMs. One patient's therapy is not completed and is on-going. The patients mandibular AVM is cured, a third AVM in this patient in the infratemporal fossa is still undergoing treatment. The follow-up range is 11 months – 41 months, with a mean follow up of 29 months. No complications were noted in treatment of mandibular AVMS. One patient required a minor gingival surgery after treatment of an additional intramaxillary AVM.

Conclusions
Endovascular approaches to manage mandibular AVM can be curative. The intraosseous variety is largely a fistula between artery and vein within the bone. All respond well to endovascular ethanol therapy alone. Surgery was not required in any patient. Surprisingly no complications were encountered in this patient series. Long term cures are noted in this patient series with endovascular approaches alone. No massive surgical resections in any patient, even in patients with multiple AVMs of the soft tissues, mandible and maxilla, were required to affect cure. In patients who suffered hemorrhages from floating teeth, bone formed and stabilized the teeth and no further hemorrhages occurred. Ethanol sclerotherapy proved curative in mandibular intraosseous AVMs in patients who had additional facial soft-tissue AVMs and intramaxillary AVMs that were cured as well at long term follow up.

O-160

Diagnosis and Management of Intraosseous Arteriovenous Malformation

W Yakes¹, A Yakes¹
¹Vascular Malformation Center, Englewood, CO

Purpose
Arteriovenous malformation (AVM) of bone is a difficult management problem. Because standard embolic agents (glue, PVA, Onyx, Embospheres, etc.) are not curative and only palliative, ethanol and ethanol with coils are evaluated in an attempt to curatively treat bone AVMs. Extremity bone AVMs are particularly problematic in that patients frequently have multiple AVMs (~50%).

Materials and Methods
Twenty-eight patients (18 f, 10 m); age range 6 – 48 years, mean: 20 years) presented with bone AVMs involving the upper extremity, lower extremity, pelvis, spine, and head and neck areas. All patients underwent MR, arteriography, and endovascular repair of their bone AVMs. Ethanol alone and ethanol with coils were the sole embolic agents. No surgery was performed on any patients.

Results
Twenty-six of 28 patients are cured of their AVM at arteriographic follow up (range 8 months – 120 months; mean: 42 months). Two patient's therapy is on-going (mandible/maxilla/face multiple AVMs). Complications include one coil migration to the lung (retrieved without sequelae), three patients with skin injury in the lower extremity (healed uneventfully). One patient required a minor gingival surgery.
Conclusions
Bone AVMs in the literature are rarely cured, save by amputation. Ethanol or ethanol with coils has proven to be consistent in ablating bone AVMs and durable at long term follow up consistently curing these AVMs. When bone AVM is present in an extremity, multiple AVMs in that extremity occur around 50% of the time. Acceptable complication rates are noted in this series that were not debilitating. This minimally invasive form of treatment routinely is efficacious in permanently ablating these difficult lesions that have proven untreatable by other means.

O-162

Novel imaging platform reduces patient radiation exposure during diagnostic and interventional X-ray angiography

K van der Marel¹, I van der Bom², M Howk¹, T Narain¹, M Gounis¹, A Puri¹, A Wakhloo¹
¹University of Massachusetts Medical School, Worcester, MA, ²Philips Healthcare, Andover, MA

Purpose
Intracranial aneurysms increasingly are being treated endovascularly, as this has been shown to be safer than surgical clipping (1). Since improved angiographic image quality and suite availability have further stimulated the demand for catheter-based angiography, this prompts concerns over ionizing radiation exposure to patients and staff (2, 3). To address radiation dose while preserving image quality, a novel synergistic approach to adjust algorithms and hardware has been employed in the development of a new commercially available angiographic imaging platform, Allura Clarity (Philips Healthcare) (4). Here, we evaluated the difference in mean radiation dose between Allura Clarity and its predecessor platform (Allura Xper) during diagnostic catheter angiograms and endovascular aneurysm treatment in a retrospective case review.

Materials and Methods
This review was conducted under an IRB-approved data registry. Cumulative dose area product (DAP), total fluoroscopy time, and total contrast volume were collected for diagnostic catheter-based angiography procedures (group 1) or aneurysm treatment procedures with either coil embolization (group 2) or flow diverter placement (group 3), and the results were compared for cases imaged on the Allura Clarity or Xper platform (n=20 per group and platform). Cases were performed by 1-3 operators with different degrees of experience. Linear models were fit to test for effects of imaging platform, group, and their interaction, on radiation dose measures. Dose area product was normalized by total fluoroscopy time to control for differences in duration of radiation exposure.

Results
Panel A shows individual DAP values and illustrative regression lines. Total contrast volume and fluoroscopy time differed significantly (p<0.05) between groups [multivariate ANOVA; F(4,228)=20.3, p<0.001] but not platforms [F(2,113)=2.7, p=0.073]. Normalized DAP (Panel B) showed a significant effect of platform [ANOVA; F(1,114)=106.3, group F(2,114)=15.9], and platform-by-group interaction (F(2,114)=10.7; all p<0.001)]. Overall, mean normalized DAP was 59.5% lower on Allura Clarity as compared to Allura Xper (4206 versus 10396 mGy·cm²; t=10.3, p<0.001). For diagnostic, coil embolization, and flow diverter groups Allura Clarity
achieved dose reductions of 69.5% (t=9.7), 55.0% (t=4.2), and 47.5% (t=4.2), respectively (all p<0.001).

Conclusions
The Allura Clarity imaging platform was associated with reductions of mean normalized radiation dose of 69.5%, 55.0%, and 47.5% for catheter-based angiograms, coil embolization, and flow diversion treatment, respectively, without compromising image quality. Ongoing research will show the impact on staff dose and operator behavior in complex cases where patient exposure becomes a limiting factor.

Applications of C-arm CT Venography in Dural Venous Sinus Aneurysms: Techniques, Diagnosis and Treatment.

A Tumu1, G Chintalapani2, C Lincoln1, H Shaltoni3, H Morsi3, M Mawad1

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Purpose
C-arm CT based 3D venography is a powerful tool for diagnosing and treating various venous anomalies. It can provide valuable data in patients with symptomatic venous aneurysms (1). We will review the principles of C-arm CT based 3D venography, post-processing techniques required to make accurate diagnoses and utility of 3D venography in endovascular treatment of dural venous sinus aneurysms and various other venous anomalies.

Materials and Methods
C-arm CT based 3D venography was performed in three patients. A 5F catheter was placed in
the internal carotid artery and 3D rotational angiographic imaging was acquired as follows: 1. Acquisition protocol: 5 sec DSA protocol (Siemens Artis zee biplane, 5 sec rotation time, 2 rotations, 133 frames/rotation, 70kv, 0.36mGy/frame). 2. Injection protocol: 2.5cc/sec for 18cc, 0s injection delay and 8s x-ray delay. The x-ray delay was set to the time difference between the acquisition frames corresponding to the arrival of contrast in the veins and the internal carotid artery (See Figure 1).

Results
C-arm CT based 3D venography was able to make an accurate diagnosis, guide subsequent endovascular treatment and evaluate post-treatment effects in three patients with dural venous sinus aneurysms. All three patients had significant or complete resolution of symptoms after endovascular treatment with balloon assisted coiling.

Conclusions
C-arm CT based 3D venography techniques provide valuable information in the diagnosis and treatment in patients with dural venous sinus aneurysms. Specialized image acquisition and post-processing techniques provide advantages over standard CT and MR venography in the detection of the dural venous sinus aneurysms and eventual endovascular management of these lesions (2). Additionally, C-arm CT based 3D venography is useful in the diagnosis and treatment of many other venous anomalies including venous stenosis and thrombosis.
Calculating X-ray delay for venous imaging

(Filename: TCT_O-163_figure1.jpg)

Tuesday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Michigan AB (Level 2)

09F - PARALLEL SCIENTIFIC PAPER SESSION-INFLAMMATORY AND INFECTIOUS DISEASES
O-164

10:30AM - 10:38AM
Preliminary Analysis of Fast T2 Relaxometry based Myelin Water Imaging Data in Multiple Sclerosis Patients

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Purpose
In demyelinating disease myelin water imaging (MWI) technique could be used as a sensitive marker to detect early changes in normal appearing white matter (NAWM) and to follow miniscule changes in the evolution of lesions in multiple sclerosis (MS). So far, MWI reconstruction requires a very high signal to noise ratio (SNR) achieved by a high number of averages resulting in very long acquisition times (30 mins). A new, more robust MWI processing technique, including spatial priors into image reconstruction, allows for lower SNR, less averages and, therefore, shorter acquisition times (<10 mins). In this study we aimed to prove the feasibility and reliability of this technique in MS patients then to be utilized in a larger study.

Materials and Methods
Five multiple sclerosis (MS) patients and 2 healthy controls (HC) were imaged at 3T Skyra including T2W and MWI. For MWI a 2D multi-echo spin echo sequence with TE=7-220ms, ΔTE=7ms, TR=2500ms, 3mm slice thickness, 3 slices, 10 mins acquisition time was applied. Regions of interest (ROIs) were defined in frontal and occipital NAWM, in the corpus callosum (CC) and in the pyramidal tract (PT). Multiple sclerosis lesions were defined on T2W images and transferred onto myelin water fraction (MWF) maps.

Results
In MS patients MWF was significantly lower in lesions (3.5%) compared to NAWM with 5.8 % (p<0.001). There was no significant difference between MWF in NAWM in HC and MS patients. MWF in the CC and PT was significantly higher (CC 11.2%, PT 13.4%, p<0.001) in comparison to MWF in corresponding NAWM.

Conclusions
Myelin water fraction measures were in line with previous studies and lesions appeared clearly distinctive in MWI (Figure 1). Myelin water imaging allows for quantitative assessment of NAWM and lesions in MS, which could be used as an additional sensitive imaging endpoint for larger MS studies.
Correlation of Quantitative MR Metrics of Morphometry and Lesion Load with Performance on a Novel Inter-Hemispheric Speed of Processing Task in MS Patients

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Purpose
The purpose of this study is to explore the relationship between performance of MS patients on a novel inter-hemispheric speed of processing task (IHSPT) and multiple quantitative imaging measures, including whole brain volume (WBV), T2 lesion load and corpus callosal morphometric indices (CCI).

Materials and Methods
We reviewed MRI of patients who completed the IHSPT at the NYU MS Care Clinic from 11/09-9/12. We calculated total and regional CCI normalized to callosal antero-posterior diameter. In a subset of patients with appropriate thin-slice imaging, WBV and T2 lesion load
were measured using Brainreader (Horsens, Denmark) and FireVoxel (in-house) software. Pearson correlation coefficients between IHSPT and each of these measures were calculated for all patients, as well as stratified by Expanded Disability Status Scale (EDSS) (unimpaired (0-1.5), mild (2.0-3.5) and moderate (4.0-6.5)).

Results
MR imaging of 84 patients who completed the IHSPT were included in the analysis (31 unimpaired, 36 mild, 17 moderate); WBV and T2 lesion load were measured in 32 patients who had appropriate thin-section imaging. Slower inter-hemispheric processing speeds on the IHSPT correlated significantly with posterior CCI ($r=0.59$, $p<0.001$) and total CCI values ($r=-0.41$, $p=0.02$) in the unimpaired group, but not in the other disability strata. In the subset of patients in whom T2 lesion load/WBV were calculated, T2 lesion load correlated with slower processing ($r=0.38$, $p<0.04$), driven primarily by patients in the unimpaired and mildly impaired groups ($r=0.48$, $p<0.02$). No correlation was found between performance on IHSPT and WBV for any disability strata.

Conclusions
Inter-hemispheric speed of processing task correlates with posterior and total CC atrophy in the unimpaired group suggesting that performance on this test of inter-hemispheric processing is specifically dependent on the integrity of the posterior CC, affected early on in the disease course. T2 lesion burden also correlated with IHSPT, but the effect was due to the less impaired patients. Lack of correlation between IHSPT and CCI or T2 lesion load in the moderately impaired group may be due to the more diffuse pathology in advanced stages of disease.

O-166

Active Lesions and Longitudinal Changes in Fractional Anisotropy in Multiple Sclerosis Patients: a Tract-Based Analysis

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Purpose
Although prior diffusion tensor imaging (DTI) studies have demonstrated decreased fractional anisotropy (FA) in the corpus callosum and normal-appearing white matter of multiple sclerosis patients, how lesion activity relates to this underlying tissue injury is unknown. We hypothesized that patients with active lesions would show greater longitudinal decline in fractional anisotropy in major tracts compared to those with stable disease.

Materials and Methods
Twenty-nine patients with relapsing-remitting multiple sclerosis were included in this study – 13 had active lesions on the baseline scan and 16 had no active lesions. Each patient underwent two 3T contrast-enhanced MRI scans with a DTI sequence and a mean interval of 2.4 years between scans. The forceps major and minor of the corpus callosum and the bilateral corticospinal tracts were selected as the major white matter tracts for interrogation. These tracts were reconstructed using region-of-interest placement on standard anatomical landmarks and a fiber assignment by continuous tracking algorithm using TrackVis (version 0.5.2.2) software. Presence and location
of active lesions were assessed visually. Mixed-effects regression models were used to determine the association between active lesions and longitudinal change in fractional anisotropy.

Results
Active lesions were associated with greater decline in fractional anisotropy in the forceps major (p=0.035), right corticospinal tract (p=0.039), and marginally in the left corticospinal tract (p=0.065), but not the forceps minor (p=0.17). The effects of additional factors including age, gender, total lesion burden, steroid/Tysabri use, disease duration, and Expanded Disability Status Scale were explored, but they were not associated with longitudinal changes in fractional anisotropy.

Conclusions
Fractional anisotropy of major white matter tracts declined more rapidly in patients with active lesions, suggesting greater diffuse white matter injury with active disease. Diffusion tensor imaging may provide a noninvasive means of monitoring white matter injury following relapses.

FLAIR*: In Vivo Histology for the Diagnosis of Multiple Sclerosis in Clinical Practice

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Purpose
Current MRI criteria to support the diagnosis of MS are based on dissemination in time (DIT) and space (DIS) of central nervous system (CNS) white matter lesions (WML). Application of these criteria may not be straightforward thereby delaying diagnosis. Using T2*-based sequences enables the in vivo visualization of a characteristic feature of MS lesions, a central vein (CV). FLAIR* is a postprocessing algorithm combining T2* with FLAIR, an established sequence for WML detection. This study explored whether FLAIR* is superior to current MRI criteria for a
diagnosis of MS using MRI datasets acquired at a single time point and a standard field strength (3T).

Materials and Methods
Twenty-five people with relapsing MS (pwRMS; 14 men and 11 women; age 41±11.2 years; disease duration 6± 5.2 years) underwent MRI. FLAIR* images were generated using freely downloadable image processing software; MIPAV (www.mipav.cit.nih.gov) and JIST (www.nitrc.org/projects/jist/). FLAIR* images were assessed independently by two observers. White matter lesions >3mm were identified and the presence of a central hypointensity suggestive of a CV (CV sign; CVS) recorded. A proportion of >40% CVS positive WML was considered diagnostic for MS. Diagnoses based on a proportion of >40% CVS+ WML were compared with diagnoses made using DIS/DIT criteria applied at a single time point on these datasets.

Results
In 25 pwRMS, 338 WML were identified. Interobserver agreement for the presence of the CVS was good (κ = 0.65). All pwRMS met the diagnostic criterion of CVS+ in >40% of WML (range 58-100%, mean 88 ± 11.8). Three of 25 pwRMS met the DIS/DIT criteria.

Conclusions
In a clinical setting and using manufacturer sequences, FLAIR* allows in vivo detection of a characteristic histological feature of MS WMLs. Prospective studies in patients with clinically isolated syndromes are required to confirm the diagnostic value of FLAIR*.

O-169
11:10AM - 11:18AM

Assessment of Venous Blood Flow Parameters with 4D Flow Analysis in Multiple Sclerosis

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Purpose
4D-phase contrast assessment of deep venous blood flow in patients with multiple sclerosis to age-matched controls, to investigate the potential role of chronic cerebrospinal venous insufficiency as a mechanism for triggering central nervous system (CNS) demyelinating disease.

Materials and Methods
Demographics: Thirty-four patients with multiple sclerosis were compared to 25 age and sex-matched healthy controls. Imaging: MR data were obtained on a 3T scanner (Discovery MR750, GE Healthcare, WI). 4D phase-contrast MRV was performed on the deep venous structures of the head, neck, and upper chest. Postprocessing: Image postprocessing was performed by a single operator who was uninvolved with the MR data acquisition and blinded to the clinical information. The image sets were segmented based on phase contrast data (Mimics, Materialize) and exported to advanced visualization software (EnSight, CEI). The MR venography (MRV) data were reformatted into 2D planes orthogonal to the major dural venous sinuses and flow analysis was performed. Statistics: Comparison of venous flow parameters was performed on a vessel-by-vessel basis between the MS and healthy control groups. Group differences were analyzed by employing two-sample unpaired Student's t-tests. False discovery rate control was used to correct for multiple comparisons.
Results
No statistically significant differences were noted for any of the venous flow waveforms parameters obtained between the multiple sclerosis and healthy controls.

Conclusions
The hypothesis that chronic cerebrospinal venous insufficiency plays a role in the pathogenesis of multiple sclerosis is controversial. Our analysis, using 4D volumetric phase contrast MR venography, did not demonstrate statistically significant differences for any flow parameters measured in the cerebrospinal venous vasculature between MS patients and healthy controls.

O-170

Temporal Evolution of Brain Lesions: Correlation on Magnetic Resonance Imaging with Clinical, Serological and Epidemiological Factors in Patients with Neuromyelitis Optica

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Purpose
Various types of brain lesions were defined on magnetic resonance imaging (MRI) of patients with neuromyelitis optica (NMO). These were found mostly in areas of high aquaporin 4 expression. Study purposes are: 1) to compare the temporal change in the number of lesions in different regions of the brain on MRI, 2) to compare these changes with clinical severity parameters.

Materials and Methods
A retrospective study was designed including patients diagnosed with NMO or NMO spectrum disorders. Brain MRIs were evaluated by a neuroradiologist and a radiologist in consensus. Electronic patient records for the clinical information, first MRIs at the time of diagnosis and last follow-up MRIs of 50 patients were reviewed. Patients with at least one visible T2, FLAIR hyperintense lesion were included. The lesions were divided into four types in accordance with previous literature; periependymal (PE), brainstem+corticospinal tract (BS+CST), white matter (WM) and other lesions. Change in number of each lesion type between the first and last MRI was analyzed. Spearman correlation was calculated for the change in each lesion type with Expanded Disability Status Scale (EDSS) and relapse numbers.

Results
Forty-two patients (35 female, 7 male) were included in the study. The mean age was 47 (range 2-76) years. The average time interval between first and last MRIs was 42.2 (range 0.37-144.57) months. Thirty-seven patients were NMO IgG seropositive, four patients were negative and one patient was not tested. Statistically significant increase was found in PE (p=0.01), WM (p< 0.001) and in overall lesions (p< 0.001) between first and last MRI. EDSS scores were higher for BS+CST lesions.

Conclusions
Neuromyelitis optica shows some characteristic brain lesions. This study's results suggest that
the overall lesion load increases over time and BS+CST lesion count correlates with the clinical disability.

O-171

11:26AM - 11:34AM

QUANTITATIVE MEASUREMENT OF BLOOD BRAIN BARRIER CHANGES IN HIV ASSOCIATED COGNITIVE IMPAIRMENT USING DYNAMIC CONTRAST ENHANCED MRI-CAN IT BE A GAME CHANGER?

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Purpose
Human immunodeficiency virus (HIV) associated neurocognitive impairment (NCI) occurs despite highly active antiretroviral therapy. Many potential causes were put forth to explain the NCI in HIV and one of them is ongoing low grade infection. The inflammation associated with this low grade infection is known to cause blood-brain barrier (BBB) disturbance and disruption. We have used dynamic contrast enhancement derived metrics K-trans and K-2 to measure the increased capillary permeability, a direct indicator for the BBB disruption and attempted to correlate these metrics with established neuro inflammatory marker Neopterin and neuropsychology scores. The BBB disruption in the HIV could indicate that the adequate antiretroviral dose is not reaching the target and therefore warrants a revision of the effective dose. Therefore we premised that BBB disruption can help us to achieve the twin objective A: Its association with NCI and possible role for dosage tailoring

Materials and Methods
A pilot project of 17 patients was evaluated in this study. All the patients are HIV positive and have been on antiretrovirals with varying levels of HAND. All were under HAART regime and virally controlled. Laboratory investigations include cerebrospinal fluid (CSF) for B-2 Microglobulin and Neopterin. All underwent MRI (3T) Philips with 16-channel phased array head coil and the protocols included 3D-T1 volumes, Flair and T-2 and single voxel spectroscopy interrogation of the frontal white matter and basal ganglia with short TE (20Msec). Contrast-enhanced DCE and immediate and delayed postcontrast studies (20 MTS Delay) were obtained. The DCE data were postprocessed using Nordic ICE neuro lab. The steps included the registration to an anatomical space, motion correction followed by plotting of the time curves of signal change in basal ganglia, frontal white matter and the Cortex. Subjects underwent neuropsychiatric evaluation with a five-cognitive domain neurocognitive testing on a screening battery. Raw scores were transformed into z-scores and averaged into a global z-score. Statistical evaluation (SPSS -2) was done using Pearson correlation and two-tailed t test.

Results
K-trans a marker of capillary permeability has increased relative to normal individuals in 13 out of 17 patients (P value: 0.05). Using Pearson correlation coefficient the KTRANS values were correlated with CSF Neopterin, B-2 Microglobulin and cognitive scores. There is positive correlation with R value ranging from 0.6 TO O.8 in the frontal white matter and 0.5 to 0.6 in the Caudate Nucleus for Neopterin. The Nadir CD4 counts also showed high positive correlation
with K-trans values. B-2 Microglobulin and cognitive scales have not shown any significant correlation with K-trans values.

Conclusions
This study proves that the BBB damage continues in spite of antiretroviral drugs and k-trans a marker of permeability is a powerful biomarker to measure the same. The measurement of capillary permeability can be a very effective way to measure the effective CNS penetration of antiretrovirals.

O-172

11:34AM - 11:42AM

Susceptibility-Weighted Imaging (SWI), Diffusion-Weighted MR, Contrast Enhancement (CE), T1-Hyperintensity and CT-Hyperdensity in CNS Toxoplasmosis and Primary CNS Lymphoma.

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Purpose
Cerebral toxoplasmosis and primary central nervous system (CNS) lymphoma (PCNSL) are both important diagnostic considerations in patients with human immunodeficiency virus (HIV)/AIDS. Our goal is to present a comparison of the imaging features between these entities utilizing susceptibility-weighted imaging (SWI), diffusion-weighted imaging (DWI), contrast enhancement (CE), T1-hyperintensity, and CT-hyperdensity.

Materials and Methods
The electronic medical records and PACS databases were searched for patients with either CNS toxoplasmosis or PCNSL. Clinical follow up, laboratory results, HIV status, CD4 count and histopathology reports were analyzed to distinguish between these two entities. Forty patients were identified, but 15 excluded due to lack of susceptibility-weighted imaging (SWI). Twenty-five patients ultimately met the criteria and comprised the study, including 14 patients with CNS toxoplasmosis and 11 with PCNSL.

Results
Positive (i.e., dark) foci on SWI were demonstrated in 92% of patients with CNS toxoplasmosis and 27% of patients with PCNSL. Precontrast T1-hyperintense signal was present in seven of 14 patients (50%) with toxoplasmosis and in one of 11 patients (9.1%) with lymphoma. Comparing CNS toxoplasmosis to PCNSL, the average number of FLAIR-hyperintense (11.7 versus 3.3 lesions, respectively, p=0.004), CE (7.2 versus 1.5 lesions, respectively, p=0.027), DWI-positive (6.0 versus 1.0, respectively, p=0.018), T1-bright (3.4 versus 0.2, respectively, p=0.047), and SWI-dark (4.5 versus 0.5 lesions, respectively, p=0.010) lesions per patient, each were much higher in patients with toxoplasmosis, and significantly different in number, from PCNSL. However, the average number of CT-hyperdense lesions was similar in both groups (0.5 versus 0.6, respectively, p=0.54). The average size of CNS toxoplasmosis lesions on SWI was 5.3 ±3.6 mm.

Conclusions
Our preliminary study indicates that foci of SWI-positive signal loss are present in the vast majority of patients with cerebral toxoplasmosis, but are not present in the vast majority of
PCNSL patients. This would suggest that hemorrhagic lesions are common in toxoplasmosis lesions. Thus, SWI may be an addition to the radiologists' armamentarium in distinguishing CNS toxoplasmosis from PCNSL.

Toxoplasmosis versus Lymphoma: Cerebral lesion characterization using dynamic susceptibility contrast MRI and relative cerebral blood volume estimates

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Purpose
To assess the clinical utility of relative cerebral blood volume (rCBV) estimates from dynamic susceptibility contrast (DSC) MRI for distinguishing cerebral toxoplasmosis from cerebral lymphoma in at-risk patients. These lesions often are indistinguishable by conventional contrast-enhanced MRI, and there is limited literature on the diagnostic efficacy of DSC-MRI.

Materials and Methods
This IRB-approved single-institution study was performed by retrospective radiology and pathology database review (2004-2013) of all patients diagnosed with cerebral toxoplasmosis or cerebral lymphoma who underwent routine contrast-enhanced MRI and DSC-MRI. Five patients had a prospective clinical diagnosis of cerebral toxoplasmosis with response to anti-toxoplasmosis therapy, and one patient had pathology-proven cerebral toxoplasmosis (4 male, 2 female, age range 34-55 years, mean age 44 years). Eleven patients had pathology-proven cerebral lymphoma (8 primary and 3 secondary; 4 male, 7 female, age range 29-84 years, mean age 67 years). In total, there were 14 cerebral toxoplasmosis lesions and 15 cerebral lymphoma lesions visible on at least two contiguous axial post-gadolinium images. Relative cerebral blood volume maps were made from DSC-MRI (GRE-EPI, TE=35ms, 90° flip angle, pre-load, postprocessing leakage correction. Volumetric regions of interest (ROIs) of segmented lesion
enhancement were used to extract mean lesion rCBV and normalized to normal-appearing white matter.

Results
There was no significant rCBV difference (2-tailed unpaired t-test, p=0.37) between primary [2.07±0.19 (mean±SEM)] and secondary (2.94±0.68) cerebral lymphoma, so these lesions were grouped for subsequent analyses. Relative cerebral blood volume was significantly lower (2-tailed unpaired t-test, p<0.0001) in cerebral toxoplasmosis (1.00±0.13) versus cerebral lymphoma (2.24±0.21). The area under the receiver operating characteristic (ROC) curve was 0.9524 (p<0.0001). An rCBV threshold of >1.7 yielded 73% sensitivity and 93% specificity for lymphoma, with a likelihood ratio of 10.3.

Conclusions
Relative cerebral blood volume derived from DSC-MRI is significantly lower in cerebral toxoplasmosis than cerebral lymphoma, and an rCBV threshold of 1.7 yields a high likelihood ratio with good sensitivity and specificity for diagnosis. Relative cerebral blood volume is helpful for distinguishing between cerebral toxoplasmosis and cerebral lymphoma and may facilitate more timely initiation of appropriate directed therapy.
Mean rCBV value significantly differ for Toxoplasmosis and Lymphoma (p
Purpose
Posterior reversible encephalopathy syndrome (PRES) is diagnosed by both clinical and imaging findings. Literature regarding associated factors and prognostic significance of contrast enhancement in PRES is sparse. Our goal was to evaluate for an association between contrast enhancement in PRES and various clinical factors, by analyzing a large series of contrast-enhanced MRI scans in patients with PRES.

Materials and Methods
An MRI report database was searched for patients with clinical and MRI suspicion of PRES between 1997-2014 who were administered intravenous gadolinium-based contrast. The presenting symptom, etiology of PRES, neurologic follow-up, and maximum systolic (SBP) and diastolic (DBP) blood pressure within 1 day of MRI were obtained. Patients were grouped into four categories of hypertension and five categories of clinical outcome. Two staff neuroradiologists reviewed the MRIs by consensus and recorded the presence of intraparenchymal hemorrhage (IPH), MRI severity(1) and pattern of contrast enhancement (none, cortical, parenchymal/nodular, leptomeningeal, or a combination). Statistical analysis was performed to investigate for a correlation between the above-mentioned factors and patterns of contrast enhancement.

Results
One hundred thirty-five patients (67.4% females) were included, ages ranging from 7-82. Blood pressure (BP) values were available for 124 patients, and clinical outcomes were available in 96. In 59 patients (43.7%), contrast enhancement was present, the most common patterns being leptomeningeal (n=24) and leptomeningeal plus cortical (n=21). No significant association was found between presence of enhancement and any of the variables (for p<0.05). When enhancement was present, an association was found between age and extra-leptomeningeal patterns (p=0.0084).

Conclusions
The presence of contrast enhancement in PRES does not seem to be associated with gender, etiology, presence of IPH, clinical outcome, or radiological severity. There may be an association of nonleptomeningeal patterns with age or SBP, which needs to be investigated prospectively. Contrast may be helpful to exclude other pathologies (e.g., infectious or ischemic), but it is not necessary to diagnose PRES.
Biometric and diffusional changes in apparently normal fetal head magnetic resonance imaging scans of fetuses with congenital heart disease

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Purpose
To evaluate the impact of various congenital heart diseases (CHDs) on fetal biometrics and apparent diffusion coefficient (ADC) values in different areas of fetal brains with no neuroimaging abnormality.

Materials and Methods
Nineteen fetal head magnetic resonance imaging (feMRI) scans of fetuses with CHDs performed between 2011-2014 were analyzed. Inclusion criteria were no other known neuroimaging [MRI and ultrasound (US)] abnormality with CHD (ICHD group). Suitable fetuses were classified either by site of obstruction (SOO) or estimated cerebral blood flow (ECBF) according to
established definitions. The SOO parameter yielded 3 groups: right-sided obstruction with a pulmonary artery (PA) diameter less than the aorta (AO) diameter (n=9), left-sided obstruction (PA>AO, n= 5), and other defects (normal-sized PAs and AOs, n=5). The ECBF parameter yielded 3 groups: normal (n=9), elevated (n=3) and (3) reduced (n=7). Apparent diffusion characteristic values were measured in the white matter of the frontal, parietal, temporal and occipital lobes, and in the basal ganglia (BG), thalamus, pons and cerebellum. Prenatal US and MRI biometrics were retrieved and converted to percentiles by Chervenak (US) and Garel (MRI) normograms. Biometrical parameters included ventricle size, biparietal diameter (BPD), cerebral BPD (cBPD), occipitofrontal diameter (OFD), cerebral OFD (cOFD), head circumference (HC), abdominal circumference (AC), femur length (FL), estimated fetal weight (EFW), corpus callosum (CC), transverse cerebellar diameter (TCD), vermis height and anteroposterior diameter of the vermis(APD). Results were compared to 26 normal feMRI and US scans matched for 31-36 weeks gestational age (controls).

Results
Fetuses with iCHD compared to control had lower ADC values in the BG (1411±140 versus 1301±91, respectively, p<0.002) and pons (1356±127 versus 1233±122, respectively, p<0.002), as well as decreased AC percentiles (57.3±20.2 versus 32.9±22.6, respectively, p<0.008). Fetuses with left-sided obstruction had lower ADCs in the pons (1236±109, p<0.036) and lower AC percentiles (25±19, p<0.019). The normal-sized PAs and AOs group also had reduced ADCs in the pons (1116±47, p<0.0001) and AC percentiles (25.4±8.7, p<0.008). Normal and reduced, but not elevated ECBF, groups had significantly decreased pons ADC values (1243±100 p<0.015 and 1201±82 p<0.01, respectively) and in AC percentiles (26.4±22 p<0.017 and 25.1±11, p<0.002, respectively).

Conclusions
Fetuses with CHD and apparently normal central nervous system (CNS) imaging studies have microstructural diffusional changes in the pons and BG as well as decreased AC percentiles. Different fetal iCHD groups exhibit distinct patterns of diffusional and biometrical changes specific to each group. Further studies should be undertaken to elucidate the clinical significance of these findings in fetuses with CHD.

O-176
10:38AM - 10:46AM

Evaluation of Subependymal Grey Matter Heterotopias on Fetal MRI

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Purpose
To evaluate accuracy in diagnosing subependymal gray matter heterotopias in fetuses with spinal dysraphism on fetal MRI.

Materials and Methods
A single center HIPPA compliant and institutional review board approved retrospective analysis was performed of fetal MRIs with spinal dysraphism from 1/2004 through 8/2014. Images were reviewed by two board certified fellowship-trained pediatric neuroradiologists. Corresponding obstetrical ultrasound, postnatal imaging and clinical/operative reports were analyzed.
Results
Two hundred three MRIs were identified in fetuses with spinal dysraphism. Of these, 161 fetuses were identified as having spinal dysraphism without evidence of omphalocle-extrophy-imperforate anus-spinal defects (OEIS) complex or complicating limb, body wall, or calvarial defects. In this cohort, a total of 95 fetuses had postnatal brain MRIs which were included in our analysis. In those with postnatal correlation, 23.2% (22/95) were suspected to have subependymal gray matter heterotopias on fetal MRI. However, only 50% (11/22) of these cases were confirmed on postnatal brain MRI. Of note, 100% (22/22) of these fetuses suspected to have heterotopia on fetal MRI had ventriculomegaly, while only 74% (54/73) of the remaining not suspected to have heterotopia had ventriculomegaly. On postnatal brain MRI, a total of 28.4% (27/95) demonstrated imaging findings consistent with subependymal gray matter heterotopia. Only 40.7% (11/27) were diagnosed prospectively via fetal MRI.

Conclusions
Fetal MRI is limited in its ability to identify subependymal gray matter heterotopias in fetuses with spinal dysraphism. It is believed that this relates to a combination of factors including artifact from fetal motion, the very small size of fetal neuroanatomy, and possibly irregularity of the germinal matrix caused by stretching of the ependyma/subependyma in the presence of ventriculomegaly.
Is Fetal Magnetic Resonance Imaging at 1.5-Tesla Adequate to Delineate Intracranial Abnormalities?

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Purpose
Fetal MRI traditionally has been performed at a field strength of 1.5T. This practice is largely related to safety concerns regarding increased power deposition as well as other theoretical risks that may exist at higher field strengths. Despite these concerns, there is growing interest in imaging the fetus at 3T, and preliminary work has demonstrated improved signal and anatomical delineation. There is very little data, however, regarding the accuracy of fetal MRI at 1.5T. Furthermore, specific shortcomings of 1.5T fetal imaging, which would help to identify targets for improvement, have yet to be elucidated. The goal of this study was to measure the performance of fetal MRI at 1.5T.

Materials and Methods
This HIPAA-compliant study was IRB approved. Patients were identified retrospectively from a database of all fetal MR exams performed at 1.5T at our institution. Patients were included if a postnatal MRI of the brain was performed. Reports from the fetal and postnatal brain exams were reviewed for intracranial abnormalities. Postnatal MRI was considered the gold standard. First, the pre/postnatal exam pair was classified as either perfect agreement (agreement of all findings) or discrepant (differ by at least one finding). For each individual finding, Cohen's Kappa coefficient was used to measure agreement between the studies.

Results
Two hundred sixty-eight patients met inclusion criteria. Seventy-nine percent (211/268) of fetal studies demonstrated perfect agreement with the postnatal MR exam. Considering individual findings, there was almost perfect agreement (Kappa: 0.93) between the pre/postnatal exams. Overall, sensitivity and specificity of the fetal exam for findings detected postnatally were 91.3 and 99.8%, respectively. Cohen's Kappa, sensitivity, and specificity of the fetal exam for most commonly observed findings are presented in Table 1. The vast majority of individual findings demonstrated near perfect agreement. Least agreement was observed for cranial nerve, inner ear, and pituitary abnormalities as well as for focal cortical dysplasia (Kappa range: 0-0.45); these findings accounted for 5% of all abnormalities.

Conclusions
Overall, fetal MRI at 1.5T was highly accurate in identifying intracranial abnormalities detected on postnatal brain MRI. Although such findings were rare (5% of all findings), areas for potential future improvement include cranial nerve, inner ear, and pituitary abnormalities as well as focal cortical dysplasia.
Closed versus Open: Spinal Dysraphisms on Fetal MRI

U Nagaraj¹, K Bierbrauer¹, J Peiro¹, B Kline-Fath¹

¹Cincinnati Children’s Hospital Medical Center, Cincinnati, OH

Table 1. Cohen's Kappa, Sensitivity and Specificity of 1.5T Fetal MRI

<table>
<thead>
<tr>
<th>Findings</th>
<th>Kappa</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventriculomegaly/Colpocephaly</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dysgenesis of the Corpus Callosum</td>
<td>0.942</td>
<td>0.929</td>
<td>0.99</td>
</tr>
<tr>
<td>Subependymal Heterotopia</td>
<td>0.758</td>
<td>0.682</td>
<td>0.99</td>
</tr>
<tr>
<td>Aqueductal Stenosis</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chiari II</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Vermian Hypoplasia</td>
<td>0.96</td>
<td>0.964</td>
<td>0.99</td>
</tr>
<tr>
<td>Polymicrogyria</td>
<td>0.78</td>
<td>0.74</td>
<td>0.98</td>
</tr>
<tr>
<td>Agenesis of the Corpus Callosum</td>
<td>0.979</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cerebellar Hypoplasia</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Intracranial Hemorrhage</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Schizencephaly</td>
<td>0.875</td>
<td>1</td>
<td>0.98</td>
</tr>
<tr>
<td>Optic Nerve Hypoplasia</td>
<td>0.458</td>
<td>0.308</td>
<td>1</td>
</tr>
<tr>
<td>Normal Study</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Purpose
To compare fetal MRI findings in open (OSD) and closed spinal dysraphisms (CSD).

Materials and Methods
A single center HIPPA compliant and institutional review board approved retrospective analysis was performed of all fetal MRIs with spinal dysraphism from 1/2004 to 8/2014. Images were reviewed by two board certified fellowship-trained pediatric neuroradiologists. Corresponding obstetrical ultrasound, postnatal imaging and clinical/operative reports were analyzed.

Results
Spinal dysraphism was identified in 203 fetal MRIs. Twenty (9.8%) were categorized as CSD with 16 of these patients having postnatal confirmation via MRI and/or clinical documentation. Of these, 25% (4/16) had posterior fossa abnormalities, 12.5% (2/16) had ventriculomegaly, and 37.5% (6/16) had additional findings to support a diagnosis of omphalocele-extrophy-imperforate anus-spinal defects (OEIS) complex. One hundred forty-seven (72.4%) fetuses were identified as having OSD without complicating limb, body wall, or calvarial defects. Of these, 96.6% (142/147) had posterior fossa abnormalities, 82.3% (121/147) had ventriculomegaly and none had OEIS. Twenty fetuses with postnatally confirmed OSDs were randomly selected to compare to CSDs. Continuity of the epidermal ± subcutaneous tissues with the wall of the sac/defect on fetal MRI was seen in 93.8% (15/16) of CSDs as opposed to 5% (1/20) of OSDs. Average skin thickness overlying the sac was significantly less in OSDs (0.7 mm) versus CSDs (2.9 mm, p<0.001). Although the presence of fat within the defect was not identified on prenatal imaging of CSDs, 50% (8/16) of these children had lipomyelomeningocele or lipomyelocele confirmed on postnatal MRI.

Conclusions
There are multiple characteristic imaging findings in CSDs that can allow for differentiation from OSDs on fetal MRI. CSDs tend to have sac wall continuity with the epidermal and subcutaneous tissues, greater sac wall thickness, decreased incidence of posterior fossa anomalies and a high association with the OEIS complex. Lipoma in CSDs could not be defined prenatally.
Abnormal Neuroimaging Findings Correlating With Clinical Factors in Infants with Congenital Diaphragmatic Hernia

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1Cincinnati Children's Hospital Medical Center, Cincinnati, OH, 2Cincinnati Children's Hospital Medical Center, Cincinnati, OH
Purpose
Survivors of congenital diaphragmatic hernia (CDH) are known to have long term neurodevelopmental sequelae. However, few studies have focused on central nervous system injury in patients with CDH, and the timing and mechanism of injury remain poorly understood. The purpose of this study is to identify neuroimaging abnormalities on MRI in infants with CDH and correlate those with clinical factors in attempt to understand cause of injury.

Materials and Methods
A retrospective IRB approved study of 23 infants with CDH was performed. Brain MRI was reviewed by two radiologists blinded to the clinical data (except age), and conflicts were resolved by consensus. Brain injury scoring was performed using a scale that evaluated ventriculomegaly; extraaxial spaces; intraventricular and parenchymal hemorrhage; white matter, cerebellar, cortical and basal ganglia injury. Clinical information was obtained by medical chart review.

Results
Mean gestational age was 37.6 weeks with MRI performed at median day of life 31 (range 11-179 days). The total injury score ranged from 0-6 with a mean score in the 23 patients of 1.7 (total possible score 21). Ten of 23 infants had normal brain MRIs. The most common pathology was enlarged extra-axial spaces (9/23 infants). Other findings included cerebellar hemorrhage (5/23), ventriculomegaly (4/23), grade I-II intraventricular hemorrhage (4/23), white matter injury (4/23), parenchymal hemorrhage (1/23), and basal ganglia injury (1/23). The clinical factors associated with brain injury score were need for ECMO (p = 0.009) and need for inotropes (p = 0.047). Infants who required G-tubes were more likely to have brain injury (p = 0.046). Gestational age, Apgar scores, ventilator days, bloodstream infection, and endotracheal infection were not correlated with presence of injury or total injury score.

Conclusions
The majority of infants with CDH have evidence of at least mild injury on brain MRI with enlargement of the extra-axial spaces being the most common abnormality identified. Higher brain injury score correlated with need for ECMO and inotropes suggesting that hypoxia and hypoperfusion are significant factors in these infants suffering from pulmonary hypoplasia and hypertension.
macrocrania on head ultrasound who underwent subsequent MRI or CT between March 2006 and December 2012. Children with history of intracranial hemorrhage were excluded. Results of the initial ultrasound and subsequent MRI or CT were compared to evaluate for change in imaging diagnosis. A chart review was performed to determine the neurologic status and consequent clinical management.

Results
Forty-five patients (69% male, 31% female) with a mean age of 5.4 ±1.9 months met inclusion criteria. Abnormal neurologic findings were reported in 25 patients (56%), including developmental delay (47%), hypotonia (11%), and seizures (7%). A total of 65 follow-up studies were performed (41 MRI, 24 CT). Imaging diagnosis did not change in 98% of subjects. Additional imaging findings of potential significance were identified in two subjects (4%). One subject with clinical findings of seizure had dysmorphic brain morphology suspected to be of genetic/syndromic etiology. The second had an incidental Chiari I malformation which resolved on follow-up imaging without neurosurgical intervention. No patients developed communicating hydrocephalus requiring neurosurgical intervention.

Conclusions
Additional imaging in patients with suspected benign macrocrania on US rarely leads to a change in imaging diagnosis or neurosurgical intervention, but may expose patients to unnecessary radiation or sedation. Clinical follow up alone or limited brain MRI not requiring sedation may be the most appropriate management in the absence of focal neurologic deficits, seizures, or loss of developmental milestones. Prospective studies applying these management strategies are warranted.

O-181

Correlation of Fetal MRI with Postmortem Imaging and Neuropathology in Cases of Thanatophoric Dysplasia

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Purpose
Thanatophoric dysplasia (TD), a usually perinatal lethal form of chondrodysplastic dwarfism, includes both skeletal abnormalities as well as complex malformations of the brain, including enlargement and abnormal sulcation of the temporal lobes as well as hippocampal dysplasia (1). Although both skeletal and brain pathologies usually can be diagnosed before 24 gestational weeks (GW) by fetal MRI, a complete diagnostic workup should include postmortem assessment and confirmation of intrauterine findings. Ideally this includes a multimodal approach of both postmortem imaging and autopsy. We aimed to investigate the potential of several postmortem examination methods in the confirmation and refinement of the intrauterine diagnosis of TD.

Materials and Methods
We included all subjects (n=6) in which fetal MRI at our department lead to an intrauterine diagnosis of TD. Fetal MRI was performed on 1.5T or 3T clinical MRI units between GW 17 and 23. Postmortem imaging included postmortem MRI at 3T in two cases, postmortem CT in
two cases and postmortem x-ray in three cases. In addition the postmortem MRI of a 14GW old subject with TD was included, from which fetal MRI was not available due to the early gestational age. In three of six cases an autopsy was performed. Fetal brains were fixed in formalin and embedded in paraffin. Histological examination was performed using HE staining.

Results
Skeletal findings in fetal MRI included short, bowed long bones, micromelia and narrow thorax with short ribs and were confirmed by postmortem CT and x-ray. In addition postmortem imaging revealed skeletal abnormalities like platyspondyly, irregular metaphyses and alterations of the pelvic bones. Enlargement of the temporal lobe with abnormal sulcation was seen in five of six subjects in fetal MRI and was confirmed in two of six with postmortem MRI as well as in one of six additionally at autopsy. Using postmortem MRI abnormal temporal lobe sulcation could be seen even at 14GW. In contrast in one case of TD in which fetal MRI revealed unsuspicious temporal lobes histological analysis confirmed normal temporal lobe anatomy.

Conclusions
Although TD can be reliably diagnosed using fetal MRI as early as GW 17, postmortem examination in case of fetal demise has the potential to both confirm intrauterine findings and reveal additional pathologies that currently cannot be sufficiently assessed by fetal MRI.
important in the formation of thalamocortical and cortico-cortical connections. The SP is vulnerable in perinatal brain injury and probably has a role in schizophrenia and autism.

Materials and Methods
Eight postmortem fetal human brains (19 - 24 GW) without the cerebral pathologies were imaged at 3T MRI (T2-weighted sequences, TR 3100, TE130). Furthermore, five 3T in vivo MR scans (T2-weighted sequences, TR 5300, TE 140) were performed for noncerebral pathologies one of which also had a postmortem examination. The sSP and dSP were identified with histology (hematoxilin-eosin, HE) and their visibility was assessed on T2-w coronal MR images by two independent raters.

Results
The superficial and deep SP were delineated on HE sections and found on all T2W images where the sSP was hyperintense to the dSP, while both layers were hyperintense to the cortical plate (that is above sSP) and intermediate zone (that is below the dSP).

Conclusions
The fetal superficial and deep subplate can be reliably discriminated by postmortem and in vivo 3T MRI. Evaluation of these functionally distinct zones may improve the early diagnosis of fetal brain abnormalities and the prognostic assessment in cases of periventricular leukomalacia.
Quantification of Fetal Vermian Lobulation – in Vivo and Post Mortem

G Dovjak¹, P Brugger², G Gruber², E Schwartz¹, G Langs¹, D Prayer¹, G Kasprian¹
¹Medical University of Vienna, Vienna, Austria, ²Center for Anatomy and Cell Biology, Department of Systematic Anatomy, Medical University of Vienna, Vienna, Austria

Purpose
A normally developed cerebellar vermis seems to determine the cognitive outcome of fetuses
with hindbrain malformations (1). This MRI study aims to quantitatively assess normal vermian development in human fetal brains in vivo. Furthermore the accuracy of fetal MRI-based vermian visualization is determined by comparing in vivo with postmortem segmentation results.

Materials and Methods
Twenty-nine fetuses (18-30 gestational weeks (GW), mean 25.6GW) were scanned prenatally (1.5T, T2-TSE, resolution 0.7/0.7/4.4mm before 24GW and 0.9/0.9/4.4mm after 24GW) and seven fetuses (16-30GW, mean 21.9GW, 3T, CISS sequence, resolution: 0.33/0.33/0.33mm) scanned within 24 hours postmortem were selected for postprocessing. A T2-weighted midline sagittal slice was identified and 2D vermian segmentation was performed using ITK snap.

Results
Seven of the nine Vermian lobules could be discriminated prenatally and postmortem. The mean proportional percentage of each vermian lobule was (in vivo versus postmortem): 6.88% versus 6.82% (I and II), 10.13% versus 11.42% (III), 27.67% versus 29.87% (IV, V), 21.9% versus 21.42% (VI, VII), 13.84% versus 15.24% (VIII), 15.8% versus 10.88% (IX), 3.78% versus 4.35% (X) across all gestational ages (18-30GW). The standard deviation ranged between 1.08-3.97 (in vivo) and 1.94%-3.31% (postmortem) per lobule. Significant differences (paired t-test) between in vivo and postmortem measurements (proportions) occurred at the Lingula (p=.038) and Uvula (p=.012). 3D models of postmortem cerebellar hemispheres were generated.

Conclusions
Fetal MRI accurately visualizes different vermian segments between 18 and 30GW. Proportions of the vermian lobules correlate between postmortem and in vivo measurements and remain stable during this observational period. These data will serve as reference for a detailed prenatal characterization of hindbrain malformations (2).
Selected regional changes in brain diffusivity in fetal isolated mild ventriculomegaly

G Yaniv¹, E Katorza¹, R BERKOVITZ¹, D Bergman¹, A Biegon², C Hoffmann¹
¹Sheba, Tel Hashomer Hospital, Ramat Gan, Israel, ²Stony Brook University School of Medicine, brooklyn, NY

Purpose
To evaluate the impact of symmetric and asymmetric isolated mild ventriculomegaly (IMVM, atrial width ≥10 ≤15 mm) on apparent diffusion coefficient (ADC) values in fetal brain areas.

Materials and Methods
Sixty-seven sequential fetal head magnetic resonance imaging (feMRI) scans performed between 2009-2014 were compared to 38 normal feMRI scans matched for gestational age (controls). Ultrasound- and MRI-proven IMVM cases were divided into asymmetrical (AVM, ≥2 mm
difference in atrial width), symmetrical (SVM, <2 mm difference in atrial width) and asymmetrical IMVM with one normal-sized ventricle (AV1norm).

Results
Apparent diffusion coefficient values were elevated significantly in the basal ganglia (BG) of the SVM and AV1norm groups compared to controls (p<0.004 and p<0.013, respectively). The BG ADC values were elevated significantly ipsilateral to the enlarged atria relative to the normal-sized atria in the AV1norm group (p<0.03). Frontal lobe ADC values were reduced significantly in the AVM and SVM groups (p<0.003 and p<0.003 versus controls). Temporal lobe ADC values were reduced significantly in the AVM group (p<0.001 versus controls).

Conclusions
Isolated mild ventriculomegaly patterns are associated with distinct ADC value changes in different brain regions. Apparent diffusion coefficient values may reflect the pathophysiology associated with different IMVM patterns and may serve as prognostic factors in fetuses with mild VM.

O-185

Different fetal isolated mild ventriculomegaly patterns are associated with changes in brain and body biometry as assessed by ultrasound and magnetic resonance imaging

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1Sheba, Tel Hashomer Hospital, Ramat Gan, Israel, 2Stony Brook University School of Medicine, brooklyn, NY

Purpose
To evaluate whether different isolated mild ventriculomegaly (IMVM, atrial width ≥10 <15 mm) patterns are associated with fetal biometrical changes.

Materials and Methods
Sixty-five sequential fetal head magnetic resonance imaging (feMRI) scans performed between 2009-2014 were analyzed retrospectively. Various ultrasound (US) and feMRI biometric parameters were extracted from institutional records and compared to 30 normal feMRI scans matched for gestational age (GA) (controls, 29-37 weeks). Ultrasound (US)- and MRI-proven IMVM cases formed three groups: asymmetrical ventriculomegaly (AVM, ≥2 mm difference in atrial width, gestational age 32-38 weeks, n = 8), symmetrical ventriculomegaly (SVM, <2 mm difference in atrial width, GA 29-35, n = 17) and asymmetrical ventricles with one normal-sized ventricle (AV1norm, GA 30-37 weeks, n = 40). Ultrasound parameters included bony biparietal diameter (BPD), bony occipitofrontal diameter (OFD), bony head circumference, abdominal circumference, femur length and estimated fetal weight percentiles. Fetal head MRI parameters included cerebral BPD, cerebral OFD (cOFD), corpus callosum, transverse cerebellar diameter anterior-posterior diameter of the vermis (APD) and vermis height.

Results
Occipitofrontal diameter and cOFD percentiles were elevated significantly in all the IMVM groups compared to controls. Bony biparietal diameter percentiles were elevated significantly in the AV1norm group (P < 0.019). Anterior-posterior diameter percentiles were elevated significantly solely in the AVM group (P < 0.003). All other US and feMRI parameters were similar for all groups.
Conclusions
All VM groups had a significant increase in OFD and cOFD percentiles, while APD and BPD percentiles were elevated only in specific IMVM groups. These data contribute to our understanding of ventriculomegaly pathophysiology in utero.

Tuesday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Erie (Level 2)

09H - PARALLEL SCIENTIFIC PAPER SESSION-SOCIOECONOMICS II
O-186

Developing a Commercial Website For An Academic Radiology Department: Is It Even Necessary or Possible?

M Keiper¹, L Grignon¹, T Donovan¹, J Gross¹
¹University of Nebraska Medical Center, Omaha, NE

Purpose
To determine the necessity of a commercial website for an academic radiology department and to assess the most effective method for radiology website development in the setting of significant branding obstacles at a large academic medical center.

Materials and Methods
The necessity of a commercial radiology website was assessed using surveys and personal sales visits to referring clinicians as well as metrics regarding the utilization of the existing academic radiology website by referring providers. Bimonthly meetings between radiology representatives and medical center marketing personnel were scheduled over an eight-month period during which appropriate use and rules for the overall appearance and functionality of the website were established. The content of the website was developed during the eight-month period, and the website subsequently was launched following the eight-month period.

Results
Initial referring provider surveys indicated a competitive requirement for a commercial website to establish meaningful business relationships and a secondary vehicle for communication with providers external to the academic group practice of the medical center. Common obstacles to successful launch of the commercial website included concerns regarding brand dilution of the parent medical center, creation of a radiology specific logo and brand, and overall website design with respect to coherence with the parent medical center website. Significant compromise regarding co-branding of radiology and the parent medical center were required. Ultimately, a radiology specific logo, limited tag line, and radiology specific branding were achieved.

Conclusions
A functional and accessible commercial radiology website is essential for an academic radiology department to effectively compete in the outpatient radiology market. Developing a commercial website is possible but requires dedication and significant compromise between the parent entity and academic radiology department. Once established, an effective website seems to provide an additional sales and marketing tool that may create new community referral patterns.
Radiology A Natural Leader in Marketing and Service at a Large Medical Center

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¹University of Nebraska Medical Center, Omaha, NE

Purpose
To demonstrate that radiologists are ideal medical center leaders of service and service line marketing through recognition as service and sales experts in outpatient medicine.

Materials and Methods
Radiologists in a large academic medical center identified themselves as experts in service and marketing of outpatient and ambulatory medicine by virtue of daily management of a highly competitive and high volume outpatient radiology market inherent to radiology practices. The radiology department offered the medical center consultation in developing a more effective and successful scheduling and patient access departments, thereby optimizing outpatient service benchmarks. Once expertise was established, the radiology department offered additional resources for effective outpatient sales and marketing efforts.

Results
After consultation with radiology experts, the medical center scheduling and access departments vastly improved and achieved appropriate benchmarks. As a result, radiology referral volumes increased by 15% over a two-year period. Due to this organizational and financial success, radiology representatives were identified as service experts in outpatient medicine and were allowed to develop a commercial website, appointed to multiple outpatient planning committees for the medical center and were offered a leadership role in radiology marketing at the medical center. The radiology department also was offered personal involvement and featured in overall service line marketing and sales within the organization.

Conclusions
Radiology practices ideally are suited as a consulting entity for service optimization and sales efforts due to inherent experience and expertise in competitive outpatient imaging markets. By applying this knowledge and leadership to outpatient care in a large medical center, the radiology department positions itself as a valuable asset in improving service and potentially outpatient market share for the institution. This success also may allow the radiology department to benefit directly from medical center wide service line marketing and sales efforts.

Multiple Procedure Payment Reduction (MPPR): How are Neuroradiologists Affected

B Rehani¹, D Rosman², W Dillon³
¹University of California, San Francisco, San Francisco, CA, ²Massachusetts General Hospital, Boston, MA, ³Univ of California, San Francisco Med Ctr, San Francisco, CA

Purpose
To understand the basics tenets of the 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. To analyze how MPPR has evolved with time.

Materials and Methods
The MPPR legislation was studied extensively and key elements are summarized. The history, implementation and potential future impact also were studied.

Results
Imaging-specific MPPRs have been applied to advanced diagnostic imaging services, which the federal government defines as CT, MRI, and Ultrasound. 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. Multiple procedure payment reduction 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.

O-189

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 tenets of health care reform, mechanisms by which the Patient Protection and Affordable Care Act (PPACA) expands health care coverage, how PPACA pays for its coverage and how it may affect the future of healthcare. To outline in comprehensible terms PPACA's effect on consumers, on neuroradiologists and on the specialty of radiology at large.

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 implementation and potential future legislative measures also were studied.

Results
The 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 accounts for approximately half of the 30 million 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 the 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 allow them to be better prepared for the future.

O-190

Early discharge after elective aneurysm coiling: Is it safe?

C Lum1, N Zakhari2, D Iancu3
1University of Ottawa-Interventional & Diagnostic Neuroradiology Section, Ottawa, Ontario, 2University of Ottawa, Ottawa, Ontario, 3The Ottawa Hospital, Ottawa, Ontario

Purpose
Traditional length of stay (LOS) for patients undergoing coiling of unruptured aneurysms has been two days (48 hours). With maturation of coiling techniques, patient outcomes appear to be improving. This provides potential opportunity to explore shortened LOS and potential cost-savings. We sought to examine the association between LOS and 30-day outcomes for patients undergoing elective aneurysm coiling. We hypothesize that early discharge (the next day) after the coiling is safe and is not associated with a greater proportion of adverse events compared to patients discharged after the standard two days.

Materials and Methods
We retrospectively reviewed our coiling database for elective endovascular aneurysm coiling procedures performed between January 2009 - October 2013. The primary outcome measure was any adverse event within 30 days (visits to the emergency department, readmission, prolonged admission>30 days, death). We explored the following potential variables: age, gender, aneurysm size, location (anterior or posterior circulation), technique used (simple versus assisted with balloon, stent or flow-diverter), periprocedural complications, changes in modified Rankin scale (mRS) category at discharge and diffusion restriction on predischarge MRI (absent, <= 5 lacunar infarcts, >5 lacunar infarcts). A Fisher's exact test was used to examine the relationship between LOS and 30-day outcome and potential predictors of prolonged LOS was performed using univariate and multivariate logistic regression analysis.

Results
Ninety-eight consecutive patients were included: 70 female, mean age 56.6 years (14-78). The median LOS was 2.51 days (SD 6.08 days). There were 27 (27.6%) early discharge patients versus 71 patients discharged after two days. Adverse outcomes were found in 19 patients
(19.4%). The adverse outcomes were visits to the ED for the following: headache, groin hematoma, imbalance and transient ischemic attack. There were five readmissions, two prolonged admissions and one death (patient never discharged). On the univariate analysis, there was no significant difference in 30-day adverse outcomes between early and standard discharge ($p=0.775; OR=1.27, CI 0.43 - 3.79$). There was no significant association between the presence of diffusion restriction and 30-day adverse outcome ($p=1, OR=0.92 CI 0.28 - 3$). On multivariate analysis, the only significant variables were use of flow diverter ($OR=4.4, CI=1.0536-18.3743$), any change in periprocedural neurological status ($OR=1.8857, CI 0.3423-10.3891$) or a clinical change in mRS category during the initial admission ($OR=168E+006, CI=\text{infinite}$).

Conclusions
Early patient discharge the next day after uncomplicated elective coiling appears safe and is not associated with an increase in 30-day adverse outcomes compared to the standard 48-hour stay. Patients with a neurological change either during or immediately after the procedure or those treated with flow-diverters should not be discharged early. This supports a prospective study evaluating early discharge for patients with uncomplicated, elective aneurysm coiling.

O-191
11:10AM - 11:18AM

Institutional Experience Integrating Global Neuroradiology into a Residency Program

J Swanson$^1$, W Brinjikji$^1$, J Verdoorn$^1$, N Campeau$^1$, J Mendel$^2$
$^1$Mayo Clinic, Rochester, MN, $^2$Partners In Health, West Newton, MA

Purpose
Historically, radiologists have been less involved in global health than other specialties because of a lack of local imaging equipment and challenges transmitting image data. With increased global Internet access and local availability of digital neuroimaging, it is possible to build international teleradiology infrastructure focused on countries lacking neuroradiology expertise. We describe the benefits of integrating a global teleradiology program into our residency program including resident education and professionalism in neuroradiology.

Materials and Methods
Partners In Health (PIH) has provided medical care and training in the developing world and, in particular, Haiti for over 27 years. In response to the 2010 earthquake, Mirebalais University Hospital was constructed by PIH in collaboration with the Haitian Ministry of Health. It is a 330-bed hospital with a digital radiology department including a 32-slice CT. This CT is one of only five CTs in Haiti and the only one in a public hospital. In Haiti, there are no radiologists in public hospitals, so a PACS was configured so radiologists in the United States and Canada can provide CT interpretations via a mirrored PACS in Boston. Integrating this program into our residency required departmental approval to ensure there were no programmatic issues with participation, legal consultation to ensure malpractice coverage, and hospital IT approval for use of the PIH in client PACS. Following institutional approval in February 2014, residents and staff were recruited from the Mayo Clinic Radiology Residency Program to interpret neuroradiology CT examinations.

Results
We have eight staff neuroradiologists and 25 resident/fellow volunteers interpreting neuroradiology CT scans. Our residency program is assigned to interpret studies 2-3 times
monthly. Shifts are on weekday evenings, typically last 2 hours, and are staffed by four residents and two neuroradiology attendings. Since February 2014, we have interpreted over 600 head and spine CTs. In addition to the clinical benefits to the patients and staff in Mirebalais, involvement in this program has provided substantial educational benefits stemming from the range of pathology not frequently encountered in industrialized countries. These include infectious pathology such as neurocysticercosis, tuberculosis, meningitis and advanced HIV, late-stage head and neck neoplasms, and congenital malformations. This program also provides professional benefits. Both staff and trainees are able to fulfill ACGME values including Fairness and Equity, Leadership and Collaboration, and Stewardship and Service. The program has built camaraderie between trainees and staff. Integrating global health teleradiology also allows residents to apply their neuroradiology training separate from clinical rotations.

Conclusions
Global teleradiology can be integrated successfully into a large residency program providing educational and professional benefits to staff and trainees, as well as clinical benefits to referring physicians and patients in resource poor settings.
41yo Female w/HIV - Encephal

Diagnosis: Toxoplasmosis

(Filename: TCT_O-191_Slide1.GIF)
32yo Female – Back Pain

Diagnosis: Pott Disease
29yo Female - Coma

Diagnosis: Craniopharyngic
Effects of Height and Blood Volume on Enhancement Following Administration of Gadolinium-based Contrast: A Paradigm Challenge and Implications for Clinical Imaging

T Williams¹, D Qiu¹, S Dehkharghani¹, A Sairane¹

¹Emory University, Atlanta, GA
Purpose
Administration of intravenous gadolinium-based contrast agents (GBCA) for MRI is ubiquitous in clinical practice. Standard weight-based dosing in widespread clinical use aims to achieve uniform enhancement by normalizing circulating agent concentration by weight. We hypothesize that readily attainable factors predicting circulating plasma volume, unaccounted for by standard dosing strategies, could account for both qualitative and quantitative fluctuations in enhancement quality. The purpose of this study was to analyze the effect of age, sex, height, and estimated blood volume on intravascular enhancement in patients undergoing standard weight-based dosing.

Materials and Methods
One hundred patients with normal cerebral MR venograms and contemporaneous height and weight measurements were identified retrospectively. All patients underwent a standard contrast-enhanced MR venography examination consisting of a precontrast axial mask and postcontrast axial images of the head following administration of gadobenate dimeglumine according to standard weight-based dosing (with a maximum dose of 20 cc) on a 1.5T clinical scanner. Identical regions of interest were drawn on both the mask and postcontrast images in the left basal ganglia (BG), superior sagittal sinus (SSS) at the level of the internal cerebral veins, right jugular bulb (RIJB), left jugular bulb (LIJB), and within background. Relative signal enhancement of the SSS, RIJB, and LIJB was calculated for all patients relative to the BG. Patients were then dichotomized based upon administered dose (< 20 cc or 20 cc). Multivariate linear regression was used to quantify the relative impacts of demographic factors as well as calculated blood volume (using the Nadler formula incorporating height, weight, and sex) influencing relative enhancement in both the <20 cc and 20 cc groups.

Results
For patients receiving a full 20 cc weight-based dose, calculated blood volume was significantly negatively correlated with relative enhancement of the SSS and LIJB (p<0.05). No significant effects of age or sex were noted. In the patient group with <20 cc weight-based dose of GBCA, both patient height and calculated blood volume were significantly negatively correlated with relative enhancement of the SSS, while height was significantly negatively correlated with relative enhancement of the LIJB (all p<0.05). This set of patients also demonstrated nearly a 20% change in relative enhancement for every 10 cm change in patient height. Figure 1 illustrates the relative impact upon vascular enhancement in two 93 kg patients, one 188 cm in height (A) and the other 157.5 cm in height (B) both receiving 20 cc GBCA.

Conclusions
Standard weight-based dosing strategies insufficiently account for differences in circulating blood volume, potentially under-dosing taller patients at a given weight, while overdosing shorter patients at the same weight. An expanded biometric dosing paradigm leveraging readily attainable subject data may mitigate unintended variations in relative enhancement, impacting both qualitative and quantitative diagnostic imaging.
Recent Trends in the Volume and Utilization Rates of Vertebroplasty and Kyphoplasty among Providers in the United States: Analyzing the Impact of Recent Randomized Clinical Control Trials

M Cox¹, D Levin¹, S Long¹, W Morrison¹, L Parker¹, V Rao¹
¹Thomas Jefferson University, Philadelphia, PA

Purpose
Vertebroplasty and kyphoplasty are percutaneous procedures used to treat painful vertebral body fractures, usually from osteoporosis (1). In 2009, the results of two randomized clinical control trials were published in the New England Journal of Medicine (NEJM) that called into question the efficacy of vertebroplasty and kyphoplasty when compared to placebo (1, 2). The purpose of this study was to evaluate the impact of these two randomized clinical control trials on subsequent volume and utilization rates of vertebroplasty/kyphoplasty procedures in the United States.
Materials and Methods

Current Procedural Terminology, 4th edition codes for thoracic and lumbar vertebroplasty/kyphoplasty (22520-22525) were studied from 2006 to 2012. For each of the codes, the total volume of procedures performed and utilization rates per 100,000 fee-for-service Medicare beneficiaries were calculated. The total volume of procedures and utilization rate by specialty also were calculated. The utilization rates were included in the analysis to adjust for yearly fluctuations in the total Medicare population.

Results

The total volume of vertebroplasty/kyphoplasty procedures performed in 2006 was 90,772. The volume of vertebroplasty procedures peaked in 2008 at 101,807 and thereafter fell steadily to 82,258 in 2012. The utilization rates of vertebroplasty and kyphoplasty also showed a similar trend. The utilization rate was 252 per 100,000 Medicare beneficiaries in 2006. The utilization rate peaked at 292 in 2008, and fell each year after 2008 to 222 in 2012. The total volume and utilization rate for all specialty groups peaked at 2009 and showed a steady decrease afterwards. Radiologists performed the highest number of procedures, performing 34,576 procedures (42%) in 2012. Orthopedic surgeons performed the next highest number of vertebroplasty/kyphoplasty procedures, performing 21,246 procedures (26%) in 2012.

Conclusions

Our study shows that while vertebroplasty and kyphoplasty procedures continue to be performed at a relatively high volume and rate in the United States, there has been a substantial decrease in both volume and rates after 2009. All specialty groups showed a similar decrease in both volume and utilization rate after 2009. Radiologists continue to perform the majority of vertebroplasty/kyphoplasty procedures, with orthopedic surgeons remaining the largest nonradiologic participant. These decreases suggest coincided with the publication of the controversial NEJM articles on vertebroplasty, suggesting that they have had an impact on performance of vertebroplasty and kyphoplasty in the U.S.
O-195

Evidence Levels for Neuroradiology Articles: Low Agreement Between Raters.

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¹University of North Carolina at Chapel Hill, Chapel Hill, NC, ²Centro Hospitalar de Lisboa Central, Lisbon, Portugal, ³Hospital Garcia de Orta, Almada Portugal, ⁴Faculdade de Medicina da Universidade de São Paulo, São Paulo, Brazil

Purpose
Because evidence-based articles are difficult to recognize among the large volume of publications available, some journals have adopted Evidence-Based Medicine (EBM) criteria to classify their articles. Our purpose was to determine if an EBM classification used by a
subspecialty imaging journal allowed consistent categorization of levels of evidence among different raters.

Materials and Methods
One hundred consecutive AJNR articles were classified as to their level of evidence by the two original manuscript reviewers and their interobserver agreement was calculated. After publication, abstracts and titles were reprinted and independently ranked by three different radiologists at two different time points. Interobserver and intra-observer agreement was calculated for them.

Results
The interobserver agreement between the original manuscript reviewers was -0.2283 (SE = 0.0000, 95%CI = -0.2283 to -0.2283), between the three postpublication reviewers for the first evaluation was 0.1899 (SE = 0.0383, 95% CI = 0.1149 to 0.2649), and for the second evaluation, performed 3 months later, was 0.1145 (SE = 0.0350, 95% CI = 0.0460 to 0.1831). The intra-observer agreement was 0.2344 (SE = 0.0660, 95%CI = 0.1050 to 0.3639), 0.3826 (SE = 0.0738, 95%CI = 0.2379 to 0.5272) and 0.6611 (SE = 0.0656, 95%CI = 0.5325 to 0.7898) for the three postpublication evaluators respectively. These results show no agreement to fair inter-reviewer agreement and a tendency to slight intrareviewer agreement.

Conclusions
Inconsistent use of evidence-base criteria by different raters limits their utility when attempting to classify neuroradiology-related articles.

O-196

Should contrast be administered in MRI evaluation of pediatric outpatients with headache?

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1Assaf Harofeh Medical Center, Zerifin, Israel

Purpose
To assess the necessity of routine contrast administration in brain MRI of pediatric outpatients referred for evaluation of chronic headache.

Materials and Methods
A retrospective review of MRI examinations was performed from January 1 – February 17, 2014 of 30 pediatric outpatients referred for evaluation of chronic headache. Independent review was performed by two certified neuroradiologists where each MRI was reviewed first as a noncontrast examination and then with postcontrast images. When the initial interpretation differed between the two raters, final interpretation was reached by consensus.

Results
In seven patients no abnormalities were found. In the remainder of patients, findings were predominantly incidental (not explaining headache) and included: small developmental venous anomalies (DVAs) in six patients, cystic changes of the pineal gland in eight patients (size 2-9 mm), nonspecific FLAIR hyperintensities in four patients, teleangiectasia in one patient, tubular cerebellar lesion suggestive of thrombosed venous varix in one patient, mucosal thickening in the paranasal sinuses in nine patients, and opacification of the mastoids in two patients. The only
changes that were missed on precontrast images were: one small DVA, one teleangiectasia and one small pineal cyst, none of which hold clinical significance.

Conclusions
The use of routine contrast administration in brain MRI of pediatric outpatients with chronic headache may not be necessary, as clinically significant findings were not missed on precontrast images. In cases where significant findings are noted without contrast, the patient can be called back for further evaluation with contrast.

Tuesday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

10A -ASHNR: T-BONED: BEYOND THE TONES AND BONES

10A-1
Temporal Bone Inflammatory Disease
Shatzkes, D.
Lenox Hill Hospital
New York, NY

10A-2
Temporal Bone Neoplasia: Imaging Considerations for Surgery
Hagiwara, M.
NYU Langone Medical Center
New York, NY

10A-3
Conductive Hearing Loss and Third Window Lesions
Moonis, G.
Columbia University Medical Center/ New York presbyterian Hospital
New York, NY

10A-4
Postsurgical Imaging of the Temporal Bone: A Systematic Approach
Tuesday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)

10B - SYMPOSIUM: EMERGENCY ROOM TRIAGE: TRAUMARAMA AND OTHER URGENCIES: PART III: BACK PAIN, NUMBNESS AND WEAKNESS (AR) (SAM)

10B-1
Spinal Cord Injury

Chokshi, F.
Emory University School of Medicine
Marietta, GA

1:15PM - 1:30PM

10B-2
Spinal Cord Infarction

Johnson, M.
Yale University School of Medicine
New Haven, CT

1:30PM - 1:45PM

10B-3
Spinal Cord Compression and Instability

Go, J.
LAC/USC Medical Center
Los Angeles, CA

1:45PM - 2:00PM

10B-4
Spinal Infections that Can Ruin Your Day

Symko, S.
Kaiser permanente
Denver, CO

2:00PM - 2:15PM
Tuesday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

10C - ASPNR: PEDIATRIC APPLICATIONS OF ADVANCED NEUROIMAGING TECHNIQUES: AN UPDATE

10C-1

PET-MRI: How Studies on Cerebral Glucose Metabolism May Improve Diagnosis and Management of Pediatric Brain Disorders

Chugani, H.
Children's Hospital of Michigan
--, MI

10C-2

Anatomical and Functional Connectivity of the Pediatric Brain: Can Insights into Cerebral Organization Predict Neurocognitive Functions?

Mukherjee, P.
University California, San Francisco
San Francisco, CA

10C-3

Advanced MR Spectroscopy: Brain Metabolites as Diagnostic Clues and Biomarkers of Outcome and Treatment Response

Panigrahy, A.
Children's Hospital of Pittsburgh of UPMC
Pittsburgh, PA
10C-4

Pediatric Epilepsy: How Advanced Neuroimaging Impacts Management

Gaillard, W.
Children's National Research Institute
NW Washington, DC

Tuesday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)

10D - SYMPOSIUM: CONNECTOME AND GENOMICS: OMICS AND BIG DATA FOR NEURORADIOLOGY: SESSION III: OMICS AND BIG DATA FOR BRAIN TUMORS

10D-1

1:15PM - 1:30PM

Basic Genomics: what the Neuro-Oncologist and Neurosurgical Oncologist Wants the Radiologist to Know

Nicholas, M.
University of Illinois Hospital & Health Service System
Chicago, IL

10D-2

1:30PM - 1:45PM

Brain Tumors and Imaging Genomics: The TCGA experience

Colen, R.
MD Anderson Cancer Center
Houston, TX

10D-3

1:45PM - 2:00PM

PET-MRI and Molecular Imaging

Kircher, M.
Memorial Sloan Kettering Cancer Center
New York, NY

10D-4
Neuroinformatics for Brain Tumors

Gevaert, O.
Stanford University
Stanford, CA

10D-5

Panel Discussion: What Will the Diagnosis of Brain Tumor Patients Look Like in 5-10 Years?

Tuesday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

10E - ADVANCED IMAGING SEMINAR: FUNCTIONAL NEUROIMAGING BIOMARKERS OF PSYCHIATRIC DISORDERS (PART II)

10E-1

Molecular-level fMRI of Chemical Processes Relevant to Mental Disorders

Jasanoff, A.
Massachusetts Institute of Technology
Cambridge, MA

10E-2

Functional (Dys)connectivity in Psychiatric Disorders Characterized with fMRI

Finn, E.
Yale School of Medicine
New Haven, CT

10E-3

Hippocampal CBV and Metabolism as Predictors of Progression to Psychosis
Schobel, S.  
Columbia University Medical Center  
New York, NY

Tuesday  
1:15PM - 2:45PM  
Sheraton Chicago Hotel & Towers, Michigan AB (Level 2)

10F - CSI: PREPARING YOUR RESEARCH FOR PRESENTATION AND PUBLICATION

10F-1  
1:15PM - 1:35PM

Image Formatting and Manipulation

Vossough, A.  
Children's Hospital of Philadelphia and Hospital of the University of Pennsylvania  
Philadelphia, PA

10F-2  
1:35PM - 1:55PM

Tables and Graphs

Ginat, D. · Rozenfeld, M.  
University of Chicago  
chicago, IL · Chicago, IL

10F-3  
1:55PM - 2:15PM

Advanced Powerpoint

Shah, G.  
University Michigan Health System  
Ann Arbor, MI

10F-4  
2:15PM - 2:45PM

Online Publications: Stay Out of the Trap (Predatory Publishers)

Castillo, M.  
University of North Carolina School of Medicine  
Chapel Hill, NC
Diagnostic Evaluation of Parathyroid CT

C. Egan¹, D. Brickman¹, M. Shindo¹, B. Hamilton¹, M. Milas¹
¹Oregon Health and Sciences University, Portland, OR

Purpose
4D MDCT is an effective technique for preoperative localization of parathyroid adenomas. The number of phases to achieve sufficiently high accuracy for minimally invasive directed parathyroidectomy remains uncertain. Our goal is to determine sensitivity and specificity of dual phase MDCT for parathyroid adenoma localization.

Materials and Methods
We retrieved 187 consecutive dual-phase CT parathyroid studies at our institution over 6 years. Cases lacking surgical confirmation were excluded. Multiglandular disease was excluded for this review, but will be evaluated separately in the future. Studies were reviewed independently by a neuroradiology fellow and senior neuroradiologist blinded to results of all imaging studies, surgical-pathologic results, and laboratory values. Adenoma size, laterality, and quadrant were assigned as reported by Zald et al (1). Concordant lateralization by MDCT and surgery was considered true positive (TP), MDCT detection of adenoma not visualized surgically as false positive (FP), lack of adenoma at surgical exploration and negative MDCT as true negative (TN), and negative MDCT or MDCT lateralization to wrong side as false negative (FN). Surgical adenoma removal with histologic correlation, including appropriate intra-operative drop in parathyroid hormone level, was considered gold standard.

Results
Based on our initial review of the first 50/187 patients, there were 13 males and 37 females, age range 26-86 years. Following exclusions, 23 cases remained. The neuroradiology fellow had 19 TP and 4 FN and the neuroradiology attending had 22 TP and 1 FN. Sensitivity was 82.6% for the neuroradiology fellow and 95.8% for the neuroradiology attending. Our future analysis will include the remaining cases, multiglandular disease, and quadrant localization.

Conclusions
Dual phase MDCT may have comparable sensitivity to 4D MDCT for lateralizing parathyroid adenomas prior to minimally invasive parathyroidectomy, and reduces radiation dose to patients.
**Purpose**
There are increasing applications of dual energy CT (DE CT) for characterization of head and neck lesions. In this study, we investigated the spectral Hounsfield unit attenuation curves (SHUAC) and iodine content of parathyroid adenomas (PTA) and compared them with that of normal thyroid gland and lymph nodes (LN).

**Materials and Methods**
A retrospective analysis of 13 surgically proven parathyroid adenomas was performed. All scans were obtained using the same 64-slice dual energy scanner (GE Discovery CT750HD). A multiphasic CT scan was performed after injection of 100 mL of iopamidol at 3.5 mL/sec. The 25s and 55s postcontrast acquisitions were in dual energy mode and were used for analysis. Each PTA was evaluated with three nonoverlapping regions of interest (ROIs). The normal appearing ipsilateral and contralateral thyroid lobes and a normal lymph node also were evaluated on each scan, each with three ROIs. Spectral Hounsfield unit attenuation curves of each structure were evaluated from 40 to 140 keV in 5-keV increments. The iodine content was determined based on the iodine map.

**Results**
Spectral Hounsfield unit attenuation curves showed statistically significant difference between PTA and LN at 25s postcontrast (p=0.0002), with PTA having progressively higher attenuation than LN at energy levels less than 90 keV. Spectral Hounsfield unit attenuation curves at 55s postcontrast best separates PTA from thyroid (p<0.0001), with PTA having lower attenuation than thyroid. Iodine content is higher in PTA than LN at 25s (p<0.0001), and is significantly lower in PTA compared to thyroid at 55s (p=0.0087). In addition, six out of 12 cases showed significantly less increase of iodine concentration from 25 sec to 55 sec, when PTA is compared to thyroid (p<0.05).

**Conclusions**
Dual energy CT spectral analysis and iodine content estimation may improve accuracy for distinguishing PTAs from normal thyroid tissue or LNs as part of a multiparametric evaluation.

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O-199

**Dual Versus Single Phase CT for Localization of Parathyroid Disease in Patients with Primary Hyperparathyroidism**

A Delumpa¹, D Dunaway¹, D Guffey¹, F Moron¹

¹Baylor College of Medicine, Houston, TX

**Purpose**
The purpose of this study is to evaluate the accuracy of a dual phase (noncontrast and arterial) and single phase (arterial only) CT in the detection and localization of parathyroid disease – adenoma or hyperplasia – in patients with primary hyperparathyroidism.

**Materials and Methods**
With IRB approval, this retrospective study reviewed 78 patients that underwent a parathyroidectomy over a 26-month period. From this group, 32 patients with a diagnosis of
primary hyperparathyroidism and a preoperative dual phase CT examination of the neck were included in our study. Two board certified neuroradiologists, who were blinded to the surgical results, reviewed all CT examinations in two sessions separated by at least 1 week. During the first session, only the arterial phase CT images were reviewed. In the second session, both the noncontrast and arterial phase CT images were reviewed. For each session, the radiologists were tasked with localizing any parathyroid disease to a quadrant of the neck (right upper, left upper, right lower, left lower, or ectopic). The accuracy of localization was defined in two measures: precise localization to a quadrant of the neck, and correct lateralization (right, left, or bilateral) in the neck. The gold standard for correct diagnosis and location was histology in conjunction with operative reports and laboratory data. Accuracy, sensitivity, and specificity were calculated for each reader-phase combination and compared using generalized estimating equations. Kappa statistics also were calculated to assess inter-reader agreement.

Results
In these 32 patients, 43 adenomatous or hyperplastic parathyroid glands were found and localized at surgery. The sensitivities of the arterial phase CT were 83% and 86% for precise localization and correct lateralization of parathyroid disease, respectively. The sensitivities of the dual phase CT were 80% and 84% for precise localization and correct lateralization, respectively. There was no statistically significant difference in accuracy between the single phase and dual phase CT in the localization or lateralization of parathyroid disease (p= 0.866 and 0.597, respectively). Inter-reader agreement between the two neuroradiologists was fair to excellent across all adenoma locations (kappa= 0.297-0.932).

Conclusions
Our data suggest that a single arterial phase CT is just as accurate as a dual phase (noncontrast and arterial) CT for the preoperative localization of abnormal parathyroid glands in patients with primary hyperparathyroidism. Thus, a single arterial phase CT may be sufficient for routine pre-operative parathyroid disease localization.

O-200
3:39PM - 3:47PM

Accuracy of 2D CT for the pre-operative localization of parathyroid adenomas in primary hyperparathyroidism

N Kolicaj¹, B Griffith¹, A Carlin¹, H Chaudhary¹, G Mahmood², G Talpos¹, E Peterson¹, S Patel¹, M Singer¹
¹Henry Ford Health System, Detroit, MI, ²The University of Toledo, Toledo, OH

Purpose
Minimally invasive parathyroidectomy requires accurate pre-operative localization of suspected adenomas. Multiphase CT allows for adenoma characterization while also providing anatomical information to the surgeon. 2D CT uses only an arterial and venous phase for localization, rather than the four phases required for 4D CT. The purpose of this study was to assess the feasibility of using 2D CT to localize pathologic glands in patients with primary hyperparathyroidism.

Materials and Methods
With institutional review board approval, 278 patients with primary hyperparathyroidism were identified who had undergone 2D CT with subsequent surgical cure. All scans were read prospectively by board-certified neuroradiologists. A neuroradiology fellow retrospectively
reviewed all images and reports and classified suspected adenomas based on anatomical location. Accuracy was determined by comparing imaging results to surgical findings. The ability of 2D CT to localize adenomas to one of four neck quadrants and lateralize to the correct side was assessed. Accuracy of 2D CT in identifying multigland disease also was evaluated.

Results
In patients with single gland disease, the sensitivity and specificity of 2D CT to correctly localize the quadrant was 55.4% and 85.9%, respectively. The sensitivity and specificity of 2D CT to correctly identify the lateralization of the gland was 78.8% and 67.8%, respectively. The sensitivity and specificity of 2D CT to correctly identify multigland disease was 22.9% and 79.5%, respectively.

Conclusions
2D CT is a viable method for the pre-operative localization of parathyroid adenomas and may provide a low-radiation alternative to 4D CT, particularly in the setting of single gland disease.

O-201 3:47PM - 3:55PM

Low-dose 3-phase 4D-CT using Traditional and Model based Iterative Reconstruction Maintains Accuracy for Evaluation of Hyperparathyroidism

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1Mount Sinai Hospital; Zwanger Pesiri Radiology, New York, NY, 2Mount Sinai Hospital, New York, NY

Purpose
4D CT has been shown in recent years to be an effective modality for pre-operative localization of parathyroid adenomas, however there is concern regarding the radiation dose of multiphase CT (up to 28 mSv in recent studies). The purpose of this study is to evaluate the performance of 4D CT at significantly lower dose than that reported in the literature (1-4), leveraging iterative reconstruction techniques and other dose lowering modifications. The effect of multiple patient factors on accuracy also was investigated.

Materials and Methods
After obtaining IRB approval, 258 patients with primary hyperparathyroidism were identified who underwent 4D CT and subsequently had parathyroid surgery between January 2010 and December 2013, with pathology demonstrating parathyroid adenoma/hyperplasia. All 4D CTs were performed using traditional and/or model-based iterative reconstruction, along with other dose lowering modifications. After first 100 patients, the number of phases per CT exam was decreased from four to three. Dose-length products for CT exams were obtained from dose reports in PACS and converted to effective doses. Percentage of lesions correctly lateralized by 4D CT was determined, reviewing radiology reports and using operative and pathology reports as the standard. Various subgroups were compared including three and four-phase CT, single and multigland disease, and patients with and without history of prior parathyroid surgery. BMI, pre-operative calcium and parathyroid hormone levels, and size of adenomas were compared between correctly and incorrectly lateralized groups.

Results
There were 316 lesions total: 210 affecting single glands and 106 in patients with multiple glands affected. Eighty-nine percent of lesions were lateralized correctly by CT overall, with 92.3% in
patients with unilateral disease. CT correctly predicted the presence of multigland disease in 54.2% of patients. There was a significantly higher percentage of lesions correctly lateralized by CT in the single gland than in the multigland group (93.3 versus 78, p=0.0006). Average effective dose was 3.95 mSv for 3-phase CT and 5.69 for 4-phase CT (p < 0.0001), without significant difference in percentage of lesions correctly lateralized (89.6 versus 88.1; p = 0.70) between these subgroups. There was no significant difference in percentage of lesions correctly lateralized by CT between patients with and without history of prior surgery (85.3 versus 89.5; p=0.40). There was no significant difference in BMI (27.9 versus 29.3; p = 0.22), pre-operative calcium levels (11.0 versus 10.8 mg/dl; p = 0.41), pre-operative parathyroid hormone levels (169 versus 180 pg/ml; p= 0.61) between correctly and incorrectly lateralized groups. Correctly lateralized parathyroid lesions were significantly larger on pathology than those in the incorrectly lateralized group (14.1 versus 11.7 mm; p=0.016).

Conclusions
Low-dose 3-phase 4D CT, leveraging iterative reconstruction and other dose reducing modifications, can maintain high accuracy in pre-operative lateralization of hyperfunctioning parathyroid glands, while using a fraction of previously published radiation doses.

O-202

4D MRI at 3T to Preoperatively detect Single Parathyroid Adenoma and Multi-glandular Disease: A Feasibility Study

R Khan¹, J Hurr¹, M Guerrero², R Inampudi¹, K Nael¹
¹University of Arizona Medical Center, Tucson, AZ, ²University of Arizona, Tucson, AZ

Purpose
The purpose of this study was to evaluate the performance of MRI/MR perfusion at 3T for the detection of single parathyroid adenoma and multiglandular disease with comparison to surgical findings as the gold standard.

Materials and Methods
Thirty-two patients were recruited prospectively through the department of surgery. Magnetic resonance imaging (MRI) was obtained for presurgical planning and all studies were performed on a 3T Siemens MRI scanner. Dynamic contrast-enhanced (DCE) MRI was included in each study. MR imaging interpretation was performed by two readers both neuroradiology fellowship trained and each with the certificate of added qualification in neuroradiology, with a combined 21 years of experience in radiology. For the purposes of this study, the diagnosis of a single parathyroid adenoma was made when resection of the single adenoma resulted in an intra-operative drop in parathyroid hormone of more than 50% from pre-excision level at 10 minutes postresection. For multiglandular disease, double parathyroid adenomas (two glands resected) or multigland hyperplasia (three and a half glands resected) were diagnosed when two or more enlarged glands were resected and the parathyroid hormone levels dropped more than 50% from pre-excision level at 10 minutes after corresponding resection.

Results
Thirty-two patients were identified that had a diagnosis of primary hyperparathyroidism with subsequent surgery and our MRI protocol. After exclusion criteria, 26 patients were included in the study, 17 with single adenoma, six with double adenoma, three with multigland hyperplasia
of which one had asymmetric hyperplasia (three glands affected) and two had typical hyperplasia (four glands affected). Overall sensitivity of 93% and specificity of 87% was determined, with interobserver variability of 0.64.

Conclusions
4D MRI is a feasible technique for the detection of parathyroid adenomas and hyperplasia, without the radiation risk inherent in other techniques.

O-203
4:03PM - 4:11PM

Multiparametric MR Perfusion in Characterization of Parathyroid Adenomas

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Purpose
Fast imaging tools such as time-resolved angiography with stochastic trajectories (TWIST) (1), controlled aliasing in parallel imaging results in higher acceleration (CAIPIRINHA) (2) and improved fat-suppression afforded by Dixon technique (3) can result in significant improvement in spatial and temporal resolution of dynamic contrast-enhanced (DCE) MRI, rivaling those of multiphase dynamic CT for characterization of parathyroid adenomas (PTA) but without the need for radiation (4). The purpose of this study was to establish perfusion characteristics of PTAs using a robust DCE MR perfusion technique and to perform a comparative analysis with thyroid gland and cervical lymph nodes.

Materials and Methods
Pre-operative MR perfusion datasets in 30 patients with surgically proven PTA were evaluated. MR acquisition was performed on a 3.0T MR scanner (Siemens Skyra), using a DCE perfusion (TR: 4.6 ms, 1st TE: 1.31ms, 2nd TE: 2.54ms, FA: 9°, matrix: 160 mm, FOV: 200 mm, 60 slices x 2 mm thick). Integration of TWIST-Dixon (sampling density of 33%) and CAIPRINHA with acceleration factor of four resulted in acquisition of 3D data set with voxel size of 1.3 x 1.3 x 2 mm and temporal resolution of 5.5 seconds over a craniocaudal coverage of 120 mm spanning from the inferior mandibular rim to the carina. A total of 0.1 mmol/kg of gadolinium was injected at 4 ml/sec. The arterial input function was selected automatically and DCE perfusion datasets were processed by an extended toft model (5) using an FDA approved software (Olea Medical, La Ciotat, France). Using coregistered images, regions of interest (ROIs) were placed over the known PTA, thyroid gland and a cervical lymph node (jugulodigastric station) and multiparametric perfusion including peak enhancement, time-to-peak, %wash-in and %wash-out were obtained in each patient. Data were analyzed by logistic regression and analysis of variance. Receiver operating characteristic (ROC) analysis was performed to determine the optimal parameter/s and threshold for determination of PTA versus cervical lymph node (LN).

Results
The mean ± SD of MR perfusion parameters for PTA, thyroid gland and cervical LN and the corresponding p values using ANOVA analysis are summarized in Table 1. Three perfusion parameters including time-to-peak, %wash-in and %wash-out were significantly different between PTAs and cervical LNs (Table 1). The mean time-to-peak enhancement was 11 and 27 seconds earlier in PTA compared to thyroid gland and cervical LN respectively. Receiver
operating characteristic analysis showed an AUC of 0.74 for %wash-in (threshold: 5.50, sensitivity/specificity: 75/71%) and an AUC of 0.70 for %wash-out (threshold: 0.62, sensitivity/specificity: 79/64%). Using combined %wash-in and %wash-out improved the diagnostic power resulting in an AUC of 0.84 with sensitivity/specificity: 84/78%.

Conclusions
Described MR perfusion technique can be used to characterize PTAs. Using multiparametric MR perfusion can be used to exploit the vascular nature of PTAs evident by rapid arterial enhancement and significantly higher %wash-in and %wash-out, which can be used to differentiate PTAs from cervical lymph nodes.

Table 1. Multivariate analysis of MR perfusion parameters for PTA, thyroid gland and cervical lymph node (LN)

<table>
<thead>
<tr>
<th></th>
<th>PTA</th>
<th>Thyroid gland</th>
<th>Cervical LN</th>
<th>ANOVA (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak enhancement</td>
<td>360.5 ± 87</td>
<td>215 ± 47</td>
<td>305.3 ± 153</td>
<td>PTA vs. Thyroid: &lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PTA vs. LN: 0.504</td>
</tr>
<tr>
<td>Time to peak</td>
<td>37 ± 15.8</td>
<td>48 ± 22.6</td>
<td>64 ± 35</td>
<td>PTA vs. Thyroid: 0.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PTA vs. LN: 0.001</td>
</tr>
<tr>
<td>%Wash-in</td>
<td>7.4 ± 2.6</td>
<td>4.2 ± 1.6</td>
<td>5.2 ± 3.2</td>
<td>PTA vs. Thyroid: &lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PTA vs. LN: 0.001</td>
</tr>
<tr>
<td>%Wash-out</td>
<td>0.84 ± 0.33</td>
<td>0.44 ± 0.23</td>
<td>0.58 ± 0.31</td>
<td>PTA vs. Thyroid: &lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PTA vs. LN: 0.001</td>
</tr>
</tbody>
</table>

- Data are mean ± SD, Bold Indicates significant p value

(Filename: TCT_O-203_Table-1Abs553PTA.jpg)

O-204

Does Application of a 3-Phase Multinomial Logistic Regression Model Improve Parathyroid Adenoma Localization on 4D-CT

J Chang1, L Hamberg2, G Hunter1

1Massachusetts General Hospital, Boston, MA, 2Brigham and Women's Hospital, Boston, MA

Purpose
To determine whether or not the accuracy of localization of parathyroid adenoma on presurgical 4-dimensional computed tomography (4D CT) can be improved by adding tissue characterization using a 3-phase multinomial logistic regression model to the routine radiology interpretation (1, 2).
Materials and Methods
Informed consent was waived by the institutional review body for this chart review study. From January 2012 through August 2014 there were a total of 419 patients with biochemically documented hyperparathyroidism who underwent three phase, contrast-enhanced 4D CT. The locations of the reported lesions were stored as DICOM Key images from the three phases at the time of interpretation. Seventy-six patients were referred from outside institutions with no available follow up. In 108 of the remaining 343, pathology was not available, either because surgery had not been undertaken, or because no abnormal parathyroid tissue was found at surgery. Thus, 235 patients were analyzed (43 men, 192 women: mean ages 57.6 and 60.1 years, respectively). For each patient, the stored KEY images from the 4D CT were retrieved from PACS and regions of interest (ROIs) placed on the previously identified abnormal tissues without reference to the pathology data. Hounsfield unit (HU) values from these ROIs were used to determine the probability that the indicated tissue was parathyroid adenoma using a 3-phase, multinomial logistic regression model (2). Probabilities over 50% were taken to mean parathyroid adenoma. Once the image analysis was complete, the pathology reports were examined and the results from the radiology report and the model data were classified using the pathology results as the basis for the classification. The accuracy rates of the radiology report alone, the model alone and the combined radiology and model interpretations then were calculated.

Results
There were 294 pathology positive parathyroid adenomas. The conventional radiology review identified 309 potential parathyroid lesions, of which 250 were true positive and 59 were false positive based on pathology results. The routine interpretation alone correctly identified 85% (250/294) of the pathology proven lesions. Of the 59 false positive cases, model application converted 33 of them to true negative cases. Thus routine radiology reporting followed by testing using the logistic regression model improved the overall correct identification to 96% (283/294).

Conclusions
A 3-covariate multinomial logistic regression model using HU values from a three phase 4D CT scan protocol, when used in conjunction with routine radiology interpretation, potentially improves the accuracy of 4D CT for parathyroid adenoma localization from 85% to 96%.
Phase 1

Phase 2

(Filename: TCT_O-204_Picture2.jpg)
The Utility of Ultrasound in the Evaluation of Incidental Focal FDG-Avid Thyroid Lesions: Two is better than One

R Peterson¹, D Baumgarten¹, D Schuster¹, A Karagulle Kendi¹, A Aiken¹

¹Emory University School of Medicine, Atlanta, GA

Purpose
Positron emission tomography (PET)/CT has become an important tool in diagnosis and surveillance of cancer patients. Thyroid nodules are one of the most common incidental findings with prevalence reported between 19-46%. Fluorodeoxy glucose (FDG)-avid thyroid nodules, or nodules demonstrating FDG uptake over background, have a 27-50% risk of malignancy. Currently, the standard of care is to biopsy all FDG-avid thyroid lesions if there is an ultrasound target and a reasonable life expectancy. Our study aims to determine if ultrasound criteria can be applied to FDG-avid nodules in order to further risk stratifying these nodules and possibly decrease the rate of negative biopsies.
Materials and Methods
After IRB approval, the radiology database was queried for any patient who underwent a PET/CT and thyroid ultrasound within a consecutive 6-month period from 1/2012-12/2013. Inclusion criteria included: FDG-avid thyroid nodules, diagnostic thyroid ultrasound, and sufficient pathology from fine needle aspiration (FNA). Exclusion criteria included: a prior history of known thyroid disease or thyroidectomy. An abdominal radiologist with 19 years expertise in ultrasound reviewed each ultrasound exam. Each nodule identified by ultrasound (both FDG and non-FDG-avid) was evaluated with the reviewer being blinded to the FDG avidity. For each nodule, a recommendation was made for biopsy based on the Society of Radiologist in Ultrasound (SRU) and American Thyroid Association (ATA) consensus guidelines. Ultrasound and the PET/CT characteristics were recorded for each nodule and then correlated with pathologic results.

Results
The search resulted in 201 patients. Thirty-one patients met inclusion criteria. One hundred seventy patients were excluded. Within the 31 patients, a total of 37 FDG-avid nodules were identified on PET/CT. Each FDG-avid nodule was correlated on ultrasound. An additional 49 non-FDG avid nodules were identified on ultrasound. Ninety-five percent (35/37) of the FDG-avid nodules were biopsied. Twenty-nine percent (10/35) of the biopsied, FDG-avid nodules were malignant with papillary thyroid carcinoma being the most common malignancy. The reviewer recommended biopsy of 71% (25/35) of path-proven FDG-avid nodules. Of the 10 malignant nodules, FNA was recommended for all but one cancer resulting in a sensitivity of 90%, specificity of 36%, PPV of 36% and NPV of 90%. The missed nodule did not meet size criteria for biopsy. This one missed case represented 2.9% of all FDG-avid nodules. In our series, every case of thyroid malignancy (including the missed case) demonstrated a solid, hypoechoic nodule on ultrasound. All cases of FDG-avid nodules that demonstrated any spongiform characteristics were negative for malignancy. Further stratification using ultrasound criteria would have decreased the biopsy rate by 23% in this population at the expense of one missed carcinoma.

Conclusions
We demonstrated a similar rate of malignancy in FDG-avid thyroid nodules as previously reported in the literature. However our study suggests that ultrasound characteristics and specifically ATA and SRU guidelines may be used for further risk stratification to determine FNA in FDG-avid nodules.

O-206

Is vascular flow a valid ultrasound characteristic to distinguish thyroid nodules as benign or malignant?

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¹MD Anderson Cancer Center, Houston, TX, ²University of Texas MD Anderson Cancer Center, Houston, TX

Purpose
Color Doppler ultrasound (US) been described in the literature as a diagnostic tool for predicting thyroid cancer based on the central or peripheral location of the vascular flow. The purpose of
this report is to determine if vascular flow is a reliable sign to distinguish between benign colloid nodules and nodules harboring papillary thyroid carcinoma (PTC).

Materials and Methods

Vascular flow was evaluated by power/color Doppler in 100 thyroid nodules, including 50 consecutive colloid nodules and 50 consecutive nodules with PTC. All cases were diagnosed by cytological evaluation of the US-guided fine-needle aspirate. The US studies were blinded and retrospectively reviewed by two radiologists who practice US focused on the head and neck. Intranodular vascular flow was assessed as absent, central and/or peripheral or diffuse. Student's t-test was used for the statistical analysis.

Results

Vascular flow was present in 36 colloid nodules [central (n=2), peripheral (n=12), both central and peripheral (n=18), and diffuse (n=4)], and 39 nodules containing PTC [central (n=0), peripheral (n=22), both central and peripheral (n=17), diffuse (n=0)], and was absent in 14 colloid nodules and 11 nodules with PTCs. No significant difference was noted between the presence (p=0.49) or characteristics of flow in the nodules.

Conclusions

The US characteristics of vascular flow overlap in benign colloid nodules and those with PTC. Thus, vascular flow is not a valid sign to distinguish between colloid nodules and PTC.

O-207

Intraoperative Radiography of Thyroid Specimens for the Detection of Thyroid Malignancy May Reduce Revision Surgery

R Fitzgerald¹, M Kuruva¹, S Klimberg¹, D Bodenner¹, B Stack¹

¹University of Arkansas for Medical Sciences, Little Rock, AR

Purpose

Intra-operative frozen sections fail to diagnose thyroid carcinoma accurately in up to 16% of cases. Discovery of occult thyroid carcinoma on permanent pathology in patients who undergo hemithyroidectomy necessitates completion thyroidectomy. We investigated the use of intra-operative thyroid radiography (ITR) for detection of malignancy in thyroidectomy specimens as a means to reduce the rate of revision surgery.

Materials and Methods

Following institutional review board approval, patients undergoing total or hemithyroidectomy for any reason were enrolled prospectively in this single-institution, single-surgeon study from October 2013 to August 2014. After extirpation, radiography of the thyroid specimen(s) was obtained using the Faxitron Biovision system (Tuscon, AZ) and interpreted by consensus of two radiologists. Two separate criteria were used for categorization of thyroid calcifications and benign or malignant (Figure 1). Intra-operative thyroid radiography results were compared to final histology and test characteristics were calculated for each method.

Results

Seventy-two subjects underwent total or hemi-thyroidectomy yielding a total of 77 specimens. Final diagnosis of malignancy was made in 30 specimens: 27 papillary carcinoma (20 papillary and seven micro-papillary carcinomas) and three follicular carcinomas. Incorporation of morphologic characterization of microcalcifications (Criteria B - adopted from the
mammography literature) increased the positive predictive value of ITR from 44% (Criteria A based on the presence or absence of microcalcifications) to 93%. See Table for complete test characteristics.

**Conclusions**

An interpretation approach to ITR based on morphologic characterization of calcifications yielded high specificity and positive predictive value for malignancy within excised thyroidectomy specimens. Although only modestly sensitive, ITR is a promising technique for reducing the rate of revision/completion thyroid surgery.

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive Predictive Value</th>
<th>Negative Predictive Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criteria A</strong></td>
<td>73%</td>
<td>40%</td>
<td>44%</td>
<td>70%</td>
</tr>
<tr>
<td><strong>Criteria B</strong></td>
<td>47%</td>
<td>98%</td>
<td>93%</td>
<td>75%</td>
</tr>
</tbody>
</table>

**Criteria A**: *benign* = no calcifications, macrocalcifications; *malignant* = microcalcifications (<2m)

**Criteria B**: *benign* = macrocalcifications (>2mm), punctate microcalcifications; *malignant* = loca microcalcifications (<1 cm²), fine linear calcifications, pleomorphic calcifications

(Filename: TCT_O-207_FigureASNRFaxitronJPEG.jpg)

**Tuesday**  
3:15PM - 4:45PM  
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)


**11B-1**  
Diagnosis and treatment of Neurovascular Trauma in Adults

Lopes, D.  
Rush University Medical Center  
Chicago, IL

**11B-2**  
Pediatric Neurovascular Trauma
11B-3

Neurovascular Trauma: Military Lessons Applied to a Civilian Setting

Armonda, R.
Walter Reed Army Med. Ctr.
Washington DC, DC

11B-4

Novel Uses of Intracranial Endovascular Devices for the Treatment of Neurovascular Trauma

Tateshima, S.
Ronald Reagan UCLA Medical Center
Los Angeles, CA

11B-5

Questions and Answers

Tuesday
3:15PM - 4:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

11C - PARALLEL SCIENTIFIC PAPER SESSION-PEDIATRICS EPILEPSY AND PHAKOMATOSES

O-208

Pre-surgical MRI in Children with Intractable Epilepsy and Cortical Dysplasia: Effect of Comprehensive Case Review, ILAE 2010 Classification, and Radiologist Education on Lesion Detection.

R Radhakrishnan¹, J Leach¹, L Miles¹, H Greiner¹, F Mangano²
Purpose
Interpretation of MR imaging in children with intractable epilepsy is challenging, but identification of cortical dysplasia (CD) is especially important, as MRI detectable lesions (specifically type IIb CD) have good surgical outcome with surgical resection. With the adoption of International League Against Epilepsy (ILAE) 2010 classification system in our institution, comprehensive radiologist education was provided to increase awareness of the radiologic findings of CD. The purpose of our study is 1. To identify overlooked findings in patients with pathologically proven focal cortical dysplasia on presurgical MRIs in a single tertiary pediatric institution. 2. To evaluate the changes in prospective lesion detection on MRI following ILAE 2010 and comprehensive institutional epilepsy group education.

Materials and Methods
After IRB approval, a retrospective review of the pathology database was performed for the term "cortical dysplasia" in surgical patients for intractable epilepsy from 2007 – 2014. Surgical resections prior to 2010 already had been reclassified per the ILAE 2010 nomenclature. After exclusions for inadequate MRI exams and inadequate pathologic specimens, the following were recorded: 1. Prospective radiologic interpretation (clinical report, CR), of the latest presurgical MRI. 2. Presurgical imaging review (PR) performed at epilepsy multidisciplinary conference with knowledge of clinical and noninvasive imaging and electrophysiological data. 3. Retrospective final review (FR) of the preoperative MRI after surgery, with knowledge of the resection region, but blinded to pathology. Detailed surgical notes, intraoperative photographs, pathology specimen nomenclature, and postoperative CT or MRI studies were reviewed in each case. Detailed evaluation of MRI findings of CD and hippocampal sclerosis (HS) was performed in each region. Any discrepancies were cataloged. Discrepant findings were categorized as either nonsignificant (findings that could not direct therapy) or significant (findings that could have or did direct surgical therapy).

Results
There were 174 resection regions in 78 patients with lesional MRI findings in 44 patients (56.4%) with 63 resections. In mesial temporal resections with HS/hippocampal dysplasia (16), MRI was abnormal in nine (56%). In 18 patients (23%), findings at FR that were not identified on CR, significant in 11 (25% of lesional resections). In four of these patients findings were identified only at FR. In two patients (4.5% of lesional resections) these findings were significant. From 2007-2010, there were seven (of 13 lesional resections, 53.8%) significant overlooked findings. From 2011-2014, there were four (of 31 lesional resections, 12.9%) overlooked findings, a significant improvement in lesion detection (p=0.008).

Conclusions
In 14% of children in a large presurgical cohort (25% of lesional patients), significant findings were not identified on initial clinical MRI interpretation. There was a significant improvement in lesion identification following a case review process and radiologist education.
R Hourani¹, H Al Mrad², A Beydoun³, W Nasreddine³

¹American University of Beirut Medical Center, Beirut, Lebanon, ²American University of Beirut, Beirut, Lebanon, ³American University of Beirut Medical Center, Beirut, Lebanon

Purpose
Neuroimaging is a crucial part of the evaluation of seizures and epilepsy. So far, there are no epidemiological data and limited studies about its current use in the initial evaluation of pediatric epilepsy and its yield during the initial diagnosis of epilepsy. The aim of this study was to describe the yield of diagnostic imaging in children with newly diagnosed epilepsy.

Materials and Methods
This is a multicenter prospective study. Children were recruited when first diagnosed with epilepsy (two or more unprovoked seizures), referred by neurologists from across Lebanon, MRIs were performed for all subjects and were interpreted by an expert neuroradiologist who was blinded to the clinical history and diagnosis.

Results
Neuroimaging was done for 481 children. Three hundred twenty-seven patients with epilepsy (two or more unprovoked seizures) already underwent epilepsy protocol MRI, 119 (36.39%) children had an epileptogenic lesion on the MRI, and from 154 patients with a single unprovoked seizure, 52 (33.77%) children had an epileptogenic lesion on the MRI. There was a trend towards more frequent epileptogenic lesion in patients with two or more unprovoked seizures compared to those with a single seizure that did not reach statistical significance (p = 0.57). The types of epileptogenic lesions were: Disorders of cortical malformation, others (diffuse white matter disease ...), vascular, MTS, tumoral and traumatic. When stratified by category with Category 1: Patients with epilepsy (two or more seizures). Category 2: Patients with single seizure. Results are described in Table 1. Subsequent analysis based on subtypes of epileptogenic lesions showed periventricular leukomalacia as the most common and found in 60% of patients with epilepsy and in 70% in patients with single seizure. Another variety of epileptogenic lesions was detected and will be discussed.

Conclusions
In our study, neuroimaging reveals a higher rate of abnormal findings than previously reported. Considering the significant proportion of neuroimaging abnormalities, we suggest an epilepsy-dedicated MRI protocol as part of the initial diagnosis and evaluation of children with newly diagnosed seizures.

<table>
<thead>
<tr>
<th>Categ initial</th>
<th>Type of epileptogenic lesion AB</th>
<th>Type of epileptogenic lesion AB</th>
<th>Type of epileptogenic lesion AB</th>
<th>Type of epileptogenic lesion AB</th>
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</thead>
<tbody>
<tr>
<td>Count</td>
<td>D: Disorders of cortical malformation</td>
<td>I: Other</td>
<td>VASCULAR</td>
<td>Traumatic</td>
</tr>
<tr>
<td>Row Percent</td>
<td>41</td>
<td>25</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Count</td>
<td>24</td>
<td>10</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Row Percent</td>
<td>46.15%</td>
<td>19.23%</td>
<td>17.31%</td>
<td>3.85%</td>
</tr>
<tr>
<td>Count</td>
<td>All Grps</td>
<td>65</td>
<td>35</td>
<td>29</td>
</tr>
</tbody>
</table>

(Filename: TCT_O-209_table1.png)

O-210
Disrupted global and regional structural networks and sub-networks in children with localization-related epilepsy

E Widjaja¹, S Doesburg¹, C Raybaud¹, M Smith¹, C Snead¹, M Zamyadi¹
¹Hospital for Sick Children, Toronto, Ontario

Purpose
Bilateral structural abnormality has been reported in children with localization-related epilepsy. We postulate that there would be extensive impairment in structural connectivity in children with localization-related epilepsy despite the apparent focality of the seizure disorders. The aims of this study were to investigate the structural networks in children with localization-related epilepsy, including subgroups with frontal lobe epilepsy (FLE) and temporal lobe epilepsy (TLE), and to assess the relation between structural connectivity, IQ and clinical parameters.

Materials and Methods
Forty-five children with nonlesional localization-related epilepsy, including 25 with FLE, 16 with TLE, and 28 healthy controls underwent diffusion tensor imaging (DTI). Global network (network strength, clustering coefficient, characteristic path length, global efficiency and small-world parameters), regional network (nodal efficiency), and network-based statistics were compared between patients and controls, and correlated with IQ and clinical parameters.

Results
Patients with localization-related epilepsy showed disrupted global network connectivity relative to controls, including reduced network strength, increased characteristic path length and reduced global efficiency. Similar findings were found in FLE and TLE subgroups. Patients also showed multiple regions of reduced nodal efficiency in frontal, temporal and occipital lobes. Connectivity in multiple subnetworks was reduced in patients, including frontal-temporal, insula-temporal, temporal-temporal, frontal-occipital and temporal-occipital lobes. Frontal lobe epilepsy subgroup demonstrated more areas with reduced nodal efficiency and more impaired subnetworks than TLE subgroup. Network parameters were not associated significantly with IQ, age at seizure onset or duration of epilepsy.

Conclusions
We found disruption in global and regional networks, and subnetworks in children with localization-related epilepsy. Regional efficiency and subnetworks were more impaired in FLE than TLE, likely due to rapid spread of seizure activity in FLE. Future studies are needed to evaluate the implication of disrupted networks on surgical resection and outcomes for specific epileptogenic zones, and the relation of disrupted networks with more complex cognitive function.
Purpose
The FEBSTAT study is a long-term multicenter trial aimed at understanding the relationship between prolonged febrile seizures and subsequent mesial temporal lobe epilepsy. Visual analysis of MRI scans from the FEBSTAT cohort has suggested an association between temporal lobe developmental abnormalities, including hippocampal malrotation (HIMAL), and febrile status epilepticus (FSE) (1). To clarify the relationship between temporal lobe development and FSE, we performed quantitative morphometric analysis of temporal lobe structures in the FEBSTAT cohort.

Materials and Methods
MR imagings performed within 72 hours of presentation were evaluated from 190 children age 1 month to 5 years who presented with febrile status epilepticus (FSE) and a control group of 92 children who presented with simple febrile seizure (SFS) (2). Medial temporal lobe morphology was evaluated for each subject from a coronal T2-weighted image by manual measurement hippocampal height and width, angle of the long axis of the hippocampus, distance of the hippocampus from midline, angle of the collateral sulcus, and width of the temporal horn of the lateral ventricle. Measurements were made blind to clinical data and prior image interpretation. The relationship of morphometric variables to the subjective finding of HIMAL and presenting seizure type was assessed.

Results
The subjective finding of left HIMAL in the FEBSTAT population is associated with decreased left hippocampus distance from midline (p<0.0001), increased left hippocampus height/width (p=0.046), and increased bilateral temporal horn width (left p<0.0001; right p=0.003). Febrile status epilepticus is associated with increased right temporal horn width compared to SFS (p=0.04). Receiver operating characteristic (ROC) curve analysis demonstrates a significant relationship between seizure type and bilateral temporal horn width (left AUC=.580, p=.036; right AUC=.605, p=.005).

Conclusions
Morphometric analysis of the medial temporal lobes in the FEBSTAT cohort demonstrates that the finding of HIMAL is associated with a quantitatively rounder, more medially located hippocampus with increased temporal horn width. Associations of HIMAL with angulation of the collateral sulcus and hippocampus were not found, suggesting that these features are less fundamental to the HIMAL abnormality. Interestingly, cases with left sided HIMAL also demonstrate increased width of the contralateral right temporal horn, suggesting that unilateral HIMAL represents a broader anomaly of temporal lobe development not apparent on subjective examination. The association between temporal lobe morphology and FSE is consistent with the hypothesis that medial temporal lobe developmental abnormalities predispose to prolonged febrile seizures.

O-212

A Potential Pitfall of FDG-PET/MRI Coregistration in the Evaluation for Focal Cortical Dysplasia in Patients with Intractable Epilepsy.

I Orosz¹, V Trinh¹, R Harris¹, J Qiao¹, C Geannette¹, B Salehi¹, H Ullman¹, N Salamon¹
Purpose
To illustrate a potential pitfall of the fluorodeoxyglucose positron emission tomography (FDG PET) for the diagnosis of focal cortical dysplasia.

Materials and Methods
We retrospectively reviewed 23 patients (mean age 14.5 years, sd 1.3) with pathology proven focal cortical dysplasia (FCD) Type IIA/B in the frontal lobe with subtle MRI findings. Two neuroradiology fellows, who were blinded to the known locations of FCD evaluated pre-operative PET/MRI coregistration image to identify the zone of hypometabolism. Results of the raters' evaluation were categorized into three: A. both negative, B. discordant and C. both positive. Locations of FCD were subdivided into three groups: 1. lateral frontal, 2. superior frontal, and 3. orbital frontal. The degree of FDG-PET hypometabolism was measured separately using the lesion's standardized uptake value (SUV).

Results
Fluorodeoxyglucose PET visual assessment was correlated with the locations of the FCD in the frontal lobe. Raters were able to identify 70% of lateral frontal FCD (n=10). For superior frontal FCD (n=8), only 12.5% was detected. Orbital frontal FCD (n=5) was identified in 80%. In SUV analysis, the lesions in the superior frontal lobe had a significantly less hypometabolism with cut-off SUV of 17000 Bq/mL. Raters were able to identify lesions when SUV is lower than 17000 Bq/mL.

Conclusions
Subtle FCD Type IIA/B located in the superior frontal lobe region and with SUV over 17000 Bq/mL showed false negative result in PET/MRI coregistration. Understanding this potential pitfall will be important for presurgical evaluation and require different approach using other modality such as SPECT or magnetic source imaging.
Automated Quantitative Assessment of Rasmussen's Encephalitis

S Jones¹, I Wang¹, A Alexopoulos¹, N Al-Sharif², R Burgess¹, A Joshi³, B Krishnan¹, R Leahy³, J Mosher¹, U Udayasankar¹, D Shattuck²
¹Cleveland Clinic, Cleveland, OH, ²UCLA, Los Angeles, CA, ³USC, Los Angeles, CA

Purpose
To use automated quantitative volumetric MRI to analyze patients with known Rasmussen's encephalitis, and assess the accuracy of lateralization compared with qualitative visual inspection.

Materials and Methods
Volumetric MPRAGE sequences were analyzed with BrainSuite, on a cohort of 20 patients (ages 3-42 years) with diagnosed Rasmussen's encephalitis. Four patients had multiple imaging for a total of 25 studies. A control cohort of 25 normal subjects was used for comparison. BrainSuite produced the volume of a large set of bilateral segmented brain regions, which were used for left-right comparisons. In particular, whole hemispheric volumes were derived, and plotted on a two-dimensional space (x-axis the left volume; y-axis the right volume) such that brains with no asymmetry lay as points along a diagonal, and patients with Rasmussen's fall away from the diagonal. A lateralization metric was computed (the ratio of left/right) for statistical analysis, in
particular to test whether any given patient could be distinguished significantly from the control group.

Results
As shown in the attached figure, this method produces clearly defined separation of Rasmussen's patients due to hemispheric asymmetry of total brain volume, as seen by the scattered closed/opened circles. In distinction, note the set of points from the normal control subjects, which are clustered tightly along the diagonal line that represents hemispheres with equal volume. Using half of the data as a training set, this method correctly predicted the diagnosis of Rasmussen's in 19 out of 20 patients, with no false positives. Lastly, early results on three patients with multiple scans over time showed changes in brain volume that either decreased without treatment (N=2), or increased with treatment (N=2).

Conclusions
Automated quantitative volumetric analysis of patients with Rasmussen's encephalitis can accurately distinguish them from normal controls, on the basis of hemispheric asymmetry. This work was supported by R01 NS074980-01.
DTI atlas-based analysis in children with benign childhood epilepsy with centrotemporal spikes

L Pringle¹, K Carson², T Huisman³, A Poretti⁴, T Bosemani³
¹Johns Hopkins University - School of Medicine, Baltimore, MD, ²Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, ³The Johns Hopkins University School of Medicine, Baltimore, MD, ⁴Johns Hopkins University School of Medicine, Baltimore, MD

Purpose
Benign childhood epilepsy with centrotemporal spikes (BECTS) is a common epileptic syndrome in children. Neurocognitive studies however have shown that BECTS may not be benign, but it may be associated with disability in intellectual, attention, and executive functions. We aimed to investigate children with BECTS for microstructural changes in the brain as the possible morphological basis of neurocognitive deficits.

Materials and Methods
Inclusion criteria for this retrospective study were: 1) clinical and electroencephalographic diagnosis of BECTS, 2) availability of high quality diffusion tensor imaging (DTI) data without artifacts and 3) age at MRI 18 years and younger. The DTI data were acquired on a 1.5T MR scanner using a balanced pair of diffusion gradients along 20 noncollinear directions. We performed an atlas-based analysis of DTI data and calculated FA, MD, AD, and RD for 158 anatomical regions. Diffusion tensor imaging metrics of the patients were compared with age-matched controls using paired t-tests.

Results
Twenty-one patients (11 girls and 10 boys) with BECTS and 21 age-matched controls were included in this study. Compared to age-matched controls, decrease in MD, AD and RD was found in multiple white matter regions of patients. In addition, FA was reduced in several white matter regions of patients.

Conclusions
Changes in DTI metrics in multiple brain regions suggest that BECTS may involve the brain more diffusely than thought based on electroencephalographic data. Decrease in FA may reflect disruption of both axonal membranes and myelin, abnormalities of the myelin with sparing of the axons, or a reduced density of myelinated axons. The concomitant reduction of AD supports axonal injury. However, the lack of increase in RD is suggestive of no significant loss of neuronal or glial cellular density. Diffusion tensor imaging may serve as an important noninvasive tool in the evaluation of the microstructural substructure of neurocognitive functions in BECTS.
Purpose
Tuberous sclerosis complex (TSC) is one of the major causes of childhood epilepsy. A recent study compared diffusion tensor imaging (DTI) metrics between TSC patients and control subjects using tract-basis spatial statistics (TBSS), resulting in widely decreased fractional anisotropy (FA) of the cerebral white matter in TSC group (1). But, to our knowledge, there have been no reports analyzing the impact of epileptic activity on cerebral white matter by comparing the hemisphere that contains epileptogenic tuber with contralateral hemisphere. Thus, the purpose of this study is to evaluate the white matter change due to epileptogenic activity, and to explore their spreading pattern in TSC patients with intractable epilepsy TBSS (2).

Materials and Methods
Twenty-five patients (0.4-19.6 years old, median age of 3.3; 14 male and 11 female) with intractable epilepsy who underwent DTI between 2004 and 2013 were selected retrospectively from UCLA TSC cohort. Epileptogenic tubers were defined by semiology, EEG, FDG-PET, and magnetoencephalography. Epileptogenic tubers were found in right frontal lobe (n=3), right temporal lobe (n=3), right frontal and temporal lobe (n=1), right parietal lobe (n=4), left frontal lobe (n=5), left temporal lobe (n=5), left frontal and temporal lobe (n=1), left occipital lobe (n=2), and left parietal lobe (n=1). Patients with bilateral epileptogenicity were excluded from the analysis. Tract-basis spatial statistics was processed using Functional MR Imaging of the Brain Software Library toolbox (Version 5.0, http://fsl.fmrib.ox.ac.uk/fsl/fslwiki/) (3). The hemisphere with epileptogenic tuber (epileptogenic side) was first arranged to one side using left-to-right flipping in all DTI data. For spatial normalization, all subject's data were aligned into a common space by nonlinear registration using study specific target image created by TBSS. Skelletonized images, which represent the centers of all tracts common to all subjects, were compared symmetrically in DTI metrics including FA, mean diffusivity (MD), axial diffusivity (AD), and radial diffusivity (RD) between epileptogenic side and contralateral side using permutation analysis to determine significantly different clusters between the groups.

Results
Epileptogenic side showed significantly lower FA values at cingulum, anterior and posterior limb of internal capsule, cerebral peduncle, and middle cerebellar peduncle (Figure). Nonepileptogenic hemisphere showed significantly lower FA value at inferior occipitofrontal fasciculus. MD, AD and RD showed no significant differences between epileptogenic and nonepileptogenic sides.

Conclusions
We found that FA values of cingulum and corticospinal tract were significantly lower in epileptogenic side in TSC patients, suggesting that epileptogenic activity may influence the cerebral white matter network. Tract-basis spatial statistics might be a helpful tool to explore the mechanism of epileptic network in TSC patients (4).
DTI as a biomarker of self-injurious behavior in children with tuberous sclerosis complex

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Purpose
Self-injurious behavior (SIB) refers to behavior resulting in physical injury to one's own body. Self-injurious behavior has been observed in people with tuberous sclerosis complex (TSC) as well as individuals with intellectual disabilities, autism, Cornelia de Lange syndrome, Lesch-Nyhan disease, and Smith-Magenis syndrome. Our aim was to investigate children with TSC and SIB for volumetric and microstructural changes in selected anatomical brain regions compared to children with TSC without SIB.

Materials and Methods
Diffusion tensor imaging (DTI) data were acquired on a 1.5T MR scanner using a balanced pairs of diffusion gradients along 20 noncollinear directions. We performed an atlas-based analysis of DTI data and calculated number of voxels, FA, MD, AD, and RD for following regions: globus...
pallidus, putamen, caudate nucleus, amygdala, nucleus accumbens, hippocampus, hypothalamus, postcentral gyrus, and superior parietal gyrus. Abnormalities in these regions have been reported in other diseases with SIB. The diagnosis of SIB was made based on clinical criteria. Regression analysis adjusting for age was performed.

Results
We included six children with TSC and SIB (mean age 8.9±4.0 years) and 10 children with TSC without SIB (mean age 8.8±4.9 years). In children with TSC and SIB we found a reduced number of voxels for the bilateral globus pallidus (right, 216.17±23.73 versus 285.20±48.88, p<0.001; left, 219.83±18.62 versus 276.00±34.34, p=0.001) and caudate nucleus (right, 719.33±112.49 versus 930.90±198.86, p=0.003; left, 748.33±116.84 versus 904.90±116.83, p<0.001) as well as reduced FA for the bilateral globus pallidus (right, 0.236±0.014 versus 0.272±0.016, p<0.001; left, 0.219±0.016 versus 0.249±0.014, p<0.001) and left caudate nucleus (0.162±0.019 versus 0.189±0.020, p<0.001) compared to children with TSC without SIB.

Conclusions
These findings suggest a specific role for the globus pallidus and caudate nucleus in the pathogenesis of SIB in children with TSC.

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MRI characterization of cerebellar tubers in tuberous sclerosis complex: longitudinal follow up and associations with clinical manifestations

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Purpose
Cerebral cortical tuber is one of the major central nervous system (CNS) abnormalities in tuberous sclerosis complex patients, which is associated with epilepsy. In contrast to cerebral cortical tubers, the clinical manifestation of cerebellar tuber is still unclear. The purpose of this study was to review the imaging characteristics and their chronological change, and to explore the potential associations of cerebellar tubers with other CNS abnormalities in TSC patients.

Materials and Methods
Twenty-five patients (0.4-23.8 years old, mean age 7.3; 33 female, 17 male) with 28 cerebellar tubers were selected retrospectively from UCLA TSC. Two observers reviewed the imaging characteristics of cerebellar tubers as follows: number; location; signal characteristics on T1WI and T2WI; and the presence of contrast enhancement, contour deformity, mass effect, calcification, and associated vascular anomaly (AVA). These imaging characteristics also were reviewed if they showed interval change on follow-up MRI. The presence of SEGAs, cerebral tuber with cystic degeneration, autistic spectrum disorder (ASD), and infantile spasms (IS) also were assessed as other CNS abnormalities in TSC. Independent variables were compared using two-tailed paired t test. Nominal variables were compared between two groups divided by the presence of cerebellar tubers, the affected cerebellar hemisphere, or the cerebellar tuber with
interval changes by Pearson's chi-square test. A priori, results were considered significant at p < 0.05.

Results
Twenty-two patients had one cerebellar tuber and three patients had two. Fourteen tubers were seen in the right hemisphere. All tubers involved semilunar lobules with 25 (89%) tubers in superior semilunar lobule, 23 (82%) tubers in inferior semilunar lobule, and 20 (71%) tubers in both of them (Figure). Interestingly, all tubers were exposed to the horizontal fissure (arrows). All tubers showed high intensity on T2WI and eight (35%) showed heterogeneous signal change with high and low intensity due to calcification. On T1WI, 21 (75%) tubers were low, one (4%) tuber was heterogeneous signal of high and low intensities, and six (21%) were isointensity. All tubers showed contour deformity, nine tubers (32%) showed contrast enhancement, and 11 tubers (39%) showed AVA. Twenty-one patients with 24 tubers had follow-up MR, and 15 (63%) showed interval changes. One patient developed AVA resulting in parenchymal hemorrhage. Cerebellar tubers with interval change showed significant relationship with the presence of SEGA (p<0.01). No statistical significance was observed in other comparisons.

Conclusions
Cerebellar tubers commonly are located at the lateral cerebellar hemispheres, with a strong predilection for semilunar lobules, which is related to higher brain function. AVA may be an important imaging characteristic of cerebellar tuber and may cause parenchymal hemorrhage. Cerebellar tuber with interval change may be related to presence of SEGA. The radiologist may need to be aware of the dynamic nature of cerebellar tubers in TSC patients.
Cerebellar hypoplasia and dysmorphia in neurofibromatosis type 1

A Poretti¹, S Toelle², E Boltshauser³
Purpose
Unidentified bright objects and low grade gliomas are well known cerebellar abnormalities in neurofibromatosis type 1 (NF1). Literature reports on malformative cerebellar anomalies in NF1 however are very scant. We report on clinical and neuroimaging findings in five patients with NF1 and malformative cerebellar abnormalities.

Materials and Methods
Information about neurologic and cognitive functions were collected from review of the clinical history and follow-up examinations. All MRI studies were evaluated retrospectively for cerebellar structural abnormalities. We defined cerebellar hypoplasia as a 1) small cerebellar volume with otherwise normal cerebellar structure or 2) enlarged cerebellar interfolial spaces mimicking cerebellar atrophy, but stable clinical and imaging findings over time. Cerebellar dysmorphia has been coined to refer to anomalies related to size, shape (morphology), and extension of a cerebellar hemisphere.

Results
Five patients (4 females) with NF1 were included in this study. At the last follow up the age of the patients ranged between 6 and 29 years. Clinical cerebellar findings were present in two patients and learning disability in three. Cerebellar hypoplasia was found in two patients and cerebellar dysmorphia in three. In both children with cerebellar hypoplasia, the interfolial spaces of vermis and hemispheres were enlarged. In all patients with cerebellar dysmorphia, the affected hemisphere was enlarged and the interfolial spaces of its posterior part were widened. In addition, the postero-medial part was bulky and crossed the midline in its very posterior aspect.

Conclusions
Malformative cerebellar anomalies are a rare manifestation of NF1. The exact pathogenesis is unknown, but cerebellar hypoplasia has been shown in mutant NF1 mouse models. Malformative cerebellar abnormalities may have an impact on motor and cognitive functions of affected NF1 patients, but their exact significance needs to be verified in a larger cohort of patients.
11D-2

Common Data Elements and Standardized Reporting: Ready for Prime Time?

Flanders, A.
Thomas Jefferson Univ. Hosp.
Philadelphia, PA

11D-3

Decision Support for Neuroradiology

Kahn, C.
University of Pennsylvania
Philadelphia, PA

11D-4

Panel Discussion What is the Future of Meaningful Use in Neuroradiology?

Tuesday
3:15PM - 4:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

11E - PARALLEL SCIENTIFIC PAPER SESSION-PEDIATRICS TRAUMA
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Cerebral Contusional Tears in Abusive Head Trauma: Clinical and Imaging Features

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Purpose
Limited literature exists regarding clinical features and imaging characteristics of cerebral contusional tears in very young children. A remote case series utilizing cranial sonography established the presence of subcortical white matter tears as a marker of abusive head trauma (AHT), while a more recent case series reported cerebral cortical tears, similar to the previously described subcortical tears, however with disruption of the overlying cortex, in neonates with history of difficult vaginal delivery. Given our anecdotal experience with having identified this
type of lesion in AHT, we sought to evaluate the incidence, clinical and imaging features of contusional tears in children with AHT.

Materials and Methods
Retrospective database query of children from institutional child advocacy department services clinically diagnosed as physical abuse, presenting to a tertiary pediatric hospital system between 2010-2014, was performed after IRB approval. Only patients who had undergone both MRI and CT head examinations during the initial hospitalization post-trauma were included. Upon formal imaging review, the presence of cerebral contusional tears and other neuroimaging findings were recorded by one of two pediatric neuroradiologists. The electronic medical record was reviewed for pertinent clinical and other radiographic history.

Results
Over the 5-year period, 480 physically abused children were identified, of which 234 underwent both MRI and CT head examinations. Eleven patients (11/234) with a mean age of 15.8 months (range: 18 days to 34 months) demonstrated imaging findings consistent with cerebral contusional tear, almost exclusively involving the frontal and/or temporal lobes. All contusional tears involved the subcortical white matter, and none involved the overlying cortex. Hemorrhagic fluid levels were present within 10 (10/11) of the contusional tears, and overlying cortical thinning was present in three (3/11) patients. Neuroimaging findings also included: parenchymal hemorrhage (11/11), SDH (8/11), SAH (5/11), subpial hemorrhage (6/11), cortical vein thrombosis (4/11), hypoxic ischemic injury (6/11), and skull fractures (4/11). Other skeletal fractures were seen in 6/11. Six (6/11) patients demonstrated retinal hemorrhages. In follow up, nine (9/11) patients suffer from varying degrees of neurologic deficits and/or seizures. Two patients have normal neurologic development.

Conclusions
Cerebral contusional tear is an uncommon lesion in very young children with AHT. We presume that the lesion represents shear injury of the noncompacted, immature white matter in the infant brain. Associated features of hemorrhagic fluid levels and overlying cortical thinning may relate to the phase of injury. Radiologists should be aware of the imaging features of contusional tear and its association with pediatric abusive head trauma.
Can high-resolution susceptibility weighted imaging of brain demonstrate retinal hemorrhages in abusive head trauma?

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¹Penn State Milton S Hershey Medical Center, Hershey, PA
Purpose
To evaluate the detection of retinal hemorrhages on high resolution susceptibility-weighted imaging (SWI) of brain in abusive head trauma (AHT).

Materials and Methods
After IRB approval, retrospective analysis of SWI brain from January 2011 to July 2014 was conducted in 26 infants and young children with suspected abusive head trauma. Fourteen age-matched patients with SWI brain done for other reasons served as the control. Fundoscopic detection of retinal hemorrhages was considered the gold standard. No fundoscopy was done in the control group and they were presumed to be negative for retinal hemorrhage. Susceptibility-weighted imaging sequence with a standard slice thickness of 1.5mm was obtained on either 1.5T or 3T MRI with 20 channel head & neck coil. Unprocessed magnitude (Mag), processed magnitude (SWI) and minimum intensity pixel (mIP) images were assessed independently by two board certified neuroradiologists, who were blinded to the history and fundus examination. Qualitative grading of artifacts on each of these images was made on a 3-point scale. No effort was made to assess other neuroimaging findings of abusive trauma on SWI and other MRI sequences. A final agreement on presence or absence of retinal hemorrhage was reached after consensus.

Results
A final diagnosis of AHT was made with multidisciplinary consensus in 25 of 26 cases. Fundus examination results were available in 23 of 25 cases. Positive retinal hemorrhage on fundoscope was identified in the right eye (RE) in 17 cases (74%) and the left eye (LE) in 16 cases (70%). Observer one identified retinal hemorrhage on SWI in both eyes in six cases each. Observer two identified hemorrhage in RE in 10 cases and LE in six cases. After consensus, retinal hemorrhage on SWI was identified in RE in nine cases (39%) and in LE in seven cases (30%). In the control group, observer one identified false positive retinal hemorrhage in RE in no case and in LE in one case and observer two in no cases in both eyes. Prior to consensus, the interobserver agreement in the assessment of patient and control group was 0.87. Susceptibility-weighted imaging demonstrated a sensitivity of 48.5%, specificity of 100%, positive predictive (PPV) of 100% and negative predictive value (NPV) of 43.3.% to detect retinal hemorrhages in AHT cases. Combined analysis of SWI in AHT and control cases demonstrated a sensitivity of 48.5%, specificity of 95%, PPV of 89% and NPV of 70% to assess retinal hemorrhages. The investigators identified least artifacts in Mag images followed by SWI images. Relatively more hyperintense uveoretinal layer seems to make it easier to identify hypointense hemorrhage on Mag images. Worst artifacts were seen with mIP images.

Conclusions
High resolution SWI brain demonstrates moderate sensitivity and high specificity to detect retinal hemorrhages in AHT. Unprocessed magnitude images by minimizing artifacts may provide the best opportunity to detect retinal hemorrhages followed by processed magnitude images (SWI). Further studies are needed to understand the limitations and improve the detection of retinal hemorrhages with high resolution susceptibility-weighted imaging in AHT.

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Preliminary findings comparing ultrafast MRI brain and conventional MRI brain techniques in the non-accidental trauma pediatric population.
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Purpose
MR imaging (MRI) of the brain is helpful in detailing traumatic brain injury from nonaccidental trauma (NAT), but may require patient sedation in the pediatric population. The aim of this study is to investigate the efficacy of non-sedated ultrafast MRI sequences versus conventional MRI brain in diagnosing nonaccidental trauma.

Materials and Methods
IRB approval was obtained. Patients at a children's hospital referred for brain MRI imaging for NAT were imaged with an ultrafast technique without sedation, followed by traditional MRI with sedation or the use of a papoose, depending on standard clinical care at our institution. Ultrafast techniques consisted of sagittal T1 IPAT, coronal HASTE, axial HASTE, EPI FLAIR, T2*, and diffusion-weighted imaging (DWI). Each sequence requires less than 1 minute of scan time. Conventional MRI consists of axial and coronal T2 TSE, axial T1 TSE, FLAIR, SWI, DWI and sagittal T1 3D MPRAGE. A fellowship-trained neuroradiologist reviewed the ultrafast sequences blinded to the conventional sequences, noting extra-axial hematomas, contusions, and subdural membranes of differing intensities, specifically for the presence of a layering hematocrit and subdural membranes. The same review then was performed on the traditional MRI sequences and discrepancies were noted. The clinical significance of discrepancies and whether the exam was suspicious for NAT also were determined.

Results
Fifteen patients were included from 11/2013 to 12/2014 with a mean age of 3.7 months (10 males). Mean days between exams was 0.5 (0-6). 26.7% (4/15, P=0.01) had discrepancies between the ultrafast and conventional MRI, with only one of these discrepancies being clinically significant (6.7%, 1/15, P<0.001). 33.3% (5/15) of all exams were suspicious for NAT, with one of these exams demonstrating clinically significant imaging discrepancy (20%, P=0.057).

Conclusions
Preliminary data suggest that ultrafast sequences may be an alternative to the more time-consuming conventional MRI brain sequences in the work up for suspected NAT, particularly when sedation is undesirable.

O-222

Second Opinion Interpretations of Head CTs in Patients with Suspected Nonaccidental Trauma

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Purpose
To evaluate for discrepancies between the initial and secondary interpretations of head CTs referred for the suspicion of nonaccidental trauma at an academic children's hospital.
Materials and Methods
Following IRB approval, a review was performed on noncontrast head CTs from nonacademic hospitals that were submitted to an academic children's hospital for second interpretations for suspicion of nonaccidental trauma. Exams were reviewed independently by two fellowship-trained neuroradiologists, blinded to reports. Results were compared to the initial report and discrepancies were graded using the RADPEER scoring system. In cases of scoring differences, a consensus score was determined. Lastly, in cases reviewers found suspicious for nonaccidental trauma, the initial interpretation was analyzed for verbiage communicating this suspicion. McNemar's test was performed for the significance of discrepancy.

Results
From 2/2011 to 10/2014 a total of 58 exams were included. The median age was 6.75 months (range 0-70.6 months, M:F, 1.4:1). Table 1 demonstrates details from RADPEER scoring. There was a discrepancy rate of 36% between the initial and secondary interpretations. 18.9% were categories 3 and 4, and 10.3% were category 4b. According to Jackson et al, the combined incidence of categories 3 and 4 should be less than or equal to 0.5%. Sixteen percent had imaging findings that were suspicious for nonaccidental trauma. Of these exams, only one initial report (1/9, 11%, p=0.008) discussed the possibility of nonaccidental trauma.

Conclusions
There is a high discrepancy rate with clinical significance between initial nonacademic and secondary academic interpretations of noncontrast head CTs among pediatric patients with suspicion of nonaccidental trauma. Also, the discussion of potential nonaccidental trauma in the initial report was rare, even among patients with highly concerning imaging findings. These findings indicate a significant value for second interpretations by neuroradiologists at an academic children's hospital.
Superficial Parenchymal-Leptomeningeal (Subpial) Hemorrhage in Abusive Head Trauma

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Purpose
Limited literature exists regarding superficial parenchymal-leptomeningeal (subpial) hemorrhage, with only a single case series reporting this rare type of hemorrhage as a post vaginal birth phenomenon in otherwise healthy term neonates presenting with apnea and/or seizures. Given our anecdotal experience with having identified this rare type of hemorrhage in abusive head trauma (AHT), we sought to evaluate the incidence, clinical and radiographic features of subpial hemorrhage in this population and to etiologically support this entity as being post-traumatic in nature.
Materials and Methods
Retrospective database query of physically abused children from institutional child advocacy department services clinically diagnosed as such presenting to a tertiary pediatric hospital system between 2010-2014 was performed after IRB approval. Only patients who had undergone both MRI and CT head examinations during the initial hospitalization post-trauma were included. Upon formal imaging review, the presence of subpial hemorrhage and all other neuroimaging findings was recorded by one of two pediatric neuroradiologists. The electronic medical record was reviewed for pertinent clinical and other radiographic history.

Results
Over the 5-year period, 480 physically abused children were identified, of which 234 underwent both MRI and CT head examinations. Nine patients (9/234) with a mean age of 7.08 +/- 10.82 months demonstrated imaging findings consistent with subpial hemorrhage, mostly in a fronto-parietal location. Neuroimaging findings included: SDH (8/9), SAH (8/9), parenchymal hemorrhage (9/9), contusional tear (4/9), cortical vein thrombosis (6/9), hypoxic ischemic insult (7/9), and skull fractures (4/9). Other skeletal fractures were seen in 4/9, with an additional three separate patients (3/9) demonstrating multisite cutaneous bruising. Six (6/9) patients demonstrated retinal hemorrhages. In follow up, seven (7/9) patients suffer from varying degrees of neurologic deficits and/or seizures. One patient (1/9) died as a result of AHT, while another is neurodevelopmentally normal.

Conclusions
Superficial parenchymal-leptomeningeal (subpial) hemorrhage is an uncommon phenomenon in very young children with AHT, supporting that this scarcely reported entity is etiologically posttraumatic in nature.
Diffusional Kurtosis Imaging in the Setting of Non-Accidental Trauma

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Purpose
One and one-half million nonaccidental trauma (NAT) cases are identified each year with central nervous system (CNS) injuries being the leading cause of fatality (CDC, 1990). However, the mechanism of injury is still unknown. Since advanced diffusion MRI techniques are powerful tools for evaluating tissue microstructure, we hypothesize that diffusion kurtosis imaging (DKI) may provide insights into suspected NAT pathology.

Materials and Methods
Following IRB approval, nine suspected NAT subjects (7 males, aged 13 days-17 months) receiving brain MRI for clinical purposes within 5 days of admission were studied along with age-matched normal controls (aged 9 days-17.6 months). Structural images and mean kurtosis (MK) and apparent diffusion coefficient (ADC) maps were evaluated. Regions of interest (ROIs) in white matter (WM) regions noted to have significant abnormalities were defined using Image J software (http://imagej.nih.gov/ij/).

Results
Compared with normal controls, MK maps from NAT subjects demonstrated elevated MK values at sites of focal injury seen on structural images. In more severe cases, WM abnormalities suggestive of hypoxic ischemic injury were seen on MK maps that generally corresponded to the ADC maps but were more conspicuous. For example, Figure 1A (ADC) and Figure 1B (MK) of a 2.5-month old infant demonstrated high MK and low ADC involving the cortical spinal tracts. In another 13-month old infant, abnormalities were seen in the cortical spinal tracts on MK (Figure 1D) not present on the ADC map, which presumably had already normalized (Figure 1C). Due to the small sample size, differing clinical histories and injury severity, group analysis was not performed.

Conclusions
This pilot project investigated the utility of DKI in cases of suspected NAT. Mean kurtosis maps provided distinct information concerning injury patterns compared with conventional imaging. Further exploration of WM abnormalities identified by DKI analysis is warranted to help elucidate the mechanisms underlying suspected NAT pathology.
Diffusional Kurtosis Imaging Reveals Head-Impact Associated Changes in Brain White Matter after a Single Season of Varsity High School Football

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Purpose
Diffusional kurtosis imaging (DKI) is an extension of diffusion tensor imaging that allows characterization of non-Gaussian effects of diffusion \cite{1}, which may be important for the evaluation of brain tissue microstructural changes associated with repeated head impact exposure in high school football. The purpose of this study was to determine if cumulative effects of subconcussive head impacts during a single season of high school football produce DKI changes in brain white matter.

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 MRI with DKI. Conventional diffusion metrics, fractional anisotropy (FA) and mean diffusivity (MD), as well as metrics reflecting the diffusional kurtosis, specifically mean kurtosis (MK), axonal water fraction (AWF) and tortuosity, were used to determine total number of abnormal post minus preseason white matter voxels (defined as two standard deviations above or below group mean). Risk-weighted cumulative exposure (RWE) was computed from HITs data, including combined linear and rotational components (RWECP) \cite{2}. This metric represents the cumulative risk of concussion over the course of the season.

Results
Regression analysis adjusted for age, body mass index and time between scans revealed a statistically significant linear relationship between RWE_CP and number of abnormal voxels for FA (adjusted R\textsuperscript{2}=0.49, p=0.0024), MD (adjusted R\textsuperscript{2}=0.46, p=0.00072), MK (adjusted R\textsuperscript{2}=0.46, p=0.0049), AWF (adjusted R\textsuperscript{2}=0.63, p=0.00023), and tortuosity (adjusted R\textsuperscript{2}=0.35, p=0.021).

Conclusions
Conventional diffusion and kurtosis metrics demonstrate brain white matter changes associated with cumulative nonconcussive head impact exposure following a single season of high school football, but the kurtosis metric, AWF, explained the most variance. Changes in AWF are thought to correlate strongly with alterations of axonal density \cite{3}, suggesting a potential mechanism for these head-impact related changes.
Purpose
Previous studies have reported that sports-related concussions can lead to changes in the gross brain structure. The purpose of this study was to determine if cumulative "subconcussive" head impact exposure affects gray matter volume and gray matter microstructural integrity after one season of high school football. A second purpose was to characterize these effects during practices versus games.

Materials and Methods
Twenty-eight male football players (ages 15-18 years) with no history of concussion were instrumented with the head impact telemetry systems (HITs) during all practices and games. All players received pre and postseason MRI, including a high resolution isotropic T1-weighted sequence and diffusion kurtosis imaging (DKI), from which gray matter volume and gray matter diffusion metrics were acquired. These MRI measures were used to determine total number of abnormal post minus preseason gray matter voxels (defined as two standard deviations above or below group mean) in 19 of the players with complete data sets. Risk-weighted cumulative exposure (RWE) was computed from HITs data, including combined linear and rotational components (RWECP) (1). This metric represents the cumulative risk of concussion over the course of the season.

Results
Head impact telemetry systems data revealed that 56% of head impacts occurred during practices rather than games. Regression analysis adjusted for age, body mass index and time between scans demonstrated a statistically significant linear relationship between RWEcp and number of abnormal gray matter voxels, which primarily was associated with the cumulative exposure attributed to practices rather than games (Table 1).

Conclusions
Volumetric and diffusion metrics demonstrate brain gray matter changes associated with nonconcussive head impacts following a single season of high school football. These changes primarily were associated with the cumulative exposure attributed to practices rather than games raising the possibility that altering practice methods could diminish potential risks associated with cumulative nonconcussive head impact exposure.
### Table 1: Linear Regression Results

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<th>Unadjusted</th>
<th>Adjusted for age, between</th>
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<tr>
<td></td>
<td>Adjusted R²</td>
<td>p-value</td>
<td>Adjusted R²</td>
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<tr>
<td>PRACTICES</td>
<td></td>
<td></td>
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<tr>
<td>RWEcp vs GM Volume</td>
<td>0.4824</td>
<td>0.0035*</td>
<td>0.6928</td>
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<tr>
<td>RWEcp vs MD</td>
<td>0.5284</td>
<td>0.0019*</td>
<td>0.6698</td>
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<tr>
<td>RWEcp vs FA</td>
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<td>RWEcp vs C_S</td>
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<td>0.7712</td>
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<td>0.0005*</td>
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<td>RWEcp vs C_L</td>
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<td>0.0379*</td>
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<tr>
<td>RWEcp vs Radial</td>
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<td>0.0197</td>
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<td>RWEcp vs MD</td>
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<tr>
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<td>RWEcp vs C_p</td>
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* denotes p<0.05, RWEcp = risk weighted cumulative exposure (combined linear rotational components), GM = gray matter, MD = mean diffusivity, FA = fractional anisotropy, C_S = spherical diffusivity, C_p = planar diffusivity, C_L = linear diffusivity, MK = mean kurtosis.
Purpose
To correlate volumes of parenchymal traumatic brain injury (TBI) and extra-axial hematomas to outcome in the pediatric population.

Materials and Methods
Following IRB waiver, a review was performed on a radiology database for patients less than 18 years of age with brain MRI utilizing the search terms "trauma", "MVC", "TBI", and "traumatic brain injury". The results then were filtered manually to include all cases which contained at least asusceptibility-weighted image (SWI), diffusion-weighted image (DWI) and FLAIR sequence and electronic medical record follow-up exam documenting functional status. Patients with craniotomies at the time of MRI exam were excluded. Contusion, subdural and epidural volumes were measured manually on the FLAIR, while ischemia volumes were measured on DWI sequences. Diffuse axonal injury (DAI) was quantified by counting the number of punctate hemorrhagic foci on SWI and punctate cytotoxic foci on DWI in the deep white matter. Patient follow-up exam was assigned a Glasgow Outcome Scale (GOS) score and correlated with the quantified results.

Results
From 1/2012 to 8/2014 a total of 15 patients were included. The mean age was 8.8 years (range 3-15). Average time of MRI after traumatic event was 2.9 days (range 0-13). Average time to follow-up exam was 8 months (range 1-27). Out of all of the quantified results of traumatic brain injury, only ischemia volumes had significant negative correlation with outcome (P=0.0002). Detailed results are included in Table 1.

Conclusions
In our patient population, contusion volume, number of DAI lesions, and extra-axial hematoma volumes had no significant correlation with outcome, suggesting that these types of TBI lesions have little impact in the GOS score in children. Only ischemia volumes had significant negative correlation with outcome.

<table>
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<th>Type of TBI</th>
<th>Pearson's Correlation Coefficient (r)</th>
<th>Significance</th>
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</thead>
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<tr>
<td>Total Contusion Volume</td>
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<td>P=0.60</td>
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<tr>
<td>Total Subdural Hematoma Volume</td>
<td>-0.13</td>
<td>P=0.64</td>
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<tr>
<td>Total Epidural Hematoma Volume</td>
<td>0.058</td>
<td>P=0.84</td>
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<tr>
<td>DAI Lesions</td>
<td>-0.15</td>
<td>P=0.60</td>
</tr>
<tr>
<td>Total Ischemia Volume</td>
<td>-0.82</td>
<td>P=0.0002</td>
</tr>
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</table>

Table 1. Correlation of quantified traumatic brain injury lesions to GOC score. (Filename: TCT_O-228_TBI_correlation.jpg)

O-229

Limitations of T2*-GRE and SWI in Characterizing Chronic Subdural Hematomas
Purpose
Most literature on dating subdural hematomas refers to T1 and T2 signal, without discussion of T2*-gradient-recalled echo (GRE) or susceptibility-weighted imaging (SWI). It commonly is believed that traumatic chronic subdural collections bloom on T2*-GRE/SWI. We present five infants with chronic subdural collections secondary to nonaccidental trauma (NAT) demonstrating lack of blooming on T2*-GRE/SWI sequences. We review the literature on MR appearance of evolving subdural hematomas.

Materials and Methods
We queried subdural collection drainage procedures performed at Primary Children's Hospital from 2009-2014. Cases selected were infants with confirmed NAT, chronic subdural collections, and MR imaging within 1 week of surgery.

Results
In all five cases, the operative report described chronic subdural hematomas or hematohygromas. In all cases, the subdural collection T2*-GRE/SWI signal intensity was similar to CSF (Figure a). With three cases, subdural hematoma was suggested based on minimal hemosiderin staining along membranes (Figure b) and increased FLAIR (Figure c) and T1 (Figure d) signal. Two cases showed a cerebrospinal fluid (CSF)-like signal on all sequences, without hemosiderin staining. Any subdural collection can be due to trauma (1). However, absence of blooming on T2*-GRE/SWI does not exclude a chronic subdural hematoma. Subdural blood undergoes the same evolution as intraparenchymal blood, just slower due to greater oxygen tension in subdural fluid (2). Blood breakdown results in two components: hemosiderin and hemochromes. Hemosiderin is paramagnetic/ferromagnetic, blooms on T2*-GRE/SWI, and is variably present within chronic subdural hematomas (2, 3). Hemochromes are nonparamagnetic, contribute to increased T1 and FLAIR signal, but lack susceptibility effects. Finally, many chronic subdural collections likely contain a component of CSF, which further simplifies the signal (1).

Conclusions
Any subdural collection in nonambulatory children is concerning for trauma. However, lack of blooming on T2*-GRE/SWI sequences does not exclude a chronic subdural hematoma. When present, T1/FLAIR hyperintensity is a helpful marker of nonsimple subdural fluid, and hemosiderin staining is diagnostic of old blood products.
Multicontrast Capable MAGiC synthetic MR Of The Brain Can Replace Conventional Sequences And Reduce Examination Times

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1Icahn School of Medicine at Mount Sinai, New York, NY, 2Mount Sinai Medical Center, New York, NY, 3The Mount Sinai Hospital, New York, NY

Purpose
Conventional serial acquisition of multiple MR image contrasts requires proportionately lengthy exam times and regimens are limited by practical concerns such as scanner throughput and patient satisfaction. With longer scan regimens, patient tolerance and motion become an increasing challenge. Synthetic MR [MAGiC (Magnetic resonance image compilation) GE Healthcare, Waukesha, WI] uses a saturation prepared multiecho FSE pulse sequence to generate six different image contrasts (T1, PD, T2, T2 FLAIR, T1 FLAIR, STIR) in a single 4-5 minute scan. Once quantitative T1, T2, and PD maps are acquired contrast at any TR and TE can be generated automatically or retrospectively by manipulating TE, TR, TI values on a viewer. We added synthetic MR to our routine brain imaging protocol with the aim to evaluate consistency, contrast, and quality of Synthetic MR Acquisitions in comparison to conventional techniques in day to day practice.

Materials and Methods
Thirty patients were scanned with MAGiC Synthetic MR (MAGiC) as part of a routine protocol on a clinical 3T MR scanner (Discovery HD 750 GE Healthcare, Waukesha, WI). Images were reviewed retrospectively by two neuroradiologists who assessed image quality compared to conventional T1, T1 FLAIR, T2 FLAIR and T2 acquisitions employed in the evaluation of suspected or known neurologic disease. Results were compared with paired Wilcoxon test.

Results
MAGiC synthetic MR provides multiple image contrasts which compared favorably with traditional techniques used in clinical practice.

Conclusions
MAGiC synthetic MR is a practical and reliable method of providing multiple contrasts in a single scan which compare favorably with traditional techniques. The use of synthetic MR may allow shorter examination times and improve patient tolerance while providing a broader range of contrast than currently is practical.
Determination of the Minimum Mean Structural Similarity Index (mSSIM) Necessary to Preserve Image Quality When Utilizing Compressed Sensing MR in Neuroimaging

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Purpose
Compressed sensing MR (CS MR) is a novel technique to undersample k-space, dramatically decreasing image acquisition time. However, the degree of undersampling that affects image quality in the clinical setting has not been evaluated. A quantitative measure of image quality, such as the mean structural similarity index (SSIM), would be useful to quantitate image adequacy for CS MR protocol development. The mean SSIM (mSSIM) determines how alike an undersampled image is to a full acquisition image using local pixel intensity, normalized by luminance and contrast to develop a quantitative metric of human-perceptible changes in structural information. Our purpose was to determine the minimum sampling necessary to achieve image quality that is indistinguishable from conventional MR acquisition by a subspecialist neuroradiologist and to objectively quantify that minimum image quality utilizing mSSIM.

Materials and Methods
Twelve axial images were selected as controls in an IRB approved, HIPAA-compliant retrospective analysis of 11 high resolution volumetric brain MR studies for epilepsy. The brain MR images were undersampled in the Fourier domain to simulate compressed sensing MR, and multiresolution SPIRiT (iTerative Self-consistent Parallel Imaging Reconstruction) was used to reconstruct the images at four degrees of k-space undersampling (27.5%, 42.5%, 55.3% and 91.3%) using MATLAB (MathWorks Natick, MA). Qualitative evaluation of images was performed by five fellowship-trained neuroradiologists in academic practice, who performed 48 blinded, randomized 10-second binary fixed choices, selecting the best technical quality between a conventional axial brain MR image and an adjacent undersampled image of the same slice. Quantitative evaluation of image quality for each image was determined by calculating the mSSIM. Perfect similarity results in an mSSIM of 100%. The mSSIM values of the multiresolution SPIRiT undersampled images ranged from 92-99%.

Results
Images undersampled by collecting 27.5% and 42.5% of k-space with 92 and 95% mSSIM, respectively, were all rated as lower quality by the interpreting radiologists. Images sampled at 55.3% of k-space with a 97% mSSIM were detected as inferior image quality in 99.7% of cases. Images undersampled at 91.3% of k-space with a 99% mSSIM were perceived as lower image quality in over three quarters of cases (77.6%).

Conclusions
Decreases in even 1% of the mSSIM, corresponding to undersampling of k-space by less than 10%, are detectable by subspecialist neuroradiologists and indicate the presence of perceptible technical quality reduction for brain MR. A mean SSIM 97% or less is associated with consistently compromised subjective image quality. These findings may help establish how to interpret mSSIM values in quantitating imaging quality in the development of compressed sensing brain MR protocols. Even modest applications of CS MR may affect image quality in the clinical setting.

O-232

Initial Experience with a Head-only Asymmetric Gradient System Utilizing 80 mT/m and 500 T/m/s
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1Mayo Clinic, Rochester, MN, 2GE Global Research, Niskayuna, NY, 3GE Global Research, Niskayuna, NY

Purpose
A second generation asymmetric head gradient coil has been developed as part of a program to build a compact 3T head-only MR imaging system. The expected total weight of the system is a quarter to a third of a standard whole body 3T system and only 12 liters of helium will be required for magnet cooling compared with 2,000 liters typically needed. The purpose of this study was to conduct initial human imaging with the gradient coil.

Materials and Methods
Healthy volunteers were scanned under an IRB-approved protocol. The asymmetric head gradient coil was mounted inside a whole-body 3T scanner (MR750w, GE Healthcare, Waukesha, WI) and was interfaced with the scanner's systems. Within a 37 cm inner-diameter birdcage T/R coil a Nova 32-channel head receiver array (Nova Medical Inc., Wilmington, MA) was positioned. Several standard clinical sequences including sagittal T1 MPRAGE, axial T2 2D fast-recovery FSE and sagittal T1 3D MPRAGE were acquired. For all acquisition the gradients were operated at 80 mT/m and 500 T/m/s simultaneously.

Results
Volunteer scans demonstrated excellent image quality including the skull base. The coil was able to achieve large (24-26 cm) FOVs with coverage into the upper cervical spine including visualization of the C4-5 interspace. The peripheral nerve stimulation (PNS) threshold with this asymmetric gradient coil design is much higher than a state-of-the-art body-size neuroscanner gradient coil. None of the subjects reported PNS and with use of earplugs the noise level was acceptable.

Conclusions
This gradient coil is part of a project to develop a high performance brain imager with lower costs, that is easier to site and is more accessible than standard whole body systems. We anticipate that the imager will serve as an ideal platform for advanced imaging of the brain and brain function.

O-233

Utility of real-time prospective motion correction (PROMO) for segmentation of cerebral cortex: voxel-based morphometry (VBM) analysis on 3D T1-weighted imaging

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1Department of Radiology, University of Occupational and Environmental Health School of Medicine, Kitakyusyu, Fukuoka, 2Department of Radiology, Nihon University School of Medicine, Tokyo, Tokyo

Purpose
PROspective MOtion correction (PROMO) can correct motion artifacts of the 3D T1-weighted image by using orthogonal spiral navigator acquisitions that estimate head motions. We assessed
the reliability of PROMO for the segmentation of the cerebral cortex visually and quantitatively using a voxel-based morphometry (VBM) analysis.

Materials and Methods
High resolution 3D T1-weighted imaging was obtained by MP-RAGE sequence at 3.0T MRI. Following scans were obtained on a healthy subject: 1) static scans with /without PROMO where the subject was asked to stay as still as possible and 2) motion scans with/without PROMO where the subject was asked to repeat two types of staged motions ("side-to-side" and "nodding"); each scan was acquired eight times. We used FreeSurfer for the VBM analysis. First, two neuroradiologists assessed the cortical segmentation on each scan visually using a 3-point scale as good, adequate, or poor. Then, among the static and the motion scans with/without PROMO, we compared the cortical volume of the left cerebral hemisphere calculated by the FreeSurfer quantitatively.

Results
For the visual assessment of the cerebral cortical segmentation, both of the motion scans (side-to-side and nodding) without PROMO were rated as poor, whereas the motion scans with PROMO were good or adequate; both motion scans with PROMO showed nearly equal ratings to the static scan (Figure). For the mean cortical volume calculated, there was no significant difference among the four scans (static scans with/without PROMO, and the side-to-side and nodding motion scans with PROMO: 236.2, 236.4, 233.8, and 234.3 ml, respectively).

Conclusions
There were no significant differences of the cortical volume among the static scan and the motion scans with PROMO. Our results indicate that PROMO allows the correct segmentation of the cerebral cortex in VBM analysis for "uncooperative" patient populations such as Parkinson disease and dementia.
Grey Matter Based MRI Intensity Normalization Improves automated Segmentation Of White Matter Lesions

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¹University Medical Center Hamburg-Eppendorf, Hamburg, Germany, ²University Medical Center Muenster, Muenster, Germany

Purpose
Intensity normalization is an essential preprocessing step in white matter (WM) lesion segmentation pipelines and commonly based on brain MRI histogram mapping. However,
intensity normalization is influenced severely by extensive WM lesions. Our goal was to develop an improved intensity normalization algorithm based on gray matter (GM) content which is not influenced by WM lesions.

Materials and Methods
Standard GM and WM partial volume estimates derived from a FLAIR template were multiplied with FLAIR images resulting in FLAIR GM and WM intensity maps (GMI, WMI). For normalization, histograms of GMI were thresholded decile-wise and each mapped into the corresponding standard histogram decile. WMI were masked with each binarized GMI decile map and decile-wise histogram mapping performed accordingly. Intensity normalized FLAIR images were generated by adding all normalized WMI deciles and GMI deciles (Figure 1).

Results
Compared to standard normalization technique, the applied GM-based technique increased contrast between normal appearing WM and WM lesions in FLAIR, while GM values remained constant for both techniques. Contrast to noise ratios (CNR) between GM and WM lesions were decreasing with conventional technique in comparison to the unnormalized image but clearly increased in GM-based normalized images.

Conclusions
The presented GM-based intensity normalization technique improves intensity comparability between patients with differing WM lesion loads in comparison to standard normalization techniques. Contrast of normal WM and WM lesions is increased facilitating automated WM lesion segmentation in preliminary results.
Advanced Multiparametric MRI Reveals Detailed In Vivo Brainstem Anatomy at 3-T

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Purpose
Routine MRI can only infer internal brainstem anatomy by correlation of surface landmarks to expected location of underlying individual structures. The purpose of our study was to demonstrate brainstem anatomy using T2 maps and diffusion track density imaging using clinically feasible acquisition times.

Materials and Methods
A conventional MRI protocol was modified to include a multispin echo (MSE) T2-weighted sequence (TR 5100, TE 110, Matrix 384 x 234, 2.0 mm slice thickness, NA 2, 6 min) and high angular resolution diffusion sequence with 4-slice multiband slice acceleration (3-mm isotropic resolution, b-value = 2500 s/mm², 256 directions, 8 minutes) on a 3-T Skyra MRI (Siemens Healthcare). T2 and proton density (PD) maps of the brainstem were generated using a recently described software package (1). Track density and diffusion direction-encoded images were created at 500-um isotropic resolution using 500k probabilistic tractography seeds to generate constrained spherical deconvolution model of the diffusion data (2, 3). All MRI data were evaluated at six levels, including rostral and caudal midbrain, pons and medulla (4, 5).

Results
Advanced MRI sequences utilizing T2, PD, and TDI maps reveal exquisite internal brainstem anatomical details in clinically feasible scan times that is not detected using conventional MRI. For example, the medial lemniscus, spinothalamic tract and corticospinal tract (including decussation) could be identified directly using either T2 or TDI maps. TDI can resolve the corticobulbar, corticospinal, and corticopontine fibers within the crus cerebri. T2 maps could identify the medial longitudinal fasciculus in the midbrain and pons. Additional level by level anatomical detail will be presented.

Conclusions
Recent MRI sequence and postprocessing innovations enable direct in vivo visualization and resolution of many brain stem internal features using clinical feasible acquisitions on a 3T MRI scanner. This should be useful for image segmentation and neurosurgical planning.
Clockwise starting with top left: MSE T2, EMC T2, EMC PD, DEC and Color TDI at the level of the rostral pons.
T1 Signal Hyperintensity in the Deep Cerebellar Nuclei Following Repeated Administrations of Gadolinium-Based Contrast Agent in Rats: Link with the Molecular Structure?

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¹Guerbet, Roissy CDG Cedex, France

Purpose
To compare the occurrence of signal hyperintensity in the deep cerebellar nuclei (DCN) on T1-weighted MRI in rats receiving repeated administrations of two gadolinium-based contrast agents (GBCAs).

Materials and Methods
Healthy rats (n=6/group) received 20 intravenous injections of 0.6 mmol Gd/kg (4 injections/week, 5 weeks) of either gadodiamide (linear and nonionic GBCA), or gadoterate meglumine (macrocyclic and ionic GBCA). Control group received 20 administrations of saline iso-osmolar to gadoterate (1350 mOsm/kg H2O). T1-weighted MRI was performed once per week during the treatment period (i.e., following 0, 4, 8, 12, 16 and 20 injections) and after an additional 5-week treatment-free period (Bruker® 2.35 T). Rats were euthanized at the end of the treatment-free period. Total Gd levels were measured (ICP-mass spectrometry) in the plasma and cerebellum. Blinded qualitative and quantitative evaluations of the DCN T1 signal intensity were performed.

Results
A progressive increase in T1 signal intensity in DCN was observed only in the gadodiamide group. The contrast to noise ratio was 2.77±1.40 following 20 injections of gadodiamide [p<0.001 versus gadoterate (-1.07±1.32) and p<0.01 versus saline [0.03±1.43)]. Figure 1 shows typical cerebellum images 3 days after 20 injections and anatomy of rat brain with localization of DCN. The T1 signal hyperintensity was still present at completion of the treatment-free period in the gadodiamide group. No signal enhancement was observed with gadoterate and saline. Total Gd levels were higher in the cerebellum (3.7±0.8 nmol/g) in gadodiamide group versus the saline (0.07±0.1 nmol/g, p<0.001) and gadoterate (0.3±0.1 nmol/g, NS) groups.

Conclusions
Progressive T1 signal enhancement of DCN was evidenced after repeated administrations of the linear GBCA gadodiamide in rats, while no effect occurred with either hyperosmolar saline or the macrocyclic GBCA gadoterate. Future studies should determine if gadodiamide-induced T1 enhancement in DCN is associated with local Gd ion release.
Purpose
There are seven gadolinium-based contrast agents (GBCA) approved by the FDA for use in patients undergoing MRI scans of the central nervous system (CNS). In our search of literature, no such serial dilution study involving also the GBCA most recently FDA-approved for neuroradiologic application yet has been performed. We performed an in vitro serial dilution study to identify relaxivity similarities and differences among these seven agents as may be evident during clinically realistic MR imaging sequences.

Materials and Methods
All seven GBCA FDA-approved for central nervous system (CNS) application were serially diluted in Seronorm (human serum substitute). A phantom was constructed of all 7 GBCA using 10 successive 50% dilutions of each agent between 1:8 and 1:4096 except for Gadavist that was studied using 10 successive 50% dilutions from 1:16 to 1:9192. Since Gadavist is distributed as a 1M concentration and the other six agents as 0.5M solutions but all seven agents are approved to be administered at the same delivered gadolinium dosage, this ensured that all seven agents were studied and compared at the identical dosages that would be seen on standard dose administration to clinical patients. MR imaging was performed on all the dilutions using both spin and gradient echo MR imaging sequences, varying TR values between 100 and 8000 ms, and flip angle between 10 degrees through 90 degree. The signal intensity from each dilution for each GBCA was measured for each MR imaging sequence and recorded and analyzed in Excel spreadsheets.

Results
Significant similarities were seen among the various agents, but significant differences in both signal intensity and peak intensities were observed in others. With parameters similar to those for T1-weighted imaging in clinical scans, the highest signal intensities were reproducibly measured for gadobenate (Multihance). Similarly in scans performed with longer TRs and TEs emphasizing differential T2 decay information, the signal intensity loss was greatest with gadobenate (Multihance). This study confirms the higher R1 and R2 relaxivities of gadobenate...
(Multihance) relative to both the older GBCAs as well as the newer agents gadobutrol (Gadavist) and gadoterate (Dotarem) introduced in clinical CNS imaging. These findings are potentially useful in potential administered dose modification, optimization of MR imaging scanning parameters and shortening scanning times.

Conclusions
Clinical relevance: Variations in (r1 and r2) relaxivity exist among the various GBCA FDA-approved for neuroradiologic application. These have potentially clinically significant ramifications for decisions regarding optimal dosing and imaging parameter selection among the various agents for both on-label and off-label uses to which these agents routinely clinically are applied.

Improved Detectability of Low-Contrast Lesions on Lower-Dose Head CT by Maximizing Iterative Reconstruction
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¹VA San Diego Healthcare System, San Diego, CA, ²VA San Diego Healthcare System / UCSD Med. Center, San Diego, CA

Purpose
To demonstrate quantitative and qualitative improvement in contrast-to-noise ratio (CNR) and detectability of low contrast lesions on lower dose head CTs through maximal application of iterative reconstruction (IR). Iterative reconstruction is a reconstruction method typically used to lower CT radiation dose with qualitatively equivalent images to conventionally reconstructed higher dose studies by decreasing image noise. Maximal noise reduction IR should improve CNR and detectability of low contrast lesions compared to standard reconstruction at the same dose.

Materials and Methods
Two neuroradiologists retrospectively reviewed patients with head CT and subsequent MRI within 1 week showing an acute hypodense lesion between September 2013 to March 2014, wherein CT included standard reconstruction at 5 mm and maximum IR at 5 mm and 2.5 mm slice thickness. Cases were excluded for lack of acute MRI lesions or lesions not retrospectively visible on any CT algorithm. On standard and IR images, regions-of-interest (ROIs) were measured in acute lesions retrospectively identified on the subsequent MRI, normal gray matter (GM), normal white matter (WM), and contralateral normal corresponding tissue (background). Contrast-to-noise ratios between GM and WM and between lesions and background were calculated. Contrast-to-noise ratios between standard and IR was compared with paired Student's t-test. Subjective comparison of lesion visibility was performed between matched thickness standard and IR images and between the two IR thicknesses.

Results
Forty cases with 40 lesions were included. Lesion to background CNR was better on IR (avg=0.75 versus 1.20) (p = 1.14 x 10^-6). Gray-white CNR is improved by IR (avg=0.94 versus 2.06) (p = 3.30 x 10^-9). All lesions were rated equally or more visible on IR images (Figure 1B, C) than standard (Figure 1A) with three considered not prospectively detectable on standard reconstruction.

Conclusions
Low density lesion detectability and conspicuity can be improved significantly without additional acquisition time or radiation by using maximal IR as an additional image series.
Purpose
Results by others (1) and an anomalous histogram finding during rat myelography (2) lead us to suspect that gadolinium contrast agents may be voltage dependent at neuronal membrane surface voltages. We have begun computational modelling of macrocyclic gadolinium-based agents to determine if the Gd-H2O bond lengths change in an electric field and compare molecules with a few exploratory alkyl side chains.

Materials and Methods
Calculations were performed at the density functional level of theory using Gaussian 09 (3). Structures were constructed manually and optimized under tight conditions, while ignoring symmetry, in the presence of water modeled as a polarizable continuum solvent. Spin multiplicities and stabilities initially were determined using the BP86 exchange-correlation functional with Stuttgart Dresden relativistic pseudo-potential basis sets. On the basis of improved performance, final geometries were obtained using TPSSH/SDD (4). To investigate possible structural changes as a function of electric multipole field, a general field was considered for complexes with longer alkyl chains, modeled as a negative hexadecapole field in the range of .05-1.6 eV.

Results
Molecular structures and Gd-H2O bond lengths are shown in the attached figure. Optimizations converged for field strengths of .05-1.05 eV, and corresponded to structures with an average Gd-H2O bond distance of 2.51 Å. This distance was slightly shorter than the same Gd-H2O bond (2.53 Å) in the absence of electric field.

Conclusions
Macrocyclic Gd-H2O bond lengths theoretically can undergo a one percent change in the presence of physiologic neuronal electric fields. This small change can affect observed tissue contrast (5). Because gadolinium contrast enhancement has multiple components (degrees of freedom, hyperfine interactions and paramagnetic effects), it appears likely that some agent's T1 shortening and T2* effects are voltage sensitive and could be optimized further.
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Ultra Low Radiation and Contrast Dose Digital Subtraction Angiography (DSA)

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Purpose
2D digital subtraction angiography (DSA) is the single highest contributor to patient radiation exposure and contrast load during diagnostic and therapeutic procedures. A novel processing technique for DSA was developed and the potential reduction of radiation and contrast dose in DSA studies was evaluated in vivo.

Materials and Methods
The developed algorithm improves DSA images by exploiting spatial and temporal sparsity and suppressing noise that commonly renders low radiation and contrast dose acquisitions unusable. For validation, in vivo animal studies were conducted with a clinical biplane system (Siemens Artis zee) using the following acquisition settings: 3\,\mu\text{Gy/frame} (clinical standard dose); 0.36\,\mu\text{Gy/fr} and 0.14\,\mu\text{Gy/fr}, all at 30\,\text{frame/second} frame rate. These settings correspond to dose rates of 90\,\mu\text{Gy/s}, 10.8\,\mu\text{Gy/s} and 4.2\,\mu\text{Gy/s} respectively. For each dose setting 50\% and 25\% contrast concentration injections were acquired. All datasets were processed using the current clinical standard, as well as with the proposed technique. Quantitative evaluations focused on absolute noise and contrast-to-noise between vasculature and background. All datasets were evaluated visually for vasculature content equivalence by two endovascular fellowship trained physicians.

Results
The proposed method is able to reduce the image noise by a factor of five for both 50\% contrast and 25\% contrast concentration across all tested dose levels. CNR values increase, improving the CNR of the lowest dose DSA to the conventionally processed highest dose DSA (3\,\mu\text{Gy/fr}). Visual evaluations showed no difference in vascular information between the images. Figure 1: (a) DSA image processed by conventional algorithm, the image was acquired at 3\,\mu\text{Gy/frame} and 50\% contrast concentration. (b) DSA image processed by conventional algorithm, the image was acquired at 0.14\,\mu\text{Gy/frame} and 25\% contrast concentration. (c) DSA image from the same dataset as (b) processed by the novel algorithm. (d) Difference image between (b) and (c). Display windows are (-0.06, 0.03) and (-0.03, 0.03) for DSA images and difference image respectively.

Conclusions
This proposed algorithm allows acquisition of DSA images at substantially lower radiation exposure (5\% of clinical standard), as well as reduced contrast load to the patient, while supplying image quality similar to the current clinical standard.
Delayed (Non-Procedural) Symptomatic Infarction and Symptomatic In-Stent Restenosis after Intracranial Angioplasty and Stenting in the SAMMPRIS Trial

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Purpose
The purpose of this study was to investigate the mechanisms of nonprocedural symptomatic infarction and the frequency of symptomatic in-stent restenosis (ISR) the SAMMPRIS trial.

Materials and Methods
Patients with any of the following events more than 30 days after angioplasty and stenting were identified: an (1) ischemic stroke or (2) cerebral infarct with temporary signs (CITS) in the territory of the stented artery, or (3) repeat angioplasty of the target lesion prior to a primary endpoint. Vascular imaging studies performed after these events were reviewed by two readers for ISR. Bivariate analyses assessing the association between baseline risk factors and symptomatic ISR were performed.

Results
Of 183 stented patients without a primary endpoint within the first 30 days after enrollment, 27 (14.8%) had symptomatic infarction [ischemic stroke (n=16, 8.7%) and/or CITS (n=12, 6.6%)] in the target artery territory after 30 days during follow up (median 35.0 months). One patient had an embolic CITS without ISR and a subsequent ischemic stroke in the territory associated with ISR. Fifteen of the 28 ischemic infarctions were associated with definite or probable symptomatic ISR. Three patients underwent repeat angioplasty, all for symptomatic ([TIA (2) and probable stroke (1)] ISR. One suffered a symptomatic hemorrhage after angioplasty and another suffered an ischemic stroke after the procedure. The rate of definite or probable symptomatic ISR was 10% (18/179). No association of baseline risk factors and symptomatic ISR was identified.

Conclusions
In-stent restenosis was a common cause of delayed, nonprocedural, cerebral infarction after angioplasty and stenting in SAMMPRIS.
Atypical Partial Meningoencephalocele Masquerading as a Calvarial Mass

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Purpose
To review an unusual case of partial meningoencephalocele that presented as a calvarial lesion.

Materials and Methods
A 60-year-old female presented to her primary care provider for evaluation of headache. Her work up included a brain MRI (Figure 1), which demonstrated a soft tissue mass involving the left frontal calvarium. There was abutment of the left frontal lobe without a clear plane between. A stereotactic left frontal craniotomy was performed. At surgery, the bone was unusually thick. Soft glioneuronal tissue was noted within the bone, protruding through a dural defect and attached to the underlying brain. The adjacent cerebral parenchyma, however, was unremarkable. Pathologically, the mass demonstrated disorganized cerebral cortex. The subcortical white matter and overlying leptomeninges showed reactive changes. A section of the calvarium also was submitted, which showed mild sclerosis and an indented area that corresponded to the protruding cerebral parenchyma. No neoplasm or vascular malformation was present. In conjunction with the radiologic findings, this was considered to represent focal protrusion of cerebral parenchyma and leptomeninges into, but not through, the overlying calvarium, consistent with a partial meningoencephalocele.

Results
The MRI demonstrated an expansile, mildly T2 hyperintense lesion which expanded the diploic space of the left frontal bone with sharply demarcated bony margins and only mild peripheral enhancement. The lesion appeared to be contiguous with the left frontal lobe through a squat pedicle. The adjacent brain parenchyma demonstrated minimal increased T2 hyperintensity. No other intracranial abnormalities were present.

Conclusions
The term meningoencephalocele describes congenital herniation of central nervous system (CNS) tissue and meninges through a calvarial defect. They can be complete, without overlying calvarium, or rarely partial, with preservation of the external table as in this patient. This case is atypical in that the defect occurred well off midline within the frontal bone, as opposed to the more classic midline frontonasal, skull base, or occipital location. Recognition of this finding is critical to avoid unnecessary biopsy or resection.
Can You Hear Me Now? A Case of Sensorineural Hearing Loss Due to a Hemorrhagic Intraventricular Pilocytic Astrocytoma

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Purpose
The purpose of this exhibit is to illustrate one of the less common causes of sensorineural hearing loss, superficial siderosis, secondary to an intraventricular tumor.

Materials and Methods
A 44-year-old male presented for audiologic evaluation after 10 years of tinnitus but more recently developed bilateral hearing loss, left more so than right, over the last few years. Audiologic evaluation revealed bilateral sensorineural hearing loss, left more so than right. The patient subsequently was sent for an MRI which revealed an intraventricular pilocytic astrocytoma and superficial siderosis of the 8th cranial nerve bilaterally. To our knowledge, there are no case reports in the English literature of an intraventricular tumor resulting in superficial siderosis and subsequent sensorineural hearing loss.

Results
The initial MRI exam was performed to optimize visualization of the internal auditory canal and a GRE sequence was not included. Incidentally visualized on this exam was an enhancing right lateral intraventricular mass which was confirmed to be a pilocytic astrocytoma after excision. A postoperative exam was performed that included a GRE sequence that clearly demonstrates superficial siderosis of the 8th cranial nerve bilaterally, likely due to hemorrhage from the mass. This finding can be seen retrospectively on the initial study even without the GRE sequence and explains the patient's hearing loss.

Conclusions
This case is an excellent illustration of one of the less common causes of sensorineural hearing loss. To our knowledge, there are no reported cases in the English literature of a hemorrhagic intraventricular tumor leading to superficial siderosis and subsequent sensorineural hearing loss.
Internal auditory canal protocol was performed for hearing loss which revealed an incidental enhancing mass lesion in the right lateral ventricle.

Unusual intracranial cysts with associated features of dermoid and epidermoid cyst

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Purpose
We present three cases of intracranial cystic lesions with radiologic characteristics of both dermoid and epidermoid cyst. We discuss the histology and pathogeny of these lesions. To our knowledge, such features have not been reported.

Materials and Methods
We retrospectively reviewed the MRI findings, clinical information and pathology findings of three patients explored between 2011 and 2014. Patients were three females. Average age at diagnosis was 28 years, ranging from 26 to 32 years. Lesions were revealed by seizure in one patient and progressive mass effect in two patients. After initial diagnosis, one patient presented clinical and radiologic signs of dermoid cyst rupture. All patients were operated with postoperative uneventful recovery. Pathology was consistent with dermoid and epidermoid cysts in all three patients.

Results
Location of the cysts were the following: parasellar extending to the right frontal lobe, interpeduncular cistern with mass effect on the midbrain and right cavernous region protruding to the midbrain. Two lesions presented areas of bright T1 and FLAIR hyperintensity suppressed on fat saturation sequence entwined with areas hyperintense on diffusion-weighted images. One lesion was heterogeneously hyperintense on T1 and diffusion and presented peripheral hyperT1 fatty droplets in the subarachnoidian spaces.

Conclusions
We report three cases of intracranial cystic lesions with unique imaging findings, associating features of dermoid cyst and epidermoid cyst. We present two embryologic hypotheses involving the neural crest cells that could explain this presentation.
Cerebral Amyloidoma

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Purpose
To describe conventional and advanced imaging features of a cerebral amyloidoma, with radiology-pathology correlation.

Materials and Methods
A 54-year-old female presented to an outside hospital after multiple episodes of emesis and intractable headache. On physical examination, she was neurologically intact except for right facial weakness, which had been slowly progressive over the past 8 weeks. A noncontrast head CT demonstrated a 3cm left thalamic mass with mass effect and midline shift. The patient was transferred to our facility and MR imaging including perfusion, spectroscopy and F18-FDG PET/CT of the brain was performed.

Results
MR imaging demonstrated a predominately hypointense T2 signal mass in left thalamus and internal capsule region with surrounding T2 signal prolongation. Associated mass effect and midline shift was identified. Patchy susceptibility artifact was present. The mass showed solid enhancement extending to the ventricular surface. Also noted was a radiating linear enhancement pattern extending from the lesion periphery. Dynamic susceptibility contrast (DCS) perfusion showed a decreased relative cerebral blood volume (rCBV) of 0.72. Single voxel short echo MRS showed decreased NAA/Creatine of 1.06, increased Choline/Creatine of 1.54, and the presence of a small lipid/lactate doublet. The elevated Cho/Cr ratio likely is related to decreased creatine rather than elevated choline, as compared to normal brain. The lesion showed hypometabolism on the F18-FDG PET study, and there was no evidence or extracranial malignancy. The differential diagnosis included primary glioma, lymphoma or metastatic disease. However, decreased perfusion and hypometabolism are uncommon features for a malignancy. A stereotactic biopsy of the mass revealed abundant amorphous eosinophilic material with intervening small vessels. A Congo red stain revealed the material to be consistent with amyloid, displaying apple-green birefringence under polarized light. Therefore the diagnosis of an amyloidoma (mass-like deposition of amyloid) was made. Additional work up for systemic amyloidosis was negative. The patient subsequently was treated with fractionated radiotherapy, with the goal of preventing progression. This option was chosen on the basis of the lesion location and eloquent brain, hoping to mitigate treatment morbidity. Clinically, the patient tolerated the treatment well and remains with only right facial weakness.

Conclusions
Amyloidoma is an uncommon intracerebral mass, which can be difficult to distinguish from a neoplasm. Our case highlights a characteristic MR feature of amyloidoma and the role of advanced imaging. The MR finding of extension to the ventricular surface with irregular, radiating linear enhancement at the edge of the lesion has been described in few case reports. This linear enhancement may indicate the deposition of amyloid along the intervening small vessels. The presence of hypoperfusion and hypometabolism furthers supports a non-neoplastic etiology.
Case of Dual Pathology of Hemangioblastoma and Optic Nerve Glioma

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Purpose
To describe a case of dual pathology of hemangioblastoma related to the von Hippel Lindau syndrome and optic nerve glioma.

Materials and Methods
A 25-year-old female with known case of von Hippel Lindau syndrome with positive family history. Initially diagnosed with right optic nerve (intradural) hemangioblastoma and posterior fossa hemangioblastoma treated with stereotactic radiosurgery. New nodule appeared on right optic nerve and patient underwent biopsy.

Results
Swelling and T2 hyperintense signal change along the optic pathway involving the prechiasmatic optic nerves, optic chiasm and optic tracts bilaterally. Small hemangioblastoma in the left superior cerebellar hemisphere. There is enlargement of the right intraorbital optic nerve and an enhancing nodule on the nerve. Biopsy- right optic nerve and visual pathway glioma (pilocytic astrocytoma WHO Grade 1).

Conclusions
This patient has dual pathology of hemangioblastoma related to the von Hippel Lindau syndrome and additional optic nerve glioma. To our knowledge there are no previous case reports of this combination of pathology.
Purpose
Stroke-like migraine attacks after radiation therapy (SMART) describes the occurrence of complex neurologic symptoms, sometimes reversible and often proceeded by headaches or seizures, in patients with a remote history of cranial irradiation (1, 2). Typical primary imaging features are transient gyral swelling and enhancement (3). Little is known about the pathologic substrate of SMART syndrome. Brain biopsies in prior case series reportedly showed nonspecific gliosis (3). The purpose of this Excerpta Extraordinaire is to present a case in which brain biopsy revealed marked cortical small vessel vasculopathy in a background of reactive gliosis, supporting involvement of endothelial damage and reactivity in SMART syndrome.

Materials and Methods
A 57-year-old man who had received whole brain radiation for metastatic non-small cell lung cancer 8 years prior was taken to his local hospital after having a migraine headache and not waking up for two days. He was found to have left facial droop and fever. MR imaging was negative for acute infarct but along with an EEG suggested right frontoparietal seizure activity. Lumbar puncture was normal. He received antibiotics and acyclovir until initial cerebrospinal fluid (CSF) cultures came back negative. He was transferred to our institution where he had seizures and left-sided weakness. Repeat MRI at 9 days showed worsening edema with enhancement as described below. He underwent right frontal lobe biopsy at 19 days. Seizures eventually were controlled medically. He also received steroids. Neurologic and imaging findings subsequently improved.

Results
Initial unenhanced brain MRI 2 days after symptom onset showed diffuse mild right hemisphere cortical thickening and edema without restricted diffusion. Enhanced MRI (a) at 9 days showed worsening cortical edema with restricted diffusion and gyriform enhancement, thin subdural collections, and bilateral dural enhancement. MR imaging at 21 days (b) showed biopsy changes (asterisk) persistent cortical swelling, resolved gyriform enhancement, and improved dural enhancement. Subdural collections and dural enhancement may have been related to lumbar puncture. Pathology (c, H&E stain at 400x) showed vasculopathic changes involving gray matter including markedly thickened capillaries reflecting fibrosis and atypical reactive endothelial cells. White matter was normal. No evidence of neoplasm, infarct or inflammation was seen.

Conclusions
The etiology of SMART syndrome is not well understood. Migraine headaches or seizures may precipitate the syndrome in patients with an already damaged vascular system (3). Heterogeneous symptoms and overlap in imaging appearance with seizure activity, subacute infarct, encephalitides, and carcinomatosis render diagnosis and study more difficult. Increased syndrome recognition also may decrease cases going to biopsy. Our findings of severe cortical small vessel vasculopathy correspond to the imaging findings of SMART syndrome and lend support to a pathophysiology involving endothelial damage and reactivity.
Primary Leptomeningeal Gliomatosis - Radiologic and Pathologic Correlation of a Rare Disease
Purpose
To illustrate an uncommon case of primary leptomeningeal gliomatosis with radiologic and pathologic correlation and review proposed disease pathophysiology.

Materials and Methods
A 38-year-old female with several weeks of chronic neck and head pain presented with acute onset of severe encephalopathy marked by global aphasia, restlessness and fever. Initial brain imaging showed a diffuse leptomeningeal abnormality, suggestive of a primary leptomeningeal/CSF process favoring infection or inflammation given the acute clinical onset. Cerebrospinal fluid (CSF) showed a mild pleocytosis, nonclearing of red blood cells, and markedly elevated protein (1065mg/dL). Over 3 weeks, despite empiric combination antimicrobial, antiviral and steroid therapy and brief clinical improvement, the patient worsened rapidly both clinically and by imaging progression of the leptomeningeal abnormality around the brain and cord. A dural biopsy and biopsy of a leptomeningeal "mass" subsequently were obtained. Pathology of the "mass" showed a high-grade astrocytic neoplasm with multiple atypical mitoses and high Ki-67 labeling index (Figure 1D). Without evidence of an intraparenchymal component, a diagnosis of leptomeningeal gliomatosis was rendered. Primary leptomeningeal gliomatosis (PLG) is an exceptionally rare entity that is defined by glioma restricted to the leptomeninges. Pathophysiologically, this devastating disease (4) is thought to arise from neoplastic transformation of heterotopic glial nests in the leptomeninges (1). Primary leptomeningeal gliomatosis (PLG) may mimic other meningeal processes such as tuberculosis (2, 3).

Results
Initial brain MRI (Figure 1A) demonstrates nodular leptomeningeal enhancement, primarily in the basal cisterns, with corresponding T2 FLAIR CSF signal abnormality, dramatically progressing in a nodular fashion over 22 days (Figure 1B,C) without a convincing focal primary brain parenchymal mass near the ependymal surfaces. Photomicrograph (Figure 1D) demonstrating a highly cellular and mitotically active proliferation of pleomorphic astrocytes admixed with reactive meningotheelial cells (H&E; 200x original magnification).

Conclusions
Primary leptomeningeal gliomatosis is a rare disease, which may mimic infection and inflammation on imaging. Pathologically, these tumors tend to be high grade, astrocytic neoplasms restricted to the leptomeninges and are rapidly fatal.
Purpose
Central nervous system (CNS) involvement by multiple myeloma can present as a diffuse leptomeningeal process and/or parenchymal masses. We present a pathology-proven case of CNS myelomatosis to enhance the radiologist's awareness about this rare complication of multiple myeloma.

Materials and Methods
A 75-year-old man with history of multiple myeloma treated with chemotherapy presented with fatigue and progressive lower extremity weakness for 2 weeks. The course of his multiple myeloma was severe and progressive, involving skeletal and extra skeletal sites including the pleura. Cerebrospinal fluid (CSF) analysis showed a marked pleocytosis and elevated protein. Cerebrospinal fluid cytology showed numerous atypical plasma cells, consistent with CNS myelomatosis. After establishing the diagnosis, patient received intrathecal chemotherapy. Despite treatment, he passed away 1 month later.

Results
Post-contrast MRI images show diffuse leptomeningeal enhancement and irregular thickening involving the entire spine, brain stem and posterior fossa. There are several long segment areas of T2 hyperintensity involving the central aspect of the spinal cord, likely edema from cord compression. There is a small enhancing mass in the right parietal lobe with minimal surrounding vasogenic edema and no significant mass effect.

Conclusions
This case report highlights the imaging manifestations of CNS myelomatosis, in a patient with advanced multiple myeloma. Central nervous system myelomatosis is a rare complication of multiple myeloma, with poor prognosis. Central nervous system myelomatosis should be included in the differential diagnosis in patients with known multiple myeloma who present with diffuse leptomeningeal enhancement and/or parenchymal lesions.
Unique Appearance and Behavior of Cystic Brain Metastases in Anaplastic Lymphoma Kinase Gene Rearranged Non-Small Cell Lung Carcinoma: Radiologic-Pathologic Correlation.

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Purpose
Anaplastic lymphoma kinase (ALK) gene translocation occurs in 3-5% of patients with nonsmall cell lung cancer (NSCLC). Targeted therapy with the ALK tyrosine-kinase inhibitor (TKI) crizotinib, results in dramatic responses in ALK+ metastatic NSCLC (1). However, the central nervous system (CNS) penetrance of crizotinib is poor and disease progression in the brain
frequently ensues (2, 3). Yet, little is known regarding the imaging characteristics and natural history of central nervous system (CNS) metastases in this subset of patients.

Materials and Methods
We performed a retrospective analysis of MR imaging obtained from three patients with pathologically confirmed ALK+ NSCLC brain metastases, with follow-up CNS imaging ranging from 1-3 years. Patients ranged in age from 32-62 years. All three patients had normal baseline MRI, but between 11-40 months after diagnosis, remarkably all three patients were asymptomatic when multiple cystic brain metastases were discovered on routine surveillance brain, despite the relatively large size of several of the lesions (>1 cm).

Results
Typical brain metastases in nonsmall cell lung carcinoma (NSCLC) classically are described as either solid, or heterogeneous ring-enhancing lesions, nearly uniformly associated with adjacent vasogenic edema. In all three ALK+ NSCLC patients the lesions were round or oval shaped, demonstrating a benign cystic (T1 hypointense, T2 hyperintense) appearance, remarkable for being devoid of adjacent vasogenic edema or contrast enhancement in the majority of lesions (Figure). The FLAIR appearance was variable, some lesions following cerebrospinal fluid (CSF) signal, while others appearing hyperintense, presumably related to the changing composition of the mucinous secretions identified on pathology. No perfusion was evident on arterial spin labeling (ASL). The lesions grow slowly but patients remain asymptomatic despite the larger size of some of the lesions. Given the indolent nature of these brain metastases patients can be maintained on crizotinib despite slow CNS progression, allowing control of extra-CNS metastases.

Conclusions
As presented here, brain metastases in ALK+ NSCLC have unique imaging characteristics atypical for conventional variants of NSCLC. The general absence of contrast enhancement, CSF isointense T2 signal and lack of surrounding vasogenic edema make many of these lesions appear to be relatively benign cysts, necessitating exclusion of differential considerations. Variable FLAIR appearance likely is related to changes in mucinous contents of these lesions. Recognizing the imaging features and indolent nature of these metastases is important, because it allows patients to continue therapy despite progressive brain disease to maintain control of extra-CNS metastases.
Epstein-Barr Virus Associated Smooth Muscle Tumor of the Central Nervous System

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Purpose
Epstein-Barr virus (EBV) is known to infect smooth muscle cells in immunocompromised patients including post-transplant patients and those with acquired human immunodeficiency syndrome (AIDS). Infection can result in EBV-related smooth muscle tumors (EBV-SMTs) that most commonly arise in the soft tissues, liver, and adrenal glands. Central nervous system (CNS) involvement is rare. This educational excerpta will review the unique imaging and pathologic features of EBV-SMTs of the central nervous system.

Materials and Methods
This excerpta will detail the diagnosis, clinical course, and imaging appearance of a left temporal lobe EBV-SMT with associated adrenal lesions.

Results
Although few cases have been reported, the CT appearance of central nervous system EBV-SMTs usually demonstrate a hyperdense lobulated appearance with associated vasogenic edema and either intra- or extra-axial location. MR imaging reveals T2 hypointensity and intense homogeneous contrast enhancement without restricted diffusion. The appearance on T1 sequences is variable. The attached graphic demonstrates the classic CT and MRI findings of EBV-SMTs.

Conclusions
Knowledge about the presentation and imaging appearance of Epstein-Barr virus-related smooth muscle tumors within the central nervous system and other tissues can guide diagnosis and treatment of these rare smooth muscle tumors exclusive in immunocompromised patients.
Case of Glioblastoma Multiforme Bone Metastasis.

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Purpose
To describe an unusual case of extracranial bone metastasis from a glioblastoma multiforme (GBM) causing spinal compression.

Materials and Methods
A 66-year-old female, initially presented with seizure and diagnosed with left temporal lobe GBM. Tumor treated with surgical resection, followed by course of chemotherapy and radiotherapy. Presented 7 months later with urinary incontinence and foot droop.

Results
MRI brain – left temporal lobe GBM with peripheral enhancement. Postoperative CT – Near complete resection with small residual tumor in left temporal lobe. MR imaging spine -multiple lumbar spinal lesions low signal on T1 and T2, with L5 level nerve root compression. Treated with surgical decompression. Pathology shows metastatic glioblastoma.

Conclusions
Less than 0.5% of GBM have extracranial metastasis. These can occur in bone and soft tissues.
Purpose
To report a rare case of extraventricular neurocytoma (EVN) in the sella.

Materials and Methods
An 18-year-old man without significant past medical history presented with disorientation, abdominal pain, nausea, and emesis, while travelling out of the country. Laboratory tests revealed marked hyponatremia with a Sodium of 103. No additional endocrine laboratory abnormalities were identified. Preoperative imaging findings were most suggestive of a pituitary macroadenoma. At the time of the surgery, the sodium was 130. The patient received a single dose of Tolvaptan and the sodium level increased to 163 within 24 hours. Pathologic diagnosis was consistent with a Vasopressin producing central neurocytoma.

Results
MR imaging demonstrates a large, T2-hyperintense, heterogeneously enhancing sellar mass with suprasellar and parasellar extension. The internal carotid artery cavernous segments are encased bilaterally without significant narrowing. On follow-up postoperative imaging, osmotic demyelination syndrome with abnormal signal in the pons, basal ganglia, and thalami developed, in keeping with central pontine and extrapontine myelinolysis.

Conclusions
Extraventricular neurocytoma is a rare tumor, mainly described within the cerebral hemispheres and spinal cord. This is the fourth case report of a sellar EVN reported in the literature and to our knowledge, the first case of Vasopressin secreting sellar EVN. The imaging characteristics have significant overlap with the appearance of more common sellar tumors making accurate preoperative diagnosis difficult.
Perianeurysmal cysts: imaging findings

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Purpose
Perianeurysmal cyst is a rare and complex pathophysiological entity. The purpose of this study was to present radiologic features and to discuss the origin and management of these lesions.

Materials and Methods
We retrospectively reviewed the CT and MRI findings of all the intracranial aneurysms managed in our institution from 2006 to 2014. We systematically assessed the presence of a perianeurysmal cyst at time of diagnosis and on follow-up images. Patient demographics, clinical symptoms, CT and MRI aspects of the cyst, evolution and management were collected systematically.

Results
Among 1231 consecutive intracranial aneurysms managed in our institution during the study period, only three perianeurysmal cysts were observed (<0.3%). Patients were three females aged from 48 to 74 years at diagnosis. Two aneurysms were located on the sylvian bifurcation and one close to the posterior cerebral artery (PCA). The two sylvian aneurysmal cysts were observed at the time of diagnosis, associated with a giant partially thrombosed aneurysm (maximum diameter: 28 mm and 30 mm, respectively). The last cyst was observed 5 years after the endovascular treatment of a previously ruptured PCA aneurysm, coiled and subsequently recanalized. All cysts were hyperintense on FLAIR-WI, with a hypointense T2* peripheral rim. Cysts were uniloculated (n=2) or multiloculated (n=1). Two cysts presented clinical mass effect and were surgically evacuated. In the third case, the MCA aneurysm was treated with a flow diverter stent. Interestingly, in this third case, the FLAIR signal of the cyst changed after stenting, from hyperintense to hypointense. This suggests that flow disruption in the aneurysm sac may stop the pathophysiological mechanisms leading to the cyst formation and growth.

Conclusions
Perianeurysmal cysts are very rare (<0.3%). In our study, perianeurysmal cysts were associated with either giant partially thrombosed aneurysms (2/3) or previously coiled and recanalized aneurysm (1/3). MR imaging features, evolution and surgical findings suggest that these perianeurysmal cysts are formed by a chronic hemorrhagic exudate issued from the aneurysm sac.
Successfully Treated Symptomatic Partially Thrombosed Fusiform Basilar Artery Aneurysm in a Patient with Hindbrain Malformation via Inverted Y-Stenting

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Purpose
To describe successful endovascular treatment of symptomatic partially thrombosed fusiform basilar artery aneurysm developed in a patient who has a hindbrain malformation.

Materials and Methods
The patient is a 32-year-old male with a complex hindbrain malformation who presented with acute ocular dysmotility due to a rapidly growing partially thrombosed fusiform basilar artery aneurysm. Nonflow diverting stents (Neuroform® and Enterprize® stents) were used based on expected difficulties of delivering currently available flow diverters. The aneurysm was treated via insertion of two partially overlapping stents into the vertebrobasilar system in an inverted Y configuration. Immediate symptomatic relief was achieved and the fusiform aneurysm showed progressive thrombosis. On 6-months follow-up imaging, the stents remained patent and the aneurysm essentially was obliterated completely.

Results
Initial axial T2-weighted MRI sequence (A) shows rhombencephalosynapsis, hypoplasia of the pons, and a mildly ectatic basilar artery flow void. Axial T2-weighted MRI sequence (B) obtained 4 months later shows interval enlargement of the basilar artery flow void (arrow). The corresponding time-of-flight 3D MIP MRA (C) shows a along segment fusiform basilar artery aneurysm (arrow). The 3D volume rendered CTA image (D) obtained 6 months after inverted Y stenting show satisfactory occlusion of the aneurysm and patency of the lumen.

Conclusions
Techniques utilizing traditional stent technology can be used as an alternative to create flow diversion, resultant thrombosis, and resolution of symptoms in enlarging, partially thrombosed fusiform basilar artery aneurysm when there is technical concern on using flow diverter.
Endovascular Treatment of a Giant Internal Carotid Artery Pseudoaneurysm Arising in the Setting of an Invasive Pituitary Macroadenoma.

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Purpose
The purpose of this excerpt is to describe the unusual occurrence of a giant cavernous internal carotid artery pseudoaneurysm arising in association with vascular encasement by an invasive pituitary macroadenoma and subsequent endovascular therapy utilizing flow diversion.

Materials and Methods
A 63-year-old male with occasional headaches during the preceding month presented with the acute onset of severe left retro-orbital headache and oculomotor nerve palsy. An imaging workup revealed a destructive skull base mass with an associated giant probable pseudoaneurysm of the left cavernous internal carotid artery (Figure 1). The patient underwent endoscopic trans-sphenoidal biopsy and laboratory testing with a subsequent diagnosis of prolactinoma. Endovascular therapy utilizing two Pipeline™ flow diversion embolization devices was performed with subsequent resolution of the patient's headache and slight improvement in his cranial nerve deficits/cavernous sinus syndrome.

Results
A: Sagittal MIP CT angiography image reveals a giant pseudoaneurysm (arrow) arising from the cavernous internal carotid artery with a second lobule at the cephalad aspect of the pseudoaneurysm sac (arrowhead). B: Lateral projection DSA following left internal carotid artery injection shows overlapping Pipeline devices (arrow) extending from the horizontal petrous through supraclinoid segments of the internal carotid artery with resultant sluggish flow in the pseudoaneurysm sac (arrowhead).

Conclusions
The incidence of intracranial aneurysms arising in association with pituitary adenomas (0.5-7.4%) (3) is greater than the incidence of aneurysms arising in the general population as well as the incidence of aneurysms in patients with intracranial masses of nonpituitary origin. Proposed etiologies for this increased incidence include increased blood flow through vessels supplying the tumor, hormonal effects, and direct neoplastic infiltration (3). The utility of flow diversion embolization devices has been established in treating giant aneurysms not amenable to traditional coiling, and the expected postprocedure vascular remodeling with decrease in aneurysm sac size is particularly desirable in cases such as this where a cavernous sinus syndrome is evident. To our knowledge this is the first reported case of flow diversion therapy utilized in the setting of a giant, potentially rapidly enlarging, pituitary adenoma associated pseudoaneurysm.
E-65

Endovascular Management of Carotid Artery-Esophageal Fistula

J Winblad¹, A Ku², S Macrino³
¹Allegheny Health Network, Pittsburgh, PA, ²Allegheny Gen'l Hosp., Pittsburgh, PA, ³Allegheny General Hospital, Pittsburgh, PA

Purpose
Carotid artery blowout syndrome has been described in the setting of head and neck radiation and reconstructive surgery; however, to our knowledge, has been described rarely with foreign body erosion.

Materials and Methods
A 60-year-old woman with history of locally advanced head and neck cancer, underwent radiation/chemotherapy, reconstructive surgery, and esophageal stenting at an outside facility. She presented to our institution with syncope and bleeding from her PEG tube. At endoscopy, the endoscope could not be passed beyond the upper esophageal sphincter secondary to a stricture. Her hemodynamic status rapidly deteriorated, and was refractory to vasopressors and high volume resuscitation. At this time, IR was consulted and angiography revealed a large defect in the right common carotid artery (CCA) at the level of the esophageal stent, resulting in extravasation into the esophagus. Following systemic anticoagulation with 5000 U heparin, this was treated with covered stent graft. This resulted in successful exclusion of the arterial enteric fistula, cessation of the bleeding, and no immediate complication. The patient's postprocedural
course was complicated by fever and the concern of graft infection was raised by a multidisciplinary team. One week later, the patient underwent a balloon occlusion test without neurological compromise. Subsequently, embolization of the CCA through the internal carotid artery (ICA) was performed, with successful preservation of intracranial flow via circle of Willis. At one-month follow up, the patient did develop new onset of seizures, however had no clinical evidence of recurrent hemorrhage or infection. CT angiography at this time demonstrated successful occlusion of the CCA ICA, with intact circle of Willis.

Results
See case report and images.

Conclusions
Carotid artery erosion by a foreign body is rare. The management is similar to carotid artery blowout, where stent graft can be use as a temporizing measure and embolization is the definitive treatment.
Figure 1. Large defect in right CCA resulting in extravasation of contrast into the esophagus. Figure 2. Interval placement of a 6 mm x 5 cm covered stent graft (Gore Viabahn Endoprosthesis; W.L. Gore, Flagstaff AZ), which was ballooned to 6 mm. Figure 3. 1 week follow up angiogram demonstrated successful occlusion of the fistula, with preserved flow in the CCA and ICA. Figure 4. Coil and plug embolization was performed at CCA origin, proximal to bifurcation, and Petrous ICA (not shown). Note proximity of esophageal stent to the CCA.
Orbital AVM and Cavernous Sinus Thrombosis after CAPP

D Quiñones Tapia¹, A Casasco¹, L Guimaraens¹, M Tecame¹, J Viaño Lopez¹
¹Hospital del Rosario, Madrid, Spain

Purpose
To present the development of a symptomatic orbital arteriovenous malformation (AVM) in a patient treated for sleep apnea with continuous positive airway pressure (CPAP).

Materials and Methods
A 74-year-old slim male without prior trauma or vascular risk factors presented in ophthalmology clinic with left eye proptosis, eyelid edema and conjunctival injection. No bruit. The symptoms started a week after his CPAP system was renovated, with a tighter mask and increased pressure. The eye was worse in the mornings, edema decreasing during the day. Visual acuity was preserved. Left eye IOP was increased. Orbital CT was indicated. After clinical suspicion of and indirect cavernous sinus fistula CPAP was discontinued and AAS was prescribed.

Results
Computed tomography (CT) with IV contrast demonstrated orbital edema, abnormal intraconal vessels with tubular structure suggestive of a varix, and enlarged SOV bilaterally. The cavernous sinuses enhanced without defects or bulging. An indirect cavernous sinus dural fistula was suspected. MR imaging and MR angiography (MRA) confirmed the left orbital edema and slight proptosis. MR angiography showed some faint vessels in the left apex and a structure resembling a partially thrombosed varix. Both SOV were enlarged with abnormal retrograde flow, but thrombus could not be demonstrated in the cavernous sinus. No enlarged vessels from the external carotid were seen on contrast-enhanced MRA. The left angular vein was enlarged and had some flow. Digital subtraction angiography (DSA) was performed with bilateral selective external and internal carotid artery injections. An intraconal AV fistula was detected from recurrent left cavernous sinus arterial ramus and abnormal opthalmic artery posterior ethmoidal vessels. Drainage was anterior to the SOV, angular and facial veins on the left. The fistula was slow flow. Later it was embolized from the venous side with left Int. jugular vein puncture, and retrograde catheterization of the facial vein, occluding the varix with coils and fistula with Onyx 18 until venous occlusion. The SOV drained posteriorly to the cavernous sinus on late phases after embolization.

Conclusions
A 74-year-old male under CPAP with left red eye was suspected to have an indirect cavernous sinus fistula. CPAP was discontinued. Both SOV were enlarged on CT and MRI. Digital subtraction angiography (DSA) revealed abnormal infra-orbital AVM, which was embolized through the venous side retrogradely, with resolution of all orbital symptoms. Conclusion: CPAP can worsen pre-existing nonsymptomatic orbital and cavernous sinus AMVs, due to compression of facial veins by the mask and increased airway pressure.
Recognizing Ataxia as a Rare Initial Presentation of Creutzfeldt Jakob Disease to Avoid Unnecessary Interventional Procedures: The Role of MRI In The Diagnosis.

S Jain¹, K Barry¹, K Dalen¹, A Wang², M Al Hakim³
¹Beaumont Health System, Royal Oak, MI, ²Beaumont Health system, Royal oak, MI, ³Beaumont Health system, Royal Oak, MI

Purpose
To discuss the role of MRI in the diagnosis of Creutzfeldt Jakob disease in a patient with an unusual presentation of rapidly progressive cerebellar ataxia and demonstrating the importance of making the diagnosis, to avoid unnecessary procedures which may result in risk to the health care personnel.

Materials and Methods
A 67-year-old male presented with progressive vertigo, fatigue, gait instability and decreased ability to perform fine motor activities for past 8 weeks. Initial MRI of brain was normal. Based on MRI cervical spine findings, his gait abnormality was attributed incorrectly to the spinal cord compression and myelopathy. He subsequently underwent an anterior cervical discectomy, corpectomy and fusion. Following surgery, he was re-evaluated and found to have persistent unsteady gait, absent upward gaze and severe arm ataxia. These symptoms were not explained by cervical myelopathy or spinal stenosis. A repeat MRI brain was performed, which raised the suspicion of Creutzfeldt-Jakob disease. Cerebrospinal fluid analysis was positive for 14-3-3 and Tau protein.

Results
Brain MRI demonstrated symmetric diffusion restriction and increased FLAIR signal involving the bilateral head of caudate nucleus and lentiform nucleus. Marked cerebellar vermicul atrophy, had progressed since the prior MRI performed a month earlier. There was no associated diffusion restriction or abnormal T2 signal in the cerebellum.

Conclusions
Cerebellar form (Oppenheimer Brownell variant) is a rare variant of classic Creutzfeldt-Jakob disease. These patients present with truncal ataxia and may not exhibit classic myoclonus, dementia, and characteristic electroencephalographic findings until the advanced stages. This unusual clinical presentation may result in a delay in diagnosis causing risk to the health care personnel. Close collaboration between clinicians and radiologists may help to arrive at the correct diagnosis and avoid unnecessary invasive procedures.
Indolent Progression of Coccidioidomycosis to Asymptomatic Complete Subarachnoid Spinal Block: Case Report

J Dorr¹, R Pandit¹, M Patel¹
¹Santa Clara Valley Medical Center, San Jose, CA

Purpose
Coccidioidomycosis is a fungal infection most commonly found in the southwestern United States, as well as parts of Central and South America and Mexico. Although exposure typically does not cause symptoms, in certain at-risk individuals there is a risk for a disseminated form of "valley fever" which portends greater morbidity and mortality due to infection. The most frequent, and unfortunately most severe, form of disseminated disease involves the central nervous system (CNS). While involvement of the brain and spinal column has been reported, less
commonly described is disease involving the spinal canal. In this report, a rare case of asymptomatic complete subarachnoid CNS block is described in the setting of disseminated coccidioidomycosis.

Materials and Methods
A 27-year-old Hispanic female living in the Central Valley of California has a history of coccidioidomycosis meningitis and hydrocephalus treated with VP shunt. She presented to the ED after experiencing 2 days of right sided headache, nausea, and low grade fever. Some of the patient's imaging findings are described below.

Results
Figure 1 is a sagittal T1-weighted postcontrast MR image through the lumbar spine soon after the patient's admission. The image demonstrates enhancement of the inferior thecal sac at the levels of the inferior lumbar and sacral spine (arrow). Figure 2, 3 days later, contains coronal C-spine (left) and sagittal L-spine (right) CT myelogram slices which demonstrate complete subarachnoid cerebrospinal fluid (CSF) block at C7 (black arrows) and at L5/S1 (white arrow). Figure 3, 8 days later, is a sagittal CT myelogram image after cervical injection demonstrating the superior most aspect of the cervical subarachnoid CSF block at the C5 level. Figure 4, 14 days later, contains sagittal C-spine (left) and L-spine (right) CT myelogram slices which demonstrate stable findings of spinal block at C7 and L5/S1.

Conclusions
In spite of the imaging findings of subarachnoid CSF block, the patient never experienced symptoms to suggest neurosurgical intervention would be necessary. Clinical management focused on antimicrobial treatment through various routes including intrathecal administration of amphotericin. These data suggest that, although typically considered a neurosurgical emergency, the finding of complete spinal block by myelography may be treated differently in the setting of a chronic or indolent process such as coccidioidomycosis infection.
Tuesday
3:15PM - 4:45PM
Sheraton Chicago Hotel & Towers, Erie (Level 2)
GREAT - a Randomised Aneurysm Trial: Procedural Safety and Core-lab Assessed Angiographic Baseline Results

C Taschner¹, R Chapot², V Costalat³, P Courtheoux⁴, X Barreau⁵, J Berge⁵, L Pierot⁶, K Kadziolka⁶, J Gabrillargues⁷, R Blanc⁸, A Biondi⁹, H Brunel¹⁰, S Gallas¹¹, A Berlis¹², D Herbreteau¹², B Jean¹⁴, C Groden¹⁵, H Urbach¹⁶, S El Shikh¹⁶, E Graf¹⁶, A Bonafé³

¹Medical Centre - University Freiburg, Freiburg, Germany, ²Alfried Krupp Krankenhaus, Essen, Germany, ³CHU Montpellier, Montpellier, France, ⁴CHU Caen, Caen, France, ⁵CHU Bordeaux, Bordeaux, France, ⁶CHU Reims, Reims, France, ⁷CHU Clermont-Ferrand, Clermont-Ferrand, France, ⁸Fondation A. de Rothschild, Paris, France, ⁹Besancon University Hospital, Besancon, France, ¹⁰CHU Marseille, Marseille, France, ¹¹Hôpital Mondor, Créteil, France, ¹²Universitätsklinikum Köln Institut und Poliklinik für Radiologische Diagnostik Neuroradiologie, Köln, Germany, ¹³CHU Tours, Tours, Germany, ¹⁴CHU Pitié Salpetrière, Paris, France, ¹⁵Universitätsklinikum Mannheim, Mannheim, Germany, ¹⁶Medical Center - University Medicine Freiburg, Freiburg, Germany

Purpose
To clinically evaluate the safety and efficacy of HydroSoft coils (Microvention Inc., Aliso Viejo, CA) for the treatment of intracranial aneurysms.

Materials and Methods
This randomized, controlled multicenter trial is conducted in 15 centers in France and six centers in Germany. Both ruptured and unruptured aneurysms were included. Patients were randomized between March 2010 and February 2014 to the Hydrosoft or control arms in a block design stratified by rupture status. Any bare platinum coils were allowed in the control arm, and assist devices could be used as clinically required. Clinical data were collected prospectively into a web-based database designed for this purpose. Angiographic data were reviewed by an independent core-lab.

Results
Five hundred patients were recruited. Two hundred forty-seven patients were randomized to the Hydrosoft arm of the study, 253 patients were treated with bare platinum coils. Baseline characteristics are outlined in Table 1. Adverse events, procedure related stroke and death rates, as well as 14 days mortality rates were comparable between the two arms of the study (Table 2). The calculated packing density and the angiographic outcome, as reviewed by the independent core lab (Prof. H. Desal, Prof. J. Fiehler) are shown in Tables 3 and 4.

Conclusions
Hydrosoft coils can be used in a wide spectrum of aneurysms with a risk profile equivalent to that of bare platinum coils.
<table>
<thead>
<tr>
<th></th>
<th>Hydrosoft</th>
<th>Bare</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>247</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>Mean age</td>
<td>53 years</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Gender female</td>
<td>173 (70%)</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>Ruptured aneurysms</td>
<td>103 (42%)</td>
<td>109</td>
<td></td>
</tr>
<tr>
<td>Anterior circulation</td>
<td>218 (88,5%)</td>
<td>225</td>
<td></td>
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<tr>
<td>Mean aneurysm size</td>
<td>6,9 mm (SD 2,1)</td>
<td>7,1 mm</td>
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<tr>
<td>Neck size</td>
<td>3,5 mm (SD 1,3)</td>
<td>3,6 mm</td>
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<tr>
<td>Dome-to-neck &lt;1,5</td>
<td>88 (36,5%)</td>
<td>96</td>
<td></td>
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<tr>
<td>Ballon remodelling</td>
<td>117 (47,5%)</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>Stent assisted coiling</td>
<td>26 (10,5%)</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrosoft</td>
<td>Bar</td>
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<td>------------------</td>
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<tr>
<td>Thrombembolism</td>
<td>8 (3%)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Aneurysm rupture</td>
<td>3 (1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vessel occlusion</td>
<td>1</td>
<td></td>
<td>4</td>
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<td>Vessel perforation</td>
<td>1</td>
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<tr>
<td>Stroke (procedural)</td>
<td>3 (1%)</td>
<td></td>
<td></td>
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<tr>
<td>Death (procedural)</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>Death (14 days)</td>
<td>5 (2%)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Hydrosoft</td>
<td>Bar</td>
<td></td>
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<td>------------------------</td>
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<tr>
<td><strong>Coil Volume</strong></td>
<td>0.0422 ccm</td>
<td></td>
<td></td>
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<tr>
<td><strong>Packing density</strong></td>
<td>43% (SD 22)</td>
<td>35.5</td>
<td></td>
</tr>
<tr>
<td><strong>Coil herniation</strong></td>
<td>82 (36.5%)</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Thrombus on coil ball</strong></td>
<td>10 (4.5%)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Any vessel occlusion</strong></td>
<td>5 (2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrosoft</td>
<td>Bare</td>
<td></td>
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<tr>
<td>--------------------------------</td>
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<td></td>
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<tr>
<td>Complete obliteration</td>
<td>122 (54.5%)</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>Residual neck</td>
<td>45 (20.2%)</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Residual aneurysm</td>
<td>56 (25%)</td>
<td>47</td>
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<tr>
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3:23PM - 3:31PM

**O-242**

*Carotid Revascularization and Medical Management for Asymptomatic Carotid Stenosis: CREST-2 Update*

J Huston¹, J Meschia², B Lal³, G Howard⁴, G Roubin⁵, R Brown¹, K Barrett², S Chaturvedi⁶, M Chimowitz⁷, B Demaerschalk⁸, V Howard⁴, R Lazar⁹, W Moore¹⁰, C Moy¹¹, T Turan⁷, J Voeks⁷, T Brott²
Purpose
Over 100,000 carotid procedures are done annually in the U.S. for asymptomatic carotid stenosis. The safety of carotid endarterectomy (CEA) and carotid stenting (CAS), and the efficacy of medical therapy in attenuating atherosclerosis have improved. Therefore, applicability of prior randomized trials to current treatment decisions has been questioned. The NINDS-funded CREST-2 will compare CEA and optimal medical therapy (OMT) versus OMT alone (n=1240), and CAS and OMT versus OMT alone (n=1240) in asymptomatic patients with ≥70% stenosis.

Materials and Methods
CREST-2 consists of two parallel randomized clinical trials at ≈120 centers, including collaboration with NINDS StrokeNet. The composite primary outcome is stroke or death during the peri-procedural period or ipsilateral ischemic stroke thereafter up to 4 years. Cognitive status will be assessed periodically through computer-assisted telephone interviews. Centrally directed OMT includes tight control of blood pressure (systolic target <140 mm Hg) and cholesterol (LDL target <70 mg/dl) as well as lifestyle coaching.

Results
As of December 5, 2014, 108 centers have been approved by the Site Selection Committee. Credentialing is ongoing, with 130 approved surgeons and 26 approved interventionists; 82 interventionists have been approved conditionally and will be able to submit additional cases for review under the CREST-2 Registry. The Centers for Medicare and Medicaid will offer CAS reimbursement for their enrollees.

Conclusions
CREST-2 is designed to identify the best approach for asymptomatic carotid stenosis. The first patient was randomized in December 2014. An update will be provided regarding the numbers of patients randomized, centers certified, as well as surgeons and interventionists fully approved. The CREST-2 Registry will provide the option of CAS while enhancing interventionists' credentials for participation in CREST-2, thereby enhancing initiation of centers and enrollment in CREST-2. Registration: Clinicaltrials.gov NCT02089217

O-243
3:31PM - 3:39PM

Efficacy of 3D-T2 SPACE MRI Screening Protocol to Rule Out Cauda Equina Syndrome in the Emergency Department

N Koontz¹, M McLaughlin¹, U Rassner¹, R Wiggins¹, L Shah¹
¹University of Utah Health Sciences Center, Salt Lake City, UT

Purpose
Cauda equina syndrome (CES) is a critical clinical diagnosis with varied etiologies and complex
presentations, routinely evaluated by lumbar spine (LS) MRI. For clinicians, the possibility of missing a significant pathology often necessitates unwarranted imaging. We hypothesize that advances in spine imaging allow for a limited 3D-T2 turbo spin echo sequence with variable flip angles (SPACE; Siemens, Munich, Germany) to screen for significant pathology. Screening those CES patients without "red flags" (per ACR Appropriateness Criteria® for low back pain) with a single 3D-T2 SPACE sequence protocol will be in line with initiatives to reduce healthcare costs and may reduce imaging time.

Materials and Methods
Sagittal 3D-T2 SPACE with fat saturation (FS) was added to the routine LS MRI for 76 consecutive Emergency Department patients referred for CES from August 2013 through January 2014. Three readers (radiology resident, neuroradiology fellow, and attending), blinded to clinical history and additional sequences, independently reviewed T2 SPACE FS images with multiplanar reconstructions (MPR) for listhesis, fracture, disk signal abnormality, marrow signal abnormality, visualization of the conus medullaris and cauda equina nerve roots, compression of conus medullaris/distal cord, nerve root impingement, severe spinal stenosis, intraspinal hematoma, extraspinal etiology of symptoms, presence of hardware, and abnormal cord signal. Compared to the criterion standard of routine LS MRI, sensitivity and specificity were calculated. Cohen's kappa coefficient was performed to quantify interobserver agreement.

Results
Significant pathology, including fracture, cord or conus medullaris compression, nerve root impingement, severe spinal canal stenosis, intraspinal hematoma, and abnormal cord signal were identified on 58% of patients (n = 44) on criterion standard LS MRI sequences. Compared to routine LS MRI, T2 SPACE FS with MPR was sensitive for detection of cord compression (100%), presence of orthopedic hardware (100%), fracture (92.3%), abnormal disk or marrow signal (90%), severe spinal canal stenosis (87.5%), nerve impingement (84.2%), abnormal cord signal (80%), and visualization of the conus medullaris (95%) and cauda equina nerve roots (92.7%). It was specific for abnormal cord signal (98.6%), presence of orthopedic hardware (98.6%), fracture (95.2%), listhesis (95.1%), severe spinal canal stenosis (95%), intraspinal hematoma (94.4%), extraspinal causes (93.2%), and nerve impingement (81.6%). Interobserver agreement was substantial for fracture (K = 0.779), cord compression (K = 0.634), and severe stenosis (K = 0.786), and was moderate for listhesis (K = 0.565), abnormal marrow/disk signal (K = 0.518), visualization of the conus medullaris (K = 0.509), nerve impingement (K = 0.419), and abnormal cord signal (K = 0.427).

Conclusions
Limited single sequence 3D-T2 SPACE FS with MPR is an effective screening tool for significant pathologies that may cause CES in patients presenting to the ED, which may obviate the need for time-consuming, more expensive routine LS MRI.

O boyko¹, L boyko², E Law², M Tankersley³

¹University of Southern California, Los Angeles, CA, ²University of Southern California, Los Angeles, CA, ³HealthHelp Inc, Houston, TX
Purpose
Analyze utilization trends over a 36-month period for functional neuroimaging of PET scan for clinical indication of Alzheimer disease assessment comparing utilization using Medicare (MCR) Guidelines versus a less restrictive non-denial radiology benefit management algorithm.

Materials and Methods
Request for neuroimaging positron emission tomography (PET) pre-authorization by a Radiology Benefit Management (RBM) using a non-denial system, retrospectively reviewed over a 36-months trend for High Risk AD patients using 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.

Evaluation of Diagnoses grouped into two groups by search for AD: Likely Probability High Probability MCR Restrictions and Definitions

Results
Results: Total Approved With No Study Consenus Drawn Consensus Changed RBM High Probability 877 622 212 22 11 AD Algorithm Medicare (MCR) 658 471 162 17 8 Algorithm There was very little difference in application of RBM rules sets between High Probability AD evaluation and the more restrictive MCR guidelines; both have 27% withdrawn or changed.

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 as no consensus 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. The more preselective the referring physician applies clinical criteria for high probability of Alzheimer disease the less effect or need for more restrictive guideline procedures.

O-245
Cost-Effectiveness of Plaque MRI as a Risk Stratification Tool to Guide Medical versus Surgical Management for Asymptomatic Carotid Stenosis

A Gupta1, A Mushlin2, B Navi2, H Kamel2, A Pandya2
1NY Presbyterian Hosp./Cornell Univ., New York, NY, 2Weill Cornell Medical College, New York, NY

Purpose
Stroke-related costs in the United States approached $70 billion in 2012 and are projected to nearly triple to $180 billion by 2030. Nearly 20% of ischemic strokes are caused by atherosclerosis involving the extracranial internal carotid artery. Recent evidence suggests that MRI of carotid plaque allows for the identification of high-risk asymptomatic carotid stenosis patients most likely to benefit from surgical revascularization, but the cost-effectiveness of this approach is uncertain. The purpose of our study is to evaluate the cost-effectiveness of a decision-making rule based on the MRI assessment of intraplaque hemorrhage (IPH) in asymptomatic carotid artery stenosis (CAS) patients.
Materials and Methods
We compared two competing stroke prevention strategies: (1) an intensive medical therapy-based management strategy versus (2) an imaging-based strategy, in which the subset of asymptomatic CAS patients with IPH on MRI would receive immediate carcinoembryonic antigen (CEA) in addition to ongoing intensive medical therapy. Patients in the medical therapy only based strategy could have CEA procedures only with substantial carotid stenosis disease progression, which was assessed annually with sonography of the carotid arteries. We developed a decision-analytic model to project lifetime quality-adjusted life years (QALYs) and costs for asymptomatic CAS patients with 70-89% and 50-69% carotid stenosis at presentation. Risks of stroke and complications from CEA, costs, and quality-of-life values were estimated from published sources.

Results
The medical therapy-based strategy had a lower life expectancy (12.65 versus 12.95 years) lower lifetime QALYs (9.96 versus 10.05), and lower lifetime costs ($13,699 versus $15,297) compared to the MRI-IPH-based strategy. The incremental cost-effectiveness ratio (ICER) for the MRI-IPH-strategy compared to the medical therapy-based strategy was $16,000/QALY using a base-case 70 year-old patient. When using starting patient ages of 60 and 80 years, the ICERs for the MRI-IPH-based strategy were $3,100/QALY and $73,000/QALY, respectively. The ICERs for the MRI-IPH-based strategy were slightly higher at all ages for 50-69% stenosis, but remained below a willingness-to-pay threshold of $100,000/QALY for starting ages of 60 and 70 years. Furthermore, our results were robust to plausible changes in the cost and performance of MRI, variations in disease progression and regression assumptions, stroke mortality parameters, and utility estimates. Our cost-effectiveness results were most sensitive changes in the model input values for chronic stroke costs, annual probability of stroke risk, and the relative reduction of future stroke risk with CEA.

Conclusions
We evaluated an imaging-based clinical management strategy for stroke prevention in asymptomatic CAS patients using a decision analytic model and found that decisions to pursue CEA informed by MRI-IPH imaging assessments were optimal in our base-case analyses of patients with 50-69% and 70-89% carotid stenosis. MRI-IPH can be used as a cost-effective tool to identify asymptomatic CAS patients most likely to benefit from CEA.
Table 1. Lifetime per-person clinical outcomes, quality-adjusted life years (QALYs), costs, and incremental cost-effectiveness analysis with patients starting at 70-89% stenosis

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Stroke events</th>
<th>Life years</th>
<th>QALYs*</th>
<th>Costs*</th>
<th>ICER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Starting population age 70 years (base-case analysis)</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Medical therapy</td>
<td>0.144</td>
<td>12.649</td>
<td>9.957</td>
<td>$13,699</td>
<td>Reference</td>
</tr>
<tr>
<td>IPH-based decision-making</td>
<td>0.107</td>
<td>12.954</td>
<td>10.054</td>
<td>$15,297</td>
<td>$16,000/QALY</td>
</tr>
<tr>
<td><strong>Starting population age 60 years</strong></td>
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*discounted at 3%

Two-way sensitivity analysis showing the optimal strategy for different combinations of baseline stroke risk and risk during revascularization. The MRI-IPH-based strategy is optimal in the blue region, which includes the base-case risk. Medical therapy-based strategy could be optimal given other combinations of stroke risk and hazard ratio values.

(Filename: TCT_O-245_Figure1ASNR.jpg)

O-246
Autosomal Dominant Polycystic Kidney Disease and Intracranial Aneurysms: Is There an Increased Risk of Treatment?

M Rozenfeld¹, S Ansari², A Shaibani², E Russell², P Mohan³, M Hurley²
¹University of Chicago, Chicago, IL, ²Northwestern University, Chicago, IL, ³University of Miami, Miami, FL

Purpose
Autosomal dominant polycystic kidney disease (ADPCKD) is associated with an increased risk of intracranial aneurysms (ICA). There is evidence that the vascular defects may be due to mutations in the PKD1 and PKD2 genes, which in mouse models correspond with increased rates of arterial dissection, arterial rupture, and intracranial vascular abnormalities. The purpose of this investigation is to assess whether ADPCKD confers an increased peri- and immediate post-procedural risk of aneurysm coiling and clipping.

Materials and Methods
Data for this study were obtained from the National Inpatient Sample (NIS), spanning the years 2000-2011. The NIS is a stratified sample of 20% of all U.S. nonfederal hospitals utilizing ICD-9 coding data. All patients in this study received a diagnosis of "cerebral aneurysm - nonruptured" and a procedural code consistent with either aneurysm clipping or coiling. The ADPCKD group also had a diagnosis of "polycystic kidney disease, autosomal dominant" while the control group did not. Primary endpoints included in-hospital mortality, length of stay, and total hospital charges. Secondary endpoints included "iatrogenic cerebrovascular hemorrhage or infarction", "intracerebral hemorrhage", "unspecified intracranial hemorrhage", "cerebral embolism with cerebral infarction", "dissection of carotid artery", and "dissection of vertebral artery".

Results
One hundred eighty-nine patients with ADPCKD and unruptured ICAs presented for either surgical clipping (n = 136) or endovascular coiling (n = 53). A control group of 3,555 patients without ADPCKD were analyzed, presenting for either surgical clipping (n = 1707) or endovascular coiling (n=1848). There was a significantly greater incidence of "iatrogenic cerebrovascular hemorrhage or infarction", "cerebral embolism with cerebral infarction", and "dissection of carotid artery" in the ADPCKD patients compared with the control group after endovascular coiling. There was also a significantly greater incidence of "iatrogenic cerebrovascular hemorrhage or infarction" in the ADPCKD group compared with the control group after surgical clipping. However, the mean length of hospital stay was not longer in the ADCKD group, nor were the total hospital charges higher. Additional analysis within the ADPCKD group revealed a significantly shorter length of stay when they underwent endovascular coiling versus surgical clipping (2.57 versus 5.72 days). There was however no significant difference in age or total in-hospital charges when comparing clipping and coiling in this population.

Conclusions
When compared with controls, patients with ADPCKD face an increased risk during ICA treatment, whether by endovascular coil embolization or microsurgical clipping. This risk, however, does not translate into longer hospital stays or increased hospital costs. Despite the additional catheterization-related risks of dissection and embolization, coiling results in shorter lengths of stay and no increased risk of mortality when compared with clipping.
Making Stroke Imaging Better around the World: Global Survey of Radiologists in 20 Countries

B Rehani1, W Dillon2
1University of California, San Francisco, San Francisco, CA, 2Univ of California, San Francisco Med Ctr, San Francisco, CA

Purpose
Stroke poses a major health challenge in today's world. "Time is Brain" in stroke and every minute counts in stroke management. To what extent are we able to provide timely imaging to these patients globally and if not what can be done? Our aim was to survey radiologists across developing countries in Asia, Europe and South America to assess the stroke care and find out what in their opinion are the most effective ways to improvise imaging and management.

Materials and Methods
A standardized questionnaire containing 18 questions was sent to radiologists in 25 developing countries across the world. Radiologists from 20 countries responded (response rate=80%). These include Kenya, Algeria, Rwanda, Sri Lanka, Malaysia, Costa Rica, Macedonia, Bulgaria, Mexico, China, India, Uruguay, Burma and Venezuela among others.

Results
Survey results indicated that most of the countries (72%), lack access to CT scanners. Intravenous tissue plasminogen activator (tPA) is the standard of care of ischemic stroke and cannot be given unless hemorrhage is excluded on CT. Also, this can only be administered for a specific time window after symptom onset. To maximize patients who can benefit from thrombolysis, the key is to have a short Emergency Room Door to CT scan time. Unfortunately, Door to CT scanner time is more than 30 minutes in 83% (95% CI being 80.5-85.4%). Moreover, 77% of the countries had shortage of the drug tPA. Overall, radiologists rated their knowledge as "average" in reading stroke imaging and 77% (95% CI being 74.5-79%) believed that further training would be helpful. Minority had access to Neurointerventionalist (33%) and Telestroke services (27%). When questioned about the three most powerful ways to improvise stroke imaging in their respective countries, the highest rated choices were: training programs on stroke imaging to improvise knowledge among radiologists, campaigns to increase awareness in the community and improvising access to CT.

Conclusions
This survey helps radiologists around the world communicate the imaging needs in stroke in their respective countries and how can they be met. This can help radiologists who want to reach out in their humanitarian efforts to improve imaging around the world.

Missed and Misdiagnosed Spinal Dural Arteriovenous Fistulas Are Associated with High Rates of Additional Disability

W Brinjikji1, J Morris1, D Nasr1, A Rabinstein1, G Lanzino1
1Mayo Clinic, Rochester, MN
Purpose
Spinal dural arteriovenous fistulas (SDAVF) commonly are missed on imaging or misdiagnosed as inflammatory or neoplastic processes. We reviewed a consecutive series of SDAVF referred to our institution that were missed or misdiagnosed on initial imaging and studied clinical consequences of missing or misdiagnosing the lesion.

Materials and Methods
We reviewed SDAVFs diagnosed at our institution between 1/1/2000-11/1/2014. A lesion was defined as misdiagnosed if initial MRI or CT myelogram demonstrated characteristic imaging features of a SDAVF and the patient was clinically or radiologically misdiagnosed. Characteristic features of a SDAVF were high T2 cord signal with serpiginous flow voids with or without intramedullary enhancement on MRI or a serpiginous blood vessel coursing in the spinal canal on CT myelography. Outcomes included length of delay of diagnosis, and increased disability (defined as an increase in mRS≥1-point) between initial imaging evaluation and diagnosis date.

Results
Of 132 angiographically confirmed SDAVF referred to and diagnosed at our institution, 57 (43.5%) were misdiagnosed initially. Characteristic imaging features of SDAVF were initially present in 52 patients (91.2%) receiving spinal MRIs and five patients (8.8%) receiving CT myelograms. Eleven patients (19.3%) received spinal angiograms prior to referral which were interpreted as negative but were either incomplete (i.e., not all vessels injected, nine cases) or retrospectively demonstrated the SDAVF (two cases). Median time of delayed diagnosis was 6 months (IQR=2-14 months). Fifty-three patients (93.0%) had increased disability between the initial study which demonstrated features of a SDAVF and the time of diagnosis. Due to misdiagnosis, 19 patients (33.3%) receiving steroid therapy, six (10.5%) received IV-IG, six received decompressive laminectomies and three (5.1%) received plasma exchange.

Conclusions
Misdiagnosis of SDAVF even when classic imaging features are present on MRI or CT myelography is common. Delayed diagnosis results in high rates of additional disability and costs.

O-249
4:19PM - 4:27PM

Utility of CT Imaging of the Cervical Spine in Cases of Ground Level Fall and Simple Assault

M Uriell1, M Benayoun1, J Allen1, C Holder2
1Emory University, Atlanta, GA, 2Emory Univ. School Of Med., Atlanta, GA

Purpose
CT of the cervical spine routinely is ordered for low-risk mechanisms of injury, including simple assault (SA) and ground level fall (GLF). Two commonly employed clinical decision tools for C-spine imaging in trauma are the National Emergency X-Radiography Utilization Study (NEXUS) (1), and The Canadian Cervical Spine Rule for Radiography (CCR) (2). Our aim was to assess the utility of C-spine CT for a subset of patients with SA and GLF, with stratification of patients on the basis of NEXUS and CCR criteria.
Materials and Methods
With IRB approval, the electronic medical record (EMR) database at a large level 1 trauma center was queried from 2010-2014 for patients with C-spine CT and clinical indications of trauma, assault, and/or fall. Retrospective review was performed, examining NEXUS/CCR criteria, cervical fracture, intracranial trauma, and pre-existing vertebral disease. Exclusion criteria included high risk mechanisms of injury, such as motor vehicle collision, ballistic injury, or fall from a height.

Results
At the time of this abstract, patients from July 1, 2014 to August 30, 2014 (n = 1248) have been investigated, revealing 347 patients (27.8%) with low-risk mechanisms of injury. There were no fractures in patients imaged for SA. For GLF, three were positive for acute fracture of an endplate or facet joint (<1%, CI= 0-1.83% at p<0.05). There were no unstable fractures. All acute cervical fractures with GLF would have required further imaging by either NEXUS or CCR criteria. In total, 100 patients were imaged despite meeting all five NEXUS criteria, and 87 were imaged despite full range of motion and no other contraindication to warrant imaging by CCR.

Conclusions
For simple assault and ground level fall, cervical spine CT is over utilized despite established clinical decision rules. The reason for this may lie partly in the complexity of these rules. Our results indicate that no patients imaged for simple assault had a cervical fracture, regardless of other factors, and CT should not be performed for this indication. Application of these results to clinical practice will reduce imaging costs, as well as population radiation dose exposure.

O-250
4:27PM - 4:35PM
Clinical Utility of Neurophysiological Monitoring in CT-Guided Interventions

S Sundararajan¹, R Garg¹, H Kaufman², V Gendel¹, S Roychowdhury¹
¹Rutgers-Robert Wood Johnson Medical School, New Brunswick, NJ, ²Accurate Monitoring, LLC, Fairfield, NJ

Purpose
Neurophysiological monitoring has been used primarily to predict motor and sensory deficits in surgical settings. Our neurointerventional radiology group has implemented successfully this technique in CT-guided interventions such as cryoablation of osseous metastases. We review pre and postprocedural outcomes data from a series of cases in which data from triggered EMG (tEMG), transcranial motor evoked potential (tcMEP), free running EMG (frEMG), and somatosensory evoked potential (SSEP) were used to direct interventional precision and accuracy.

Materials and Methods
A retrospective review of 17 patients who underwent CT-guided interventional procedures in our institution from 2012 to 2014 was performed. Procedures completed with such monitoring include spine and pelvic embolization and cryoablation, nerve cyst aspiration, and biopsy of neoplasms adjacent to critical neurovascular bundles. Patients were categorized by the type of neurophysiological monitoring implemented: tcMEP, tEMG, frEMG, and SSEP. Charts
highlighting patient demographics, monitoring subtype, and their utility in directing management were created. Outcomes from cases focusing on the efficacy of such monitoring were reviewed.

Results
While several modalities of neurophysiological monitoring are available, different cases benefit from certain monitoring sub-types. Interventions close to neurovascular bundles benefited from tEMG to a greater degree than tcMEPs. tcMEPs were checked to ensure that recorded triggered EMG data were not erroneous. The tEMG data acquired during selective activation of the interrogated nerve were superior in clinical utility compared to tcMEP data in establishing nerve baseline activity and reaffirming postprocedure integrity, as shown by the representative case in this abstract. fEMG was used to assess sacral nerve root function in sacral cryoaablation and embolization interventional cases. This was achieved by attaching monitoring leads to Foley and rectal-catheters for monitoring bladder and bowel activity accordingly. SSEP data served as background activity against which other monitoring data were checked. Figure A) CT image demonstrates sciatic nerve cyst (blue arrow), B) CT image shows triggered EMG probe monitoring nerve activity adjacent to sciatic nerve cyst (red arrow), C) CT image demonstrating resolution of the sciatic nerve cyst following drainage (green arrow), D) Left tibialis anterior and left gastrocnemius show consistent activation (orange ovals) with increasing current delivered through tEMG probe stimulating the sciatic nerve. This activity was without change before and after cyst aspiration.

Conclusions
Neurophysiological monitoring can help identify and prevent inadvertent damage of motor and sensory functions during minimally invasive procedures. Because these procedures are employed to improve patient quality of life, further reduction in remaining nerve root function is not considered an acceptable treatment endpoint. Therefore, we conclude that the clinical importance of neural monitoring during certain interventional procedures cannot be overemphasized.
O-251

Benefits of Routine Use of Multiplanar Reformatted Images in the CT Evaluation of Acute Pediatric Head Trauma

S Langford\textsuperscript{1}, A Panigrahy\textsuperscript{2}, S Narayanan\textsuperscript{3}, M Hwang\textsuperscript{4}, C Fitz\textsuperscript{5}, L Flom\textsuperscript{1}, G Zuccoli\textsuperscript{1}

\textsuperscript{1}Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA, \textsuperscript{2}Children's Hosp. of Pittsburgh of UPMC, Pittsburgh, PA, \textsuperscript{3}Children's Hospital of Pittsburgh, Pittsburgh, PA, \textsuperscript{4}University of Pittsburgh Medical Center, Pittsburgh, PA, \textsuperscript{5}Children's Hospital Of Pittsburgh, Pittsburgh, PA

Purpose
The purpose of this study is to evaluate retrospectively the utility of multiplanar reformats (MPR) of acquired head CT data in the detection of traumatic intracranial hemorrhage (ICH), fractures, and incidentally discovered brain anomalies.
Materials and Methods
Unenhanced CTs performed in trauma patients under 3 years old at the Children's Hospital of Pittsburgh over 1 year were reviewed retrospectively in the axial plane both with and without sagittal and coronal reformatted images. Specific information measured included presence of intracranial hemorrhage, location of hemorrhage, size of hemorrhage, type of hemorrhage, presence of fracture, presence of other traumatic injury, and presence of incidentally discovered brain anomalies including masses and craniocervical junction abnormalities. Data were reviewed to determine the sensitivity of detection of these abnormalities both with and without multiplanar reformatted images, and special attention also was paid to abnormalities detected on axial images that were proven to represent artifact when viewed in multiple planes.

Results
The routine acquisition of multiplanar reformatted images in the unenhanced CT evaluation of pediatric trauma patients resulted in improved sensitivity for detection of traumatic injury, particularly intracranial hemorrhage. Intracranial hemorrhage detected only on the multiplanar reformatted images was usually small in size and located either at the vertex or below the tentorium. Fractures detected only on multiplanar reformatted images most often were oriented in the axial plane. Multiplanar reformatted images also increased the detection of other incidental anomalies, particularly craniocervical junction abnormalities such as Chiari malformation. Viewing artifact in multiple planes also increased the confidence in diagnosing a normal study.

Conclusions
The routine acquisition of multiplanar reformatted images in the unenhanced CT evaluation of pediatric trauma patients resulted in improved accuracy, not only in detection of traumatic injury, particularly intracranial hemorrhage, but also in decreasing the false positive rate relating to artifact. Other incidental anomalies, particularly craniocervical junction abnormalities, also were detected with greater frequency on reformatted images.

Tuesday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

12A - ASHNR: EYE SEE YOU: CURRENT ORBITAL IMAGING (AR) (SAM)
12A-1
Thyroid Ophthalmopathy

Juliano, A.
Massachusetts Eye & Ear Infirmary
Boston, MA

12A-2
Evaluating Causes of Proptosis

5:15PM - 5:30PM
12A-3

**Carotid Cavernous Fistulas: Diagnosis and Management**

Cooke, D.
University of California San Francisco
San Francisco, CA

12A-4

**Orbital Inflammation and Infection**

Mosier, K.
Indiana University School of Medicine
Indianapolis, IN

12A-5

**Questions and Answers**

Tuesday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)

**12B - ASPNR: INTERESTING CASE-BASED SESSION: BEAT THE PRESIDENTS! (AR)**

12B-1

**Panelists**

Tekes, A. · Choudhri, A. · Robson, C. · Shaw, D.
Johns Hopkins Hospital · University of Tennessee Health Science Center, Le Bonheur Children's Hospital · Boston Children's Hospital · Children's Hospital & Regional Medical Center · Baltimore, MD · Memphis, TN · Boston, MA · Seattle, WA
Tuesday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

12C - MODERN INFLAMMATORY AND INFECTIOUS DISORDERS
12C-1
5:00PM - 5:20PM
The Brain, the Immune System, and the Insula
Lev, M.
Massachusetts General Hospital, Harvard Medical School
Boston, MA

12C-2
5:20PM - 5:40PM
Enterovirus: Hemiplegia and Other Neurologic Manifestations
Mirsky, D.
Children's Hospital Colorado
Aurora, CO

12C-3
5:40PM - 6:00PM
Atypical Inflammation and Infection of the Skull Base and Sinonasal Cavity
Huang, B.
University of North Carolina
Chapel Hill, NC

12C-4
6:00PM - 6:20PM
Forensic Radiology: Behind the Scenes
Tal, S.
Sackler Faculty of Medicine, Tel Aviv University
Zerifin, Zerifin

12C-5
6:20PM - 6:30PM
Discussion
Utility of Co-registration of MRI and 18F-FDG PET in the Evaluation of Treated Brain Gliomas

K Raj¹, I Nasrallah¹, J Schmitt¹, S Wang¹, A Desai¹, S Mohan¹
¹The University of Pennsylvania, Philadelphia, PA

Purpose
In high grade gliomas treated with temozolomide and radiotherapy, differentiating progressive neoplasm from treatment-induced changes on follow-up imaging is challenging. MRI, increasingly with perfusion imaging, primarily is used to differentiate these entities, but its performance remains suboptimal. 18F-FDG PET (FDG-PET) has established utility in evaluating brain neoplasia; however, its role in discriminating temozolomide/radiotherapy treatment effects from progression is not well established. This study investigates the value of FDG-PET in the follow up of post-treatment high grade gliomas, and evaluates the utility of coregistration of MRI and FDG-PET.

Materials and Methods
Eleven patients with histologically proven high grade gliomas treated with surgery and subsequent chemoradiotherapy were reviewed retrospectively. Patients underwent both MRI with dynamic susceptibility contrast-enhanced perfusion imaging and PET within a mean interval of 14.1 days. 18F-FDG uptake in enhancing regions was quantified after semi-automatic rigid registration to enhanced T1-weighted images and manual segmentation and normalized to contralateral normal white matter. Clinical follow up, MRI, and pathologic information were used to determine outcomes within a 6-month period following PET examination. Agreement between measures was assessed via tetrachoric correlation and the kappa statistic.

Results
The predictive accuracy of tumor progression versus treatment-related changes with advanced MRI alone was 90.9% with correlation of 0.77 and kappa of 0.62 (p = 0.04); that of FDG-PET alone was 63.6% with correlation of 0.35 and kappa of 0.21 (p = 0.78). Predictive accuracy of coregistered FDG-PET and MRI was 100% with kappa of 1.0 (p = 0.0009).

Conclusions
The paucity of PET data in the follow up of high grade gliomas has led to varied interpretation of tumor progression versus radiation-induced changes. Our results indicate a high diagnostic
accuracy of coregistered MRI and FDG-PET. This dual modality approach is superior to either alone in the evaluation of post-treatment gliomas and can reduce the number of false negative and equivocal interpretations.

O-253

Diagnostic utility of PET-MR evaluation as compared to semi-quantitative and qualitative 18FDG-PET/CT in differentiating radiation necrosis from tumor recurrence: Preliminary results

C Badve¹, S Abboud¹, U Yankevich¹, M Hojjati², V Garg¹, C Tatsuoka², A Sloan¹, L Rogers¹, L Wolansky¹, P Faulhaber¹
¹University Hospitals and Case Medical Center, Cleveland, OH, ²University Hospitals and Case Medical Center, Cleveland, OH

Purpose
Most PET/CT studies performed for evaluation of postradiation treatment effects in gliomas have used qualitative or semiquantitative methods with heterogeneous outcomes (1-3). The purpose of this study was to compare the efficacy of quantitative PET/CT, qualitative PET/CT and PET MR analyses to differentiate between tumor recurrence (TR) and radiation necrosis (RN).

Materials and Methods
This retrospective study included 19 glioma patients treated with surgery and radiation that were evaluated with PET CT after progression on standard MR imaging. WHO grades included 12 grade IV, six grade III, and one grade II glioma. Among these 19 patients, five had RN and 14 had TR. Final diagnosis was confirmed by pathology in 12 and by imaging and clinical follow up in seven. Of these, 10 patients also underwent PET with MR attenuation correction (PET MR). For quantitative analysis a PET edge detection tool was used to draw region of interest (ROI) around the suspicious lesion (L). Another ROI was drawn in contralateral white matter (C) and relative maximum, mean and median (r-max, r-mean, r-median) values were calculated for each lesion using the L/C ratio. Student's t-test and sensitivity analysis (using a cutoff value of two) was performed on this output. For qualitative PET CT and PET MR analysis, blinded consensus reads were performed to rate each lesion on a scale of one to five that then was classified binary into TR or RN. Wilcoxon-rank test was used for comparison between the two ratings.

Results
Among the quantitative metrics, r-median values were most effective in differentiating TR from RN (p < 0.01). Quantitative metrics also had improved sensitivity as compared to qualitative PET CT analysis, which had better specificity. However, PET MR analysis was superlative in terms of sensitivity, specificity and accuracy in differentiating between TR and RN (Table 1).

Conclusions
Our preliminary results suggest that PET MR analysis is the most efficient method of differentiating between radiation necrosis and tumor recurrence as compared to qualitative and semiquantitative PET CT analysis. A larger dataset with these parameters currently is being evaluated. In addition, analysis of quantitative perfusion parameters and their performance as compared to PET data is under evaluation.
Functional diffusion mapping of low grade glioma response to glioma associated antigen vaccine immunotherapy

A Ghodadra¹, J Mettenburg¹
¹University of Pittsburgh Medical Center, Pittsburgh, PA

Purpose
To assess changes in newly diagnosed and recurrent low grade glioma diffusivity as measured by longitudinal functional diffusion mapping following immunization with a glioma-associated antigen vaccine. Our hypothesis is that early increase in diffusivity within the tumor volume is associated with necrosis, treatment response and prolonged progression free survival.

Materials and Methods
Twenty-two patients with low grade gliomas underwent vaccine treatment with magnetic resonance imaging (MRI) performed every 3 months as part of a phase I safety trial. Patients were followed clinically for at least 2 years. Tumor volumes at each MRI time-point were segmented on T2-weighted images and coregistered to each patient's baseline prevaccine study. Apparent diffusion coefficient (ADC) maps were calculated from diffusion-weighted and B0 images. Serial functional diffusion maps (FDM) and FDM metrics were generated comparing each time-point to the one prior. The maximum and minimum FDM ratios (tumor voxels with increasing ADC/those with decreasing ADC) of the first five time-points (75-435 days postvaccine initiation) were calculated. Cox proportional hazard modelling was performed to assess for differences in progression-free survival based on the maximum and minimum FDM ratio.

Results
Of 22 patients with low grade gliomas, 11 had baseline and at least one follow-up imaging periods that included T2 and DWI sequences. The median tumor volume in the 11 patients was 1782 mm³ (quartiles: 1154 and 3361). The overall median progression free survival was 511 days (quartiles: 295 and 903). Cox proportional hazard modeling revealed a statistically significant relationship between the maximum FDM ratio (median: 2.14, quartiles: 1.11 and 3.41) and the risk of progression (RR: 0.54, 95% CI: 0.24 – 0.93 p = 0.022).

Conclusions
Longitudinal increase in the FDM ratio correlates with prolonged progression-free survival in
vaccine-treated low grade gliomas. Longitudinal assessment of ADC may serve as a good indicator of glioma treatment response.

O-255

Histogram Analysis of Amide Proton Transfer Imaging to Identify Contrast-enhancing, Low-grade Tumor Mimicking High-grade Tumor: Added Value to MR Perfusion Study

J Park¹, H Kim¹, S Kim¹, C Choi²
¹Asan Medical Center, Seoul, Korea, Republic of; ²Asan Medical Center, Seoul, Seoul

Purpose
To determine the added value of the histogram analysis of amide proton transfer (APT) imaging to MR perfusion imaging for identifying contrast-enhancing, low grade tumor (WHO grades 1 and 2) mimicking high grade tumor (WHO grades 3 and 4).

Materials and Methods
This retrospective study was approved by our institutional review board. Thirty-six patients with pathologically proven, solitary, contrast-enhancing tumors were enrolled in this study. APT-derived signals from the calculated APT asymmetry at the offset frequency = 3.5 ppm and normalized cerebral blood volume (nCBV) were measured on solid portions of the tumor using a 90% histogram cutoff (APT90, nCBV90). The diagnostic performance of the imaging parameters was determined by leave-one-out cross validation. Interobserver agreement was assessed using the intraclass correlation coefficient (ICC).

Results
The APT90 demonstrated a significant difference between contrast-enhancing, low grade and high grade tumors for both readers (P < .001 for both readers). Compared with the nCBV90, adding APT90 significantly improved the area under the receiver operating characteristic curve (AUC) for identifying contrast-enhancing, low grade tumor from 0.80 to 0.97 for reader 1 (P = .023) and from 0.82 to 0.97 for reader 2 (P = .035), respectively. Using leave-one-out cross validation, the cross-correlated AUC of the combination of nCBV90 and APT90 was 0.95 for reader 1 and 0.96 for reader 2. The ICC for the APT90 calculations was 0.89.

Conclusions
Histogram analysis of APT imaging provided an added value to MR perfusion imaging for identifying contrast-enhancing, low grade tumor mimicking high grade tumor.
Magnetic Resonance Spectroscopy (MRS) Measured 2-HG Level and Its Relationship to the Progression of Gliomas Carrying the IDH Mutation

C Holder¹, L Wang², J Olson², H Wu², S Wu², E Van Meir², H Mao³
Purpose
Mutation in isocitrate dehydrogenase 1/2 (IDH1/2) is a prognostic marker of gliomas (1, 2). The mutant enzyme produces the oncometabolite, R(-)-2-hydroxyglutarate (2HG), which can be detected in vivo and ex vivo by MRS. This study aims to investigate relationships of the 2HG concentrations obtained from MRS analysis with tumor progression features obtained from radiology and pathology exams to explore the potential of using 2HG levels as a biomarker for predicting glioma prognosis and response to treatment.

Materials and Methods
2HG concentrations from 38 IDH1/2 mutation-bearing tumor tissues were obtained by 2D correlation spectroscopy on solid state NMR (3, 4). Tumor volume measurements were acquired on Siemens Magnetom Trio 3.0 T MRI scanner. The Ki-67 tumor proliferation index (MIB) was obtained from pathology. All cases were divided into three grade groups, which include grade II (n = 8), grade III (n = 19), and grade IV (n = 11) based on WHO grade. 2HG concentrations correlated with WHO grades and MIB of tumors (n=17). Nonparametric Mann–Whitney test for comparison/Spearman for correlation were used with P < 0.05 considered as statistically significant. Longitudinal 2HG changes were observed from seven specific followed up patients.

Results
2HG is elevated in tumors at higher grades. When comparing the 2HG level with tumor volume and tumor proliferation measurements of MIB index, it was found that 2HG level is associated with increased tumor volume, and positively correlated with the MIB index. These seven cases thus provided patient-specific examples to support the general finding that 2HG level increases with tumor grade.

Conclusions
This study provides evidence that 2HG level has a strong correlation with several clinically important prognostic indices, such as tumor size and MIB value. It has been suggested that excess 2HG accumulation in tumors may contribute to formation and malignant progression of gliomas (5); however, the mechanism of this possible role is still unclear.
Use of Volumetric MR Spectroscopic Imaging and 5-ALA Fluorescence-Guided Surgery for Resection of Glioblastoma

C Holder¹, J Cordova², C Hadjipanayis², Z Liang², L Cooper², H Shu², J Olson², H Shim²

¹Emory University School Of Medicine, Atlanta, GA, ²Emory University School of Medicine, Atlanta, GA

Purpose
Glioblastoma (GBM) resection using neuronavigation based on contrast-enhanced MRI (CE MRI) results in a high rate of local recurrence, as infiltrating tumor cells extend beyond areas of contrast enhancement. Integrating metabolic maps from magnetic resonance spectroscopic imaging (MRSI) into neuronavigation may identify high-risk tumor infiltration zones outside of CE MRI for surgery. Coupling MRSI with fluorescence-guided surgery (FGS) using 5-aminolevulinic acid (5-ALA) may provide a means to enhance the degree of tumor resection further.
Materials and Methods
In an ongoing Phase II trial for new and recurrent GBM patients (n=27, at the time of this abstract), 3D echo-planar MRSI was performed and processed to give full brain metabolite volumes for import into a neuronavigation system. Patients were administered 5-ALA orally 3-5 hours before surgery. To minimize errors due to brain shift, needle biopsies were collected from tumor regions with elevated choline/NAA values within T1CE and/or T2/FLAIR-hyperintense regions before gross tumor resection. Fluorescence intensity of fresh tissue was quantified ex vivo using a hand-held spectroscopic device. Samples then were stained with SOX2 immunohistochemistry to highlight neoplastic cells, and analyzed to quantify percentage of neoplastic cells in the tissue specimen using automated pathology image analysis. Quantitative tumor segmentation was used to evaluate extent of tumor resection on postoperative MRI.

Results
Choline/NAA values were correlated significantly with percent tumor cell content, as measured from histology specimens stained for SOX2, a marker of neoplastic cells (rho=0.69, p=0.0003), demonstrating a positive linear trend between Choline/NAA and the percentage of tumor nuclei and the degree of tumor infiltration. Real-time intra-operative tumor fluorescence also was confirmed ex vivo, and showed a similar positive linear trend with choline/NAA ratios.

Conclusions
The linear trend that Cho/NAA values exhibit with pathology and quantitative intraoperative fluorescence of tumor tissue outside of CE MRI regions supports its use for identifying regions of tumor infiltration, as confirmed by SOX2 immunohistochemical analysis. This is the first time that 5-ALA-induced tumor fluorescence has been shown to correlate with MRSI-derived metabolic markers in GBMs. We believe the combination of MRSI-neuronavigation with 5-ALA FGS in this trial will result in more complete GBM resections.
Three contours of MRSI Cho/NAA ratios (green, 2X; yellow, 5X; red, 10X over normal contralateral brain tissue) are overlaid on the T1-CE MRI. Samples collected via stereotactic biopsy technique (3 – 6 samples were taken from each patient) were immunostained using SOX2 as a tumor marker. SOX2 does not stain normal brain (glial or neuronal), endothelial or immune cells. The table shows correlations between Cho/NAA and Cho/Cr ratios or total choline or creatine vs. percent of tumor cells in the specimens from the study.

<table>
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<tbody>
<tr>
<td>Cho/NAA</td>
<td>0.69</td>
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<tr>
<td>Cho/Cr</td>
<td>0.47</td>
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<tr>
<td>Total Choline</td>
<td>0.64</td>
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<tr>
<td>Creatine</td>
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(Filename: TCT_O-257_ASNR20155-ALAAbstractFigure.jpg)

O-258

**PH Weighted Molecular MRI in Preclinical and Human Brain Tumors**

B Ellingson\(^1\), R Harris\(^1\), P Nghiemphu\(^1\), A Lai\(^1\), W Pope\(^1\), R Prins\(^1\), W Yong\(^1\), L Liau\(^1\), T Cloughesy\(^1\)

\(^1\)University of California Los Angeles, Los Angeles, CA
Purpose
A decrease in pH within the tumor microenvironment results in malignant transformation, resistance to radiation therapy, chemotherapy resistance, immunosuppression, increased tumor invasion, increased mutogenesis, altered gene expression, and angiogenesis. A noninvasive imaging method for evaluating tumor tissue pH will be valuable for early detection of treatment response, tumor progression, and/or treatment failure in malignant tumors. The current study utilizes chemical exchange saturation transfer (CEST) imaging to identify tumor tissue with low pH (acidic tissue) by targeting MR excitation of amine protons on glutamine, a major source of fuel for tumor cells.

Materials and Methods
Amino acid phantoms at various concentrations, temperatures, and pH were scanned using CEST MRI on both 7T preclinical and 3T human MR systems. C57BL/6 mice inoculated with GL261 glioma tumors were scanned using pH-weighted MRI on 7T MR systems under a variety of conditions. A total of 15 patients with newly diagnosed glioblastoma were scanned with pH-weighted and physiologic MRI prior to, during, and after combination radiochemotherapy. Three patients had pH-weighted MRI matched with 18F-FDOPA PET. Additionally, two patients underwent pH-weighted MRI-guided stereotactic biopsies.

Results
Glutamine, glycine, and phenylalanine showed statistically similar increasing CEST asymmetry characteristics at 3ppm with decreasing pH. Chemical exchange saturation transfer asymmetry increased with decreasing pH, increasing amino acid concentration, and increasing temperature. C57BL/6 mice inoculated with GL261 gliomas showed increased CEST asymmetry consistent with acidic tumor in regions with histologically confirmed tumor. Standard anatomical and acidic tumor responses were different in many patients during radiochemotherapy. Tumor regions with elevated 18F-FDOPA PET uptake also illustrated low pH. Biopsy results confirmed regions with elevated CEST asymmetry contained tumor even when 18F-FDOPA PET was negative.

Conclusions
pH-weighted molecular MRI using amine CEST appears to have high sensitivity and specificity to regions containing brain tumor cells, independent of other imaging contrasts including physiologic MRI and amino acid PET.
Imaging Findings of Cancer Immunotherapy Induced Hypophysitis

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¹University of Texas MD Anderson Cancer Center, Houston, TX, ²UT MD Anderson Cancer Center, Houston, TX

Purpose

The use of immune checkpoint inhibitors, such as the anti-CTLA4 agent ipilimumab, is associated with autoimmune hypophysitis. We reviewed MRI scans of clinically confirmed immunotherapy-induced hypophysitis (IH) for useful imaging findings.
Materials and Methods
Of 968 patients treated with immunotherapy since 2005 at MD Anderson Cancer Center, 51 were referred for Endocrine consult. Of these, 27 were diagnosed with IH, defined as (1) ≥1 pituitary hormonal deficiencies (either adrenocorticotropic hormone or thyroid stimulating hormone) plus MRI abnormality or (2) ≥2 pituitary hormonal deficiencies plus headache or MRI evidence of hypophysitis. Two CAQ certified neuroradiologists reviewed all MRIs for suprasellar extension and heterogeneous enhancement of the pituitary gland, enlargement of the gland compared to a prior study and pituitary stalk thickening. Time to imaging resolution of IH, and presence of brain metastases, also were noted.

Results
Median age at diagnosis of IH was 60 years (31-75); 19 (70%) were men. Twenty-one patients had melanoma, five had prostate cancer and one had renal cell carcinoma. Nineteen of 21 (90%) IH patients with comparison scan showed increased height of the gland. Thirteen of 27 (48%) IH glands showed suprasellar convexity, 7/27 (26%) IH glands met the top of the sella and 7/27 (26%) remained intrasellar. In 7/14 without suprasellar convexity, baseline MRI enabled diagnosis by showing growth. Nineteen of 27 (70%) IH glands demonstrated stalk thickening. Ten of 27 (37%) IH glands showed heterogeneous enhancement. Mean IH gland height was 10.7mm compared to mean baseline height for the same cases 6.5mm. Twenty-four of 27 (89%) patients had MRI findings of hypophysitis on MRI interpretation. One of the three remaining patients (false negatives) had no baseline study for comparison and MRI demonstrated none of the other findings listed above. One of the false negatives had stalk thickening and heterogeneous enhancement but no growth from baseline. The third case had heterogeneous enhancement in one plane postcontrast but not in other planes, and no stalk thickening or growth of the gland. At IH diagnosis, MRI scan showed new parenchymal or dural based metastasis in 3/27 (11%) patients. One other patient had a history of brain metastasis prior to IH diagnosis. All IH resolved by 2-month follow-up scans; there was only partial resolution at 2 weeks.

Conclusions
MR imaging (MRI) demonstrated hypophysitis in 89% of IH cases. Baseline MRI scan was very helpful in diagnosis. Hypophysitis is much more common in the setting of immune checkpoint inhibitor therapy than is metastasis to the pituitary gland. MRI brain is not needed for surveillance of treated hypophysitis.

O-260 6:04PM - 6:12PM

Quantitative analysis of multi-parametric glioma MR images: a potential biomarker to predict tissue factor expression and angiogenic patterns

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Purpose
HGGs often are characterized as bizarre vascular formations that are mainly distributed in the hypoxia of glioma, which linked with aggressive behavior and poor prognosis. Tissue factor (TF), as a biomarker of cancer progression, overexpressed in cancer cells around the typical necrotic foci found in glioma. To investigate the role of TF played in bizarre vascular formations
and find new imaging biomarkers for evaluating TF expression and vascular parameters quantification.

Materials and Methods
Seventy patients, histopathologically diagnosed glioma, were recruited with local ethic committee approval. Twenty of them were performed both DCE MRI and VSI MRI prior to surgery to monitor vascular parameters and TF expression. Perfusion indices transfer coefficient (Ktrans), relative vessel size were generated. We evaluated the correlation among TF expression, vascular parameters, and MRI-measured changes in vascular permeability and vessel size. Further, U87 glioma nude mice model in situ and a series of cell experiments in vitro were taken to reveal the role of TF played in bizarre vascular formations.

Results
The percentage area of TF revealed stronger correlations with vascular parameters (MVA, MVD, diameter) of bizarre vascular pattern than VEGF, which were distributed mainly near the necrotic foci. However, the percentage area of VEGF revealed stronger correlations with vascular parameters of classic angiogenesis pattern than TF, which were distributed mainly at the margin of glioma. Then, we detected the mechanism of TF in bizarre vascular formations by U87 glioma nude mice model in situ and a series of cell experiments in vitro. Vascular parameters were decreased significantly in TF knockdown U87 nude mice by down-regulating PAR-2-dependent HB-EGF pathway in ECs, compared to U87 nude mice. Meanwhile, cancer cell invasion also was decreased significantly in TF knockdown U87 nude mice and TF knockdown U87-MGs. Furthermore, Mean values of Ktrans and VSI hotspots showed strong correlations with percentage area of TF and vascular parameters quantification in these 20 patients who were performed both DCE MRI and VSI MRI prior to surgery.

Conclusions
We found for the first time that TF expression correlated well with bizarre vascular formations. Most notably, TF may play an important role in bizarre vascular formations by up-regulating PAR-2-dependent HB-EGF pathway in ECs and increasing cancer cells invasion. Furthermore, we firstly identified the imaging biomarkers (i.e., Ktrans and VSIMRI) for TF expression and vascular parameters quantification, which would predict more closely the outcome of glioma.

O-261

Underestimation of Apparent Diffusion Coefficient-based Tumor Cellularity in Hypervascular Brain Tumor: Intra-individual Comparison with Intravoxel Incoherent Motion-Derived Perfusion and Diffusion Parameters

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¹Asan Medical Center, Seoul, Seoul, Korea, Republic of
²Asan Medical Center, Seoul, Korea, Republic of

Purpose
Apparent diffusion coefficient (ADC)-based tumor cellularity can be underestimated in hypervascular tumor. The purpose of our study is to investigate the underestimation of ADC-based tumor cellularity by determining the differences in mono-exponential and bi-exponential diffusion parameters in hypervascular and hypovascular brain tumors.

Materials and Methods
We enrolled a total of 128 patients with pathologically confirmed glioblastoma (n = 55),
metastasis (n = 31), and primary CNS lymphomas (n = 42) prior to any treatment. Two neuroradiologists independently calculated the maximum IVIM-f (fmax), minimum IVIM-D (Dmin), maximum nCBV (nCBVmax), and minimum ADC (ADCmin). The differences in fmax, Dmin, nCBVmax, and ADCmin among the three tumor pathologies were determined by one-way ANOVA with multiple comparisons. The fmax and Dmin were correlated to the corresponding nCBV and ADC using partial correlation analysis, respectively.

Results
The mean fmax significantly increased in the glioblastomas (reader 1, 0.103; reader 2, 0.109) and the metastasis (reader 1, 0.105; reader 2, 0.107), compared to the primary CNS lymphomas (reader 1, 0.025; reader 2, 0.023)(p< .001 for each). The mean ADCmin was significantly lower in primary CNS lymphomas than in glioblastoma and metastasis. However, the mean Dmin did not differ significantly in the three groups. The correlation between fmax and the corresponding nCBV was highest in glioblastoma group, and the correlation between Dmin and the corresponding ADC was highest in primary CNS lymphomas group.

Conclusions
Using true diffusion parameter separated from perfusion effect, tumor cellularity estimation does not differ among glioblastoma, metastasis, and primary CNS lymphomas.
Role of DCE-MRI parameters in assessing heterogeneity of vascularization in glioma: correlation with an classic angiogenic factor, Tissue Factor

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\(^1\)Daping Hospital, Research Institute of Surgery, the Third Military Medical University, Chongqing, Chongqing, \(^2\)Institute of Surgery Research, Daping Hospital, Third Military Medical University, Chongqing, Chongqing

Purpose
To investigate whether dynamic contrast-enhanced MRI parameters could reveal the heterogeneity of intratumoral vascularization in glioma and evaluate tissue factor (TF) expression.

Materials and Methods
Thirty-seven patients, receiving DCE MRI prior to surgery and histopathologically diagnosed glioma, were recruited with local ethic committee approval. Perfusion indices transfer coefficient (Ktrans), reverse transfer constant (Kep), volume of the extravascular extracellular compartment (Ve), blood plasma volume (Vp), accompanying with the histogram data of whole tumor section. Five serial paraffin sections were stained with TF, vascular endothelial growth factor (VEGF), CD105, CD34, \(\alpha\)-smooth muscle action (\(\alpha\)-SMA), successively. Percentage area of TF was quantified at 200X magnification field. Microvessel density and area (MVD, MVA), ferret minimum diameter of CD105, CD34 and \(\alpha\)-SMA stained vasculature were calculated from at least three regions of interest (ROIs) in hypervascular location.

Results
Statistically significant correlations were observed between several DCE parameters and TF. Tissue factor significantly correlated with the ratio of \(\alpha\)-SMA-MVD/CD34-MVD, other than CD105-MVD/CD34-MVD, revealing its profound role in pericytes/smooth muscle-like cells proliferation. Beside histogram analysis demonstrated rather low relative peak height with high TF expression.

Conclusions
We find that correlations between heterogeneous perfusion parameters and heteromorphic vessels. Tissue factor expression can reveal vascular heterogeneity. Therefore, due to strong correlation between perfusion parameters and TF expression, we conclude that MR perfusion imaging can be surrogate maker for vascular heterogeneity and TF expression.

Tuesday
5:00PM - 6:36PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

12E - PARALLEL SCIENTIFIC PAPER SESSION-INTERVENTIONAL: STROKE

O-263

A Multicenter Randomized Clinical trial of Endovascular treatment for Acute ischemic stroke in the Netherlands (MR CLEAN)
C Majoie$^1$, O Berkhemer$^2$, D Beumer$^3$, P Fransen$^4$, L van den Berg$^2$, A van der Lugt$^4$, R van Oostenbrugge$^1$, W van Zwam$^2$, Y Roos$^2$, D Dippel$^4$

$^1$Academic Medical Center, Amsterdam, Noord-Holland, $^2$AMC, Amsterdam, Netherlands, $^3$MUMC, Maastricht, Netherlands, $^4$Erasmus MC, Rotterdam, Netherlands

Purpose
In patients with acute ischemic stroke caused by a proximal intracranial arterial occlusion, intra-arterial treatment (IAT) is highly effective for emergent revascularization. However, proof of a beneficial effect on functional outcome is lacking. The purpose of this RCT was to determine the safety and effectiveness of IAT in improving functional outcome in patients with acute ischemic stroke caused by a confirmed proximal intracranial occlusion of the anterior circulation.

Materials and Methods
Patients with a proximal arterial occlusion in the anterior cerebral circulation demonstrated on vessel imaging, treatable by IAT within 6 hours after symptom onset, were randomized to IAT plus usual care, or usual care alone. Primary outcome was the modified Rankin Scale (mRS) at 90 days; mRS is a categorical scale measuring functional outcome, with range from zero (no symptoms) to six (dead). The treatment effect was estimated with ordinal logistic regression as a common odds ratio, adjusted for prespecified prognostic factors (acOR). The acOR is a measure of the likelihood that treatment leads to better mRS scores (shift analysis).

Results
We included 500 patients enrolled from 16 medical centers in the Netherlands. Mean age was 65 years (range 23 to 96), and 445 patients (89%) were treated with intravenous alteplase before randomization. Retrievable stents were used in 190 of 233 patients (82%) allocated to IAT. The acOR was 1.67 (95% CI: 1.21-2.30). There was an absolute difference of 13.5% (95% CI: 5.9% to 21.2%) in functional independence (mRS 0-2) in favor of the intervention (32.6% versus 19.1%). There were no differences in mortality or occurrence of symptomatic intracranial hemorrhage. None of the interactions between prespecified subgroups (including those defined by age $\geq$80 versus <80 and NIHSS 2-15 versus 16-19 versus $\geq$20) and treatment were statistically significant.

Conclusions
Intra-arterial treatment in patients with acute ischemic stroke caused by a proximal intracranial occlusion of the anterior circulation is effective and safe within 6 hours after stroke onset.

O-264

5:08PM - 5:16PM

The impact of occlusion site on treatment effect in patients undergoing intra-arterial therapy for acute ischemic stroke in the MR CLEAN trial.

O Berkhemer$^1$, W van Zwam$^2$, A van der Lugt$^3$, A Yoo$^4$, L van den Berg$^1$, P Fransen$^3$, D Beumer$^2$, R van Oostenbrugge$^2$, Y Roos$^1$, D Dippel$^3$, C Majoie$^1$

$^1$Academic Medical Center, Amsterdam, the Netherlands, $^2$Maastricht University Medical Center, Maastricht, the Netherlands, $^3$Erasmus MC, Rotterdam, the Netherlands, $^4$Massachusetts General Hospital, Boston, MA, USA
Purpose
To assess the influence of occlusion site found on baseline vessel imaging on treatment effect in
the MR CLEAN trial.

Materials and Methods
MR CLEAN was a randomized clinical trial of intra-arterial treatment (IAT) versus no IAT in
patients with a proximal arterial occlusion in the anterior cerebral circulation demonstrated on
vessel imaging, treatable within 6 hours after symptom onset. Primary outcome was the modified
Rankin Scale (mRS) at 90 days. The subgroup analysis of intracranial carotid terminus (ICA-T)
occlusion on treatment effect was prespecified. Exploratory analyses were M1 versus no M1, and
M2 versus no M2 occlusion. Primary and secondary endpoints of the MR CLEAN trial were
used as effect parameters. Adjustments were made for potential imbalances in major prognostic
variables: age, stroke severity (NIHSS) at baseline, time since onset to randomization, previous
stroke, atrial fibrillation, and diabetes mellitus.

Results
Of 500 subjects, 134 (26.8%) had an ICA-T occlusion, 319 (63.8%) had a M1 occlusion, 39
(7.8%) had a M2 occlusion, three (0.6%) had an A2 occlusion, four (0.8%) an isolated ICA
occlusion without M1 or A1 involvement, and of one (0.2%) patient no baseline vessel imaging
was available. There were no significant interactions between subgroups and treatment effect.
The treatment effect remained consistent in all predefined and exploratory subgroups.

Conclusions
We found no significant interaction with treatment effect in any of the intracranial occlusion site
subgroups.
Association of CT Perfusion Ischemic Core Volume with Treatment Effect and Clinical Outcome in Patients with Acute Ischemic Stroke

J Borst¹, O Berkhemer¹, H Marquering¹, Y Roos¹, R van Oostenbrugge², W van Zwam², A van der Lucht³, D Dippel³, C Majoie¹
¹Academic Medical Center, Amsterdam, Netherlands, ²MUMC, Amsterdam, Netherlands, ³Erasmus MC, Rotterdam, Netherlands

Purpose
To assess the association of baseline CT perfusion (CTP) ischemic core and penumbra volume with treatment effect and clinical outcome in patients with acute ischemic stroke.

Materials and Methods
Patients from the MR CLEAN trial who underwent CTP were included in this study. The MR CLEAN is a randomized trial investigating the effect of intra-arterial treatment (IAT) versus best treatment, including intravenous therapy, in patients with acute ischemic stroke. Patient characteristics (age, time to treatment, time to imaging, treatment allocation (IAT versus best treatment) and NIHSS) were recorded. NCCT and CTA were analyzed by expert radiologists. CT perfusion was analyzed using brain perfusion software from Philips (IntelliSpace 7.0). The primary outcome measure is good clinical outcome assessed by mRS at 90 days. A score of 0-2 is defined as good outcome and a score of 3-6 as poor. Univariate logistic analysis was performed to identify statistically significant variables, including patient characteristics, NCCT ASPECTS, level of occlusion and collateral status on CTA, and CTP ischemic core and penumbra volume. A multivariate logistic regression model was used to assess the strength of each variable.

Results
CT perfusion data of 195 patients enrolled in the MR CLEAN were included in this study. After exclusion due to severe motion (n=34) and truncation of the AIF or VOF (n=31), data from 130 patients were used. All patients with an CTP-derived ischemic core ≥70 ml had a poor outcome. We created a logistic regression model including ischemic core volume, treatment allocation and NIHSS. The odds ratio for good clinical outcome for CTP-derived ischemic core volume (ml), treatment allocation and NIHSS was 0.96 (p<0.001), 2.2 (p=0.081) and 0.93 (p=0.098), respectively.

Conclusions
CT perfusion ischemic core volume is strongly associated with patient outcome.

O-266

TICI and Age: What's the score?

L Slater¹, J Coutinho¹, T Krings¹, R Nogueira², R Jahan³, J Gralla⁴, A Davalos⁵, A Bonafe⁶, V Mendes-Pereira⁷
¹University Health Network- Toronto Western Hospital, Toronto, Ontario, ²Emory University school of medicine, Atlanta, GA, ³Ronald Reagan UCLA medical center, Los Angeles, CA, ⁴Inselspital Universitatsspital Bern, Bern, Bern, ⁵Hospital Universitari Germans Trias i Pujol,
Purpose

Previous studies have suggested that advanced age predicts worse outcome following mechanical thrombectomy. We assessed outcomes from two recent core lab reviewed databases to determine if there is an association between TICI, age and outcome.

Materials and Methods

Data from the STAR trial, an international multicenter prospective single arm thrombectomy study and the Solitaire arm of the SWIFT trial were pooled. TICI was determined by core lab review. Good outcome was defined as mRS score of 0-2 or decrease in NIHSS of ≥ 10 at 90 days. We analyzed the association between clinical outcome, reperfusion (TICI 2b-3 vs TICI 0-2a) and age (dichotomized across the median).

Results

We included 238/293 patients treated with solitaire in the STAR and SWIFT databases for whom TICI and 90 day outcome data were available. Mean and median age was 67 and 72 years (IQR 61-77) respectively, 59% were female and median NIHSS was 17. Overall, TICI 2b-3 was achieved in 84% (201/238) and good clinical outcome in 81% (193/238). Outcome was associated with reperfusion (TICI 2b-3 OR 4.52, 95% CI 2.11-9.66), but not age (age <72 OR 1.00, 95% CI 0.52-1.91). When stratified by age, the association between reperfusion and clinical outcome was more pronounced in the elderly (rate of good outcome in patients ≥ 72 years: TICI 0-2a 47.4% versus TICI 2b-3 85.6%, p<0.001; rate of good outcome in patients <72 years: TICI 0-2a 66.7% versus TICI 2b-3 83.3% p=0.11.

Conclusions

Good outcome is more dependent on reperfusion than age. The absolute difference in good outcome associated with reperfusion is more significant in patients above ≥72 years.

O-267

Mechanical Thrombectomy Versus Systemic Thrombolysis in MCA Stroke: a Distance to Thrombus Based Outcome Analysis.

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1University Hospital Leipzig, Leipzig, Germany

Purpose

Acute ischemic stroke due to occlusion of the proximal middle cerebral artery (MCA) has a poor outcome. The distance to thrombus (DT) from the carotid T can predict the outcome after intravenous thrombolysis (IVT). With a DT <16 mm, fewer than 50% of patients treated with IVT achieve a favorable outcome. We compared stent retriever-based endovascular mechanical thrombectomy with additional IVT (IVT-MT) versus IVT alone.

Materials and Methods

Patients with MCA occlusion proven by computed tomography angiography with a DT <16 mm, treated either with IVT alone or with IVT-MT, were included in the present study. Changes in
NIH stroke scale (NIHSS), the 7d NIHSS and the 90d modified Rankin Scale (mRS) scores were analyzed by treatment modality.

Results
Of 621 patients, 87 fulfilled all inclusion criteria. Fifty-nine patients were treated by IVT and 28 by IVT-MT. Although IVT-MT patients had significantly more severe strokes (NIHSS 17.1 ± 4.5) (MT) versus 14.3 ± 6.1 (IVT), (P=0.032), both the short- and long-term outcomes were significantly in favor of the patients treated with IVT-MT [7d NIHSS: 10.9 ± 6.3 (IVT) versus 6.7 ± 6.7 (MT); P=0.008/90d mRS: 4 (2 - 6) (IVT) versus 2 (0.75 – 2.5) (MT); P=0.003].

Conclusions
IVT-MT leads to a significant improvement in clinical outcome compared with IVT alone in patients with proximal MCA occlusion with a DT <16 mm.

O-268
5:40PM - 5:48PM
Comparison of Carotid Endarterectomy and Carotid Stent Revascularization of Internal Carotid Artery Pseudo-occlusion

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Purpose
The benefit of revascularization of internal carotid artery (ICA) pseudo-occlusion is not defined well, and the method of revascularization is controversial. There has been no comparison between carotid endarterectomy (CEA) and carotid stent (CAS) placement for pseudo-occlusion. The purpose of this study was to evaluate the safety of carotid endarterectomy (CEA) and carotid stent placement (CAS) and compare long term imaging and clinical follow up.

Materials and Methods
A retrospective database review was performed from 1/2010 to 1/2014 to identify patients who underwent carotid endarterectomy and carotid stent placement at two tertiary centers. The medical records and imaging studies of patients with ICA pseudo-occlusion were selected for analysis.

Results
Twenty-four patients met the criteria for ICA pseudo-occlusion, and 17 patients underwent CEA while seven patients underwent CAS. All patients had technically successful revascularization of the ICA. All patients underwent 1 year follow-up imaging. Carotid stent placement patients had 14% re-stenosis and 71% vessel maturation (defined as resolution of ICA hypoplasia) rates while CEA patients had 18% with re-stenosis and 65% vessel maturation. Peri-procedure complication for CAS was 0% and CEA was 6%. There were no deaths or strokes at 1 year in any patients.

Conclusions
Carotid stent placement shows similar outcomes in restenosis and vessel maturation rates when compared to CEA for ICA pseudo-occlusion. There was no significant difference between the two treatments in clinical outcomes or peri-procedural complications. Carotid stent placement is a revascularization option if the patient is considered high risk for CEA.
Ischemic Complications after Tailored Carotid Artery Stenting in Different Subpopulations with High-Grade Stenosis: Feared but rare

J Gomori¹, J Cohen²
¹Hadassah Hebrew University Medical Center, Jerusalem, Israel, ²Hadassah Hebrew University Medical Center, Jerusalem, Israel

Purpose
Assess the incidence of carotid artery stenting (CAS) related major complications (death, stroke, or myocardial infarction) in different patient subpopulations defined by NASCET/ACAS eligibility and treated with different, patient tailored, CAS technical variants.

Materials and Methods
A total of 249 patients; 151 men (61%) and 98 women (39%), mean age 69.9 years (range 31-92), with a total of 254 carotid artery stenosis lesions; 148 (58%) asymptomatic and 106 (42%) symptomatic were recruited retrospectively. Inclusion criteria were: age>18 years, >50% symptomatic ulcerated, or >70% symptomatic nonulcerated atherosclerotic stenosis, and >80% asymptomatic atherosclerotic stenosis, demonstrated by angiography based on NASCET criteria. Symptomatic and asymptomatic patients were dichotomized based on NASCET and ACAS eligibility. The incidence of major complications related to CAS and to individual CAS technical variants at 30 days, and from 1 to 12 months following the procedure was analyzed.

Results
Carotid artery stenting was feasible in all but one patient. No mortality and no acute coronary events were noted within the first 30 days after CAS. Six patients (2.4%), with symptomatic lesions suffered ipsilateral transient ischemic attack (TIA) (n=4) or minor stroke (n=2). All were managed conservatively with complete recovery noted in five at 3-month follow up. Twelve month follow-up data were available for 225 patients. Six patients suffered ipsilateral ischemic events; five minor strokes with complete neurological recovery; and one major left hemispheric stroke. Six patients died between the second and twelveth month after CAS due to etiologies unrelated to the procedure. No specific CAS technical variant was identified to be associated with an increased complication rate.

Conclusions
Carotid artery stenting comprises a variety of continuously evolving techniques with similar rates of major adverse events. Based on our series, the incidence of CAS-related ischemic events seems to be decreasing to less than 3% with the majority being TIA or minor strokes. Contrary to the general belief, the majority of peri-procedural ischemic events were TIA or minor strokes. Major disabling stroke is a rare complication in the modern CAS era. This suggests the need for a randomized reevaluation of the role of CAS by dedicated neurointerventionalists versus carotid endarterectomy (CEA).

O-270

Added value of CT Perfusion compared to CT Angiography in predicting clinical outcomes of stroke patients treated with mechanical thrombectomy

M Psychogios¹, I Tsogkas¹, K Wasser¹, M Knauth¹
Purpose
Patient selection is crucial for the improvement of clinical outcomes when treating stroke patients with mechanical thrombectomy. Computed tomography perfusion (CTP) images analyzed with the Alberta stroke program early CT scale (ASPECTS) have been shown to be optimal predictors of clinical outcome. In this study we compared two biomarkers, the cerebral blood volume (CBV) ASPECTS and the CT angiography (CTA) ASPECTS as predictors of clinical outcome after mechanical thrombectomy.

Materials and Methods
Stroke patients with a thrombosis of the M1 segment of the middle cerebral artery were included in our study. All patients underwent initial multimodal CT with CTP and CTA on a modern CT scanner. Treatment consisted of full dose intravenous tissue plasminogen activator and mechanical thrombectomy. Only patients with successful reperfusion, as defined by a thrombolysis in cerebral infarction score of 2b or 3, were analyzed. Two experienced neuroradiologists separately viewed and scored CBV and CTA images with the ASPECTS score. Parameters were compared between patients with poor and favorable follow-up outcome.

Results
Sixty-five patients were included. Mean age was 72 years. Median baseline National Institutes of Health Stroke Scale was 17 and median admission modified Rankin scale was five. Median baseline CBV-ASPECTS and CTA-ASPECTS for patients with favorable clinical outcome at follow up were eight (interquartile range (IQR) 8-9 and 7-9 respectively). Patients with poor clinical outcomes showed a median baseline CBV-ASPECTS of six (IQR 5-8, P<0.0001) and a median baseline CTA-ASPECTS of seven (IQR 7-8, P=0.18). Using CBV-ASPECTS and CTA-ASPECTS raters predicted futile reperusions in 95% and 56% of the cases, respectively.

Conclusions
Cerebral blood volume-ASPECTS is a significant predictor of clinical outcome of acute ischemic stroke patients, treated with combined therapy of intravenous thrombolysis and mechanical thrombectomy. CT angiography-ASPECTS does not correlate highly with CBV-ASPECTS and is not a significant predictor of outcome.

O-271
Volumetric C-arm CT perfusion imaging for acute ischemic stroke using TEmporal RESolution and SAmping Recovery (TERESAR) technique: a canine and human validation study

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Purpose
Several previous studies have demonstrated the feasibility of measuring perfusion parameters
using C-arm CT (1-3). Their accuracy was limited by low temporal resolution and sampling due to slow gantry rotation. To optimize the C-arm CTP results, we have developed the temporal resolution and sampling recovery (TERESAR) postprocessing technique (4). This study aimed to validate the potential utility of this technique.

Materials and Methods
Under approved IACUC protocol acute ischemic lesions were created in seven canines. Conventional CTP was performed 3.5 hours after induction of ischemia and was followed immediately by CBCTP measurement using a bi-plane system (Siemens Artis Zee). The CBCTP and conventional CTP dataset were coregistered, and reformed into 5mm slice thickness. Perfusion maps were calculated using the same perfusion software. AIFs were selected at the same region (basilar artery) for both CBCTP and CTP datasets. These maps then were randomized and reviewed by two experienced interventional neuroradiologists. Image quality scores and scoring confidence of the maps were recorded. Quantitative values of CBF and CBV were investigated for each lesion from CTP and CBCTP. Under an approved IRB protocol data from six AIS patients having both conventional CTP and CBCTP also were postprocessed using the same software. These were evaluated using the method just described.

Results
The TERESAR technique for CBCTP successfully recovered AIF curves similar to those of conventional CTP. Visual grading characteristics analysis showed similar image quality for CBCTP using TERESAR and conventional CTP. Prior to postprocessing conventional CTP maps were much better than the CBCTP maps. In addition, the confidence evaluations show strong agreement between CBCTP and CTP maps for identifying ischemic lesions and for making treatment decisions. The quantitative results showed good agreement between two imaging modalities.

Conclusions
C-arm CBCTP images processed with TERASAR in both canine models and patients are of comparable image quality. The diagnostic accuracy, both qualitatively and quantitatively, also correlates well. This technique advances the concept of making the angiographic suite the one-stop-shop for AIS patients.
**Figure 1:** Conventional diagnostic CTP images of a canine model for CBV) have shown the ischemic lesion in left temporal lobe, decreased CBF value and slightly increased CBV value, which salvageability. The corresponding C-arm CBCTP images (C for C-arm CBV) have shown similar results with good image quality.

(Filename: TCT_O-271_Figure1adjusted.jpg)

**O-272**

6:12PM - 6:20PM

One-stop-shop imaging solution for patients with acute ischemic stroke in the angiography suite: concept and feasibility

P Yang¹, K Niu², Y Wu³, T Struffert⁴, A Dorfler⁴, S Schafer⁵, K Royalty⁶, C Strother⁷, G Chen²
Purpose
Conventional NCCT, CT perfusion (CTP) and CT angiography (CTA) are helpful in evaluation and triage of patients with acute ischemic stroke (AIS). The delay associated with acquiring these studies detracts significantly from their potential value. In an attempt to minimize this delay, we have developed a concept of "one-stop-shop imaging solution" and performed a preliminary human study to assess its feasibility.

Materials and Methods
All studies were done under an Ethics Committee approved protocol. Postprocessing of data from 21 C-arm CT dynamic perfusion acquisitions from 17 patients undergoing revascularization because of an acute stroke were done to derive experimental NCCT, CTA, dynamic C-arm CTP maps and time-resolved C-arm CTA. Conventional NCCT, CTP, and MRI data also were collected for comparison. Three observers independently reviewed the studies evaluating the extent to which they fulfilled previously defined image fulfillment criteria and to also give their confidence in making diagnosis and treatment decisions.

Results
C-arm NCCT, CTA, CTP, and time-resolved CTA images have been generated successfully from one C-arm CT dynamic perfusion acquisition in all 21 cases. The results of image criteria fulfillment analysis showed good image quality for C-arm CTP and time-resolved C-arm CTA. The independent observer evaluations show strong agreement for identifying ischemic lesions and occluded vessels, evaluating collaterals status and making treatment decisions. Visual grading characteristics analysis has further demonstrated similar capability of selecting appropriate candidates for endovascular treatment between C-arm imaging sets and traditional imaging sets. We will illustrate these results using images from postprocessed human studies.

Conclusions
Acquisition of C-arm NCCT, CTA, CTP, and time-resolved CTA images is feasible in the angiography suite. Image quality was adequate for an accurate diagnosis and treatment option selection. This capability enhances the concept of the angiography suite as a one-stop-shop solution for patients with acute ischemic strokes.
Figure 1: Paired C-arm CBF (A) and CBV (B) images show significant right frontotemporal lobe with similar size, which may indicate a core and a small penumbra. Color-mapped 4D C-arm CTA image occlusion of right internal carotid artery. Static C-arm CTA image demonstrates poor collaterals for this patient.

(Filename: TCT_O-272_Figure1-adjusted2.jpg)
Purpose
Acute ischemic stroke (AIS) related to tandem extra and intracranial occlusion is associated with poor outcome if timely reperfusion is not achieved. In this emergent clinical setting stenting of the extracranial vessel frequently is needed. However, there is still controversy about the use of emerging stenting in this situation, regarding its efficacy and safety. The purpose of this retrospective study was to analyze the safety and efficacy of acute stenting in the setting of acute tandem lesions in AIS patients in our local prospective revascularization therapy registry.

Materials and Methods
In our cohort of 1050 patients treated with acute revascularization therapies we identified 34 consecutive AIS patients treated with emerging extracranial stenting and intracranial thrombectomy due to tandem lesions. Twenty-nine patients presented with anterior circulation stroke and five were located in the posterior circulation. Baseline clinical parameters, revascularization rate, complications and clinical outcome at 3 months were analyzed and compared to our cohort of nonstented AIS patients treated endovascularly.

Results
We identified a total of 34 consecutive AIS patients treated with emerging extracranial stenting and intracranial thrombectomy due to tandem lesions, as well as a total of 219 nonstented AIS patients treated with mechanical thrombectomy. Patients receiving emergent stenting had a mean age of 62 years, mean admission NIHSS 16, and a mean time from symptom onset till puncture of 290 minutes. Although longer procedural time related to the stenting procedure, this subgroup of patients had similar clinical outcomes at 3 months than nonstented intracranial thrombectomy AIS patients (mean mRs 0-2 90 days 43.4% vs 49.3%, p=0.3). Recanalization rates, complications, and symptomatic hemorrhages were also similar in both groups.

Conclusions
Emerging stenting of the extracranial internal carotid or vertebral artery associated with intracranial thrombectomy in AIS patients is feasible and seems to be effective and safe. Complication and favorable clinical outcome rates did not differ when compared to nonstented AIS patients treated with thrombectomy. However these results should be confirmed in pooled analysis of the ongoing clinical trials analyzing the effectiveness of endovascular therapies in AIS patients.

O-273a
6:28PM - 6:36PM
Endovascular Treatment of ICA/MCA Tandem Occlusions using the ADAPT Technique

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¹University Hospital Odense, Odense, Denmark, ²University of Southern Denmark, Odense M, Denmark

Purpose
To report our experience with the endovascular treatment of patients with acute ischemic stroke
caused by double (Tandem) occlusions of the internal carotid artery (ICA) and the middle cerebral artery (MCA) utilizing the ADAPT technique.

Materials and Methods
Between September 2013 and December 2014, 50 patients with acute ischemic stroke were treated at the University Hospital in Odense, Denmark utilizing the ADAPT technique. 15 of them had tandem occlusions of the ICA and MCA. All of these patients underwent a pretreatment evaluation with CT, CTA and CT perfusion, while the majority received i.v. thrombolysis prior to the decision making on intraarterial thrombectomy. All procedures were performed under general anesthesia, on a state of the art, biplane angiography unit. Following diagnostic angiography that revealed subtotal or total occlusion of the ICA, a 6F NeuroMax sheath was placed in the ICA, and the lesion was crossed either by a Terumo 0.035 guidewire, or a 3.5x9 mm Gateway balloon. Then a 5Max, or 5Max ACE large bore aspiration catheter was navigated over a Velocity microcatheter, first into the ICA, and subsequently into the MCA to aspirate thrombus material from both arteries with the Penumbra system. In 7 cases, additional ICA stenting was performed, either before or after clot aspiration, depending on the degree of stenosis and the remaining flow in the ICA. In all stented cases, simultaneous i.v. platelet inhibition was administered.

Results
The thrombus material could successfully be removed in all 15 cases. In 3 cases, a stentriever was additionally utilized to remove the thrombusmaterial from M2/M3 branches. FU CT 24 hours after the procedure showed hemorrhagic infarction in one patient. No other complications occurred. 11 patients showed good clinical recovery, two had 3 on the mRS at 3 months, and two died within 30 days following the treatment.

Conclusions
Recanalization of ICA/MCA tandem occlusions using the ADAPT technique is feasible, and a safe and efficient procedure associated with low complication rate and good clinical outcome. In a significant number of cases, stenting may be necessary to keep the stenotic lesion open.

Tuesday
5:00PM - 6:36PM
Sheraton Chicago Hotel & Towers, Michigan AB (Level 2)

12F - PARALLEL SCIENTIFIC PAPER SESSION-PEDIATRICS
CEREBROVASCULAR
O-274

Neurocognitive Deficits in Pediatric Sickle Cell Anemia Patients with BOLD fMRI

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1St. Jude Children's Research Hospital, Memphis, TN, 2St Jude Children's Research Hospital, Memphis, TN

Purpose
Sickle cell anemia (SCA) is a hereditary hemoglobinopathy, and the most common cause of stroke in the pediatric population. Patients frequently have elevated cerebral blood flow, and even in normal-appearing brains by conventional magnetic resonance imaging (MRI), we have
shown an attenuated blood oxygenation level-dependent (BOLD) response, and an inverse relationship between BOLD response to visual contrast stimulus and Intelligence Quotient (IQ). Here we evaluated the relationship between performance of cognitively demanding tasks in the scanner and the functional magnetic resonance imaging (fMRI) BOLD response in pediatric children with untreated SCA, compared with healthy controls.

Materials and Methods
After informed consent, 23 untreated pediatric SCA patients (12±3.07 years old) were enrolled in an Institutional Review Board-approved prospective study. Patients had hematologic and neuropsychological testing, and performed the N-back working memory task during BOLD fMRI. Data were analyzed using a general linear model to identify neural correlates of hematologic and neuropsychological parameters.

Results
BOLD activation was different (p=0.009) between the SCA patients and healthy controls. A negative association was found between number of errors of omission during the N-back task and BOLD response (p=0.006). Positive associations were found between scores on the Digit Span Backwards test and the BOLD response (p=0.012) and between hematocrit and the BOLD response (p=0.004).

Conclusions
These results provide evidence for a significant association between cognitively demanding task of working memory and the BOLD response. Working memory neurocorrelates of IQ and BOLD response support our previous works. The association between the BOLD response and hematocrit suggests a mechanistic link between the hematologic consequences of untreated SCA and neurocognitive dysfunction seen in this patient population.
Hemodynamic Etiology of Stroke Risk in Children with Sickle Cell Anemia

P Kosinski¹, P Croal², J Leung², A Kassner²

¹University of Toronto, Toronto, Ontario, ²The Hospital for Sick Children, Toronto, Ontario

Purpose
Sickle cell anemia (SCA) is a genetic disorder resulting in hemolytic anemia, vaso-occlusive crises, and irreversible organ damage. The most devastating complication of SCA is an acute ischemic stroke (AIS), which occurs in more than 10% of children by the age of 20 (1). Acute ischemic stroke is thought to be a result of a progressive narrowing of the major cerebral arteries that ultimately reduces cerebral blood flow (CBF) to the point of infarction (2). However, approximately 32% of children who suffer an AIS present with no visible stenosis on magnetic resonance angiography (MRA) (3). An alternative model is the hemodynamic insufficiency (HI) model, which argues that critically anemic children have exhausted vasodilatory capacity and are therefore at risk for ischemic events (4). Vasodilatory capacity can be assessed by obtaining measures of cerebrovascular reactivity (CVR), which can be acquired using blood oxygen level dependent (BOLD) MR in response to a vasoactive stimulus. Recent studies have not found an association between the degree of anemia (hematocrit) and CVR (4, 5). This may be a result of a heterogeneous patient population, which included both adults and children, mixture of genotypic variants, and a mixture of patients with and without treatment and stenosis. We hypothesized that CVR is associated positively with hematocrit in children with SCA (HbSS) who had no visible stenosis on MRA and were not receiving prophylactic hydroxyurea or transfusion therapy.

Materials and Methods
Twenty-two SCA children (12.2±2.2 years) were imaged on a 3T MR system with a 32-channel head coil. A CO2 breathing challenge was administered to induce vasodilation in four alternating cycles of normocapnia (40mmHg, 60 seconds) and hypercapnia (45mmHg, 45 seconds). The breathing challenge was performed in synchrony with a BOLD MR sequence. Cerebrovascular reactivity maps were generated by correlating the BOLD MR signal change on a per voxel basis with the corresponding sampled CO2 waveform using a general linear model, followed by coregistration with a T1-weighted anatomical image. Gray matter (GM) and white matter (WM) segmentation was performed over which the CVR values were averaged over. Time-of-flight MRA was assessed by an experienced neuroradiologist for visible stenosis. Hematocrit measures were obtained within a week of the MR scan during the patients' regular clinic visit. Statistical analysis was performed using Pearson correlation on SPSSv22.

Results
Gray matter CVR ranged from 0.053 to 0.234 %ΔBOLD/mmHg (0.145±0.051, mean ± SD). White matter CVR ranged from 0.038 to 0.154 %ΔBOLD/mmHg (0.096±0.031, mean ± SD). Hematocrit ranged from 0.197 to 0.334 (0.26±0.04, mean ± SD). Gray matter CVR was associated significantly with hematocrit (r=0.84, p<0.001) as shown in Figure 1A. White matter CVR also was significantly associated with hematocrit (r=0.81, p<0.001) as shown in Figure 1B.

Conclusions
Cerebrovascular reactivity is associated significantly with hematocrit in children with SCA who
had no visible stenosis on MRA and were not currently on therapy. This suggests that vascular reserve depletes with increasing severity of anemia, which seems to support the HI model of stroke risk in children with SCA.
Impaired White Matter Cerebrovascular Reactivity in Sickle Cell Disease is Associated with Decreased White Matter Structural Integrity

P Croal, J Kim, J Leung, A Kassner

The Hospital for Sick Children, Toronto, Ontario, University of Toronto, Toronto, Ontario

Purpose
Cerebrovascular reactivity (CVR) reflects the capacity of blood vessels to dilate, and is reduced in children with sickle cell disease (SCD) (1). This hemodynamic impairment may lead to insufficient oxygen supply and ischemic white matter (WM) injury. Previous studies have demonstrated changes in WM integrity in SCD, however underlying vascular contributions are not understood (2-4). Animal models suggest impaired hemodynamics precede WM lesions (5), therefore we hypothesize that an association will exist between CVR and measures of fractional anisotropy (FA), as measured with diffusion tensor imaging (DTI), reflecting the vascular contribution to changes in WM integrity in SCD.

Materials and Methods
Four SCD patients (9-17 years) and five healthy controls (14-18 years) were imaged on a 3T MRI scanner using a 32-channel head coil. Cerebrovascular reactivity data were acquired using a blood-oxygen level dependent (BOLD) sequence (TR/TE=2000/40ms, volumes=240) during computer-controlled cycles of a hypercapnic stimulus. Fractional anisotropy was acquired using a DTI sequence along 30 directions (b=1000 and 0 s/mm2, TR/TE=9000/90ms). FLAIR images were acquired for detection of WM lesions. Maps of WM CVR and FA were generated using FSLv4.1.

Results
Sickle cell disease patients showed a significant global reduction in CVR (independent samples t-test, p=0.04) and FA (p=0.01) in comparison to controls. A significant positive correlation was observed in SCD patients between CVR and FA, both globally (pearson product moment correlation coefficient, r2 = 0.995, p =0.03) and regionally in the right frontal cortex (r2 = 0.997, p =0.02). No WM lesions were evident.

Conclusions
We provide preliminary evidence that WM integrity is associated positively with CVR in SCD. This association is established before damage is evident on anatomical images, suggesting that impaired CVR leads to low-grade ischemia and WM degradation in SCD. Longitudinal studies will help establish a causal link between hemodynamic impairment and WM integrity and may shed light on the mechanisms underlying cognitive decline in SCD (4).
Elevated Cerebral Blood Flow in Sickle Cell Disease Leads to Decreased Venous Contrast in Susceptibility Weighted Imaging

P Croal\textsuperscript{1}, J Leung\textsuperscript{1}, A Kassner\textsuperscript{1}
\textsuperscript{1}The Hospital for Sick Children, Toronto, Ontario

Purpose
Sickle cell disease (SCD) is a genetic disorder characterized by hemolytic anemia, vaso-occlusive crises and endothelial dysfunction, leading to increased cerebral blood flow (CBF) and an elevated risk of stroke (1). Venous contrast, as measured with susceptibility-weighted imaging
recently has been proposed as a novel biomarker of disease severity in SCD (2). The retrospective study revealed decreased venous contrast in children with SCD and attributed this to perfusion changes rather than hematologic, however no CBF measurements were taken. By acquiring both SWI and CBF measurements, we aim to measure the association between venous contrast and CBF in children with SCD.

Materials and Methods
Ten children with SCD (6 males, 9-18 years) and no history of stroke, were imaged on a clinical 3T MRI scanner using a 32-channel head coil. Susceptibility-weighted imaging data were collected with a T2*-weighted gradient-echo sequence (TR/TE=28/20ms, voxel=0.85×0.7×1.2mm). A 2D Frangi vesselness filter was applied to minimum intensity projections using MATLAB and normalized visible venous volume (NVVV) calculated to indicate venous contrast. Cerebral blood flow was obtained using a PICORE-Q2TIPS pulsed arterial spin labelling scheme (TR/TE=2500/13ms, TI1=700ms, TI2=1800ms, voxel=3.4×3.4×4.5mm) with a single-compartment kinetic model ([ ]). T1 of blood was assumed to be 1660ms for a hematocrit (Hct) of 0.4 and corrected for reduced Hct on an individual basis (4). Cerebral blood flow was averaged over gray matter and Pearson correlation analysis performed on the resulting data.

Results
Figure 1 shows a sample vessel map overlaid onto the corresponding SWI. NVVV is plotted in each subject as a function of CBF in Figure 2. A significant linear decline in NVVV is observed for increasing CBF (r² = 0.52, p = 0.02).

Conclusions
Our study suggests that venous contrast in SWI measures is related to cerebral blood flow in children with SCD, thus SWI may be a useful biomarker for disease severity. Future studies are required to investigate the additional contribution of changes in oxygenation in SCD to venous contrast.
Regional Differences in Cerebrovascular Reactivity Developmental Patterns in Healthy Children

J Leung¹, J Kim², P Kosinski², A Kassner¹
¹The Hospital for Sick Children, Toronto, Ontario, ²University of Toronto, Toronto, Ontario

Purpose
Cerebrovascular reactivity (CVR) measures the capacity of brain blood vessels to dilate by assessing the change in cerebral blood flow (CBF) in response to a vasoactive stimulus. When combined with MRI, such hemodynamic parameters are valuable tools for the clinical assessment of cerebrovascular disease. However, very little currently is known about developmental changes of CVR. It is well documented that global CBF steadily declines from childhood to adulthood (1), while recent findings suggest that global CVR peaks around the late teens (2). Regional changes in CVR with age, however, have not been explored yet. This information is important for refining our understanding of cerebral physiology in children as it may be complementary to the heterogeneous development of cortical regions (3). The purpose of this study was to determine whether the developmental trajectories of CVR in children are region specific. We hypothesize that regional development of CVR will maintain the bi-phasic pattern described in (2), but that the rate of change will be regionally dependent.

Materials and Methods
Twenty-three healthy volunteers (age 9 to 18 years) were imaged on a clinical 3T MRI scanner (MAGNETOM Tim Trio; Siemens Medical Solutions, Germany) using a 32-channel head coil. Cerebrovascular reactivity data were acquired using blood-oxygen level-dependent (BOLD) imaging in combination with computer-controlled gas delivery of CO2 to the subject cycling between low (40 mmHg) and elevated (45 mmHg) concentrations. The BOLD sequence parameters were: TR/TE = 2000/40ms, voxel=3.4×3.4mm, slices = 25, slice thickness = 4.5mm, volumes = 240, time = 8min. Cerebrovascular reactivity maps were computed by correlating the voxel-wise BOLD signal change to the measured end-tidal CO2 waveform using FSL v4.1 (http://www.fmrib.ox.ac.uk/fsl/), then normalized into units of %ΔMR/mmHg(CO2). Surface map projections of CVR were created and coregistered into the MNI-152 template through the CIVET pipeline (4). Cortical measures were averaged in seven cortical regions (see Table 1). Mean regional CVR for each subject was computed and a piecewise linear curve fit with age was performed using MATLAB. Statistical significance was defined as a p-value < 0.05.

Results
Cerebrovascular reactivity in each cortical region exhibited different peaks ranging from age 14 to 16. Example trajectories are shown in Figure 1. Parameters computed from each curve fit is provided in Table 1, all of which are statistically significant (p < 0.05). There also appears to be an association between the slope of CVR change and age of peak CVR in each region (r² = 0.571, p = 0.049).

Conclusions
This study shows that the development of CVR in children is not uniform across all cortical regions and peaks around the mid-teens. Additional CVR data with a wider age range are
required to improve the model fit and the inclusion of CBF and high resolution structural measurements may provide insight into the relation between hemodynamic and cortical development patterns in the brain.

**Figure 1:** CVR measures versus age (•) and corresponding piecewise linear fit (--) in a) parietal and b) frontal regions.

<table>
<thead>
<tr>
<th>Region</th>
<th>Slope</th>
<th>Peak (age)</th>
<th>Corr Coeff (r)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cingulate</td>
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<td>14.9</td>
<td>0.6723</td>
<td>0.0166</td>
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<td>Frontal</td>
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<td>15.4</td>
<td>0.7204</td>
<td>0.0082</td>
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<tr>
<td>Insula</td>
<td>0.0255</td>
<td>15.4</td>
<td>0.7101</td>
<td>0.0143</td>
</tr>
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<td>Parietal</td>
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<td>14.8</td>
<td>0.7882</td>
<td>0.0014</td>
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<td>Parahippocampal</td>
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<td>0.0453</td>
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<td>Occipital</td>
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<td>0.0253</td>
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<tr>
<td>Temporal</td>
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<td>15.4</td>
<td>0.6772</td>
<td>0.0221</td>
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</tbody>
</table>

**Table 1:** Best fit piecewise linear rates of CVR ages when the
cortical regions

(Filename: TCT_O-278_ASNR_figure.jpg)

**O-279**  

**Impaired MR Cerebrovascular Reactivity in Obese Children with Obstructive Sleep Apnea**

J Kim¹, J Leung², I Narang², P Croal², A Kassner²

¹University of Toronto, Toronto, Ontario, ²The Hospital for Sick Children, Toronto, Ontario
Purpose
Childhood obesity has reached epidemic status in the last decade (1) and is also the leading cause of obstructive sleep apnea (OSA) in children (2). Obstructive sleep apnea is characterized by intermittent episodes of nocturnal hypoxia, hypercapnia and sleep disruption. Moreover, intermittent hypoxia leads to oxidative damage of the endothelial cells, resulting in endothelial dysfunction, which compromises vasodilatory capacity and increases the risk of cerebrovascular damage (3). In addition, there is impaired neurocognitive ability and poor school performance in the obese OSA population, which also is linked to cerebrovascular damage (4). Reduction in vasodilatory capacity can be assessed with MRI-based cerebrovascular reactivity (CVR). Cerebrovascular reactivity is defined as the change in cerebral blood flow in response to a vasoactive stimulus. Individuals who suffer from obesity and OSA potentially may have impaired CVR due to their endothelial dysfunction. Therefore, MR-based CVR measurements in obese children with OSA may be a physiological imaging marker for risk for cerebrovascular damage and subsequent neurocognitive deficits. We hypothesize that CVR will be impaired in the obese OSA group compared to a control group with no OSA.

Materials and Methods
Five obese OSA patients and seven lean controls without OSA were imaged on a 3T MRI scanner using a 32-channel head coil. Cerebrovascular reactivity data were acquired using a blood-oxygen level dependent (BOLD) sequence during the computer-controlled administration of a CO2 stimulus consisting of alternating cycles of normocapnia and hypercapnia. 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. Next, the surface maps were coregistered into the MNI pediatric MRI Atlas, which was segmented into the AAL regions (5). MATLAB was used to compute global and regional CVR values and SPSS v22 was used to perform Student's t-tests on CVR between the groups.

Results
From the CVR group comparison analysis, we observed that global CVR levels in gray matter was significantly lower in obese OSA patients compared to the healthy controls (p < 0.01) as shown in Figure 1. The regions of interest analysis revealed a number of AAL areas (inferior frontal, anterior cingulate, posterior cingulate, superior temporal gyrus) that showed significantly reduced CVR levels in the obese OSA group compared to controls (p < 0.05) as shown in Figure 2.

Conclusions
In this study, we have demonstrated significantly reduced CVR values in obese OSA patients compared to healthy controls. Reduced CVR may expose children who suffer from obesity and OSA to a higher risk of cerebrovascular damage which may manifest as neurocognitive deficits and poor school performance. Future studies should assess regional CVR abnormalities in obese-related OSA in relation to neurocognitive test scores.
3D Vessel Wall Imaging in the Diagnosis of Pediatric Arteriopathy

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¹UCSF, San Francisco, CA, ²University of California, San Francisco, San Francisco, CA

Purpose
Intracranial arteriopathy is a prevalent cause of acute ischemic stroke (AIS) and transient ischemic attack (TIA) in childhood, and a strong predictor of recurrence and poor short-term outcome (1, 2). However, the ability to distinguish between different arteriopathy subtypes is hindered by long imaging times required for high spatial resolution in MRI sufficient to evaluate involvement of the arterial wall. We present our experience with 3D vessel wall imaging (VWI) in children presenting with TIA/AIS of unclear etiology.

Materials and Methods
Retrospective review of our radiology database and medical records was performed under an IRB-approved protocol. Twelve children (<18 years of age, average age 9.1 years, nine boys) with TIA/AIS of unclear etiology underwent a vessel wall imaging protocol on a GE MR750 scanner using volumetric acquisition of pre and postcontrast fat-suppressed long-echo train length (ETL) FSE sequences. In contrast to conventional long ETL FSE, the GE T1 CUBE technique that we used employs parallel reconstruction and variable flip-angle excitation in order to achieve isotropic submillimeter spatial resolution with scan times less than 5 minutes.

Results
Of the 12 children admitted for TIA/AIS, seven were suspected to have a dissection based on history of minor trauma and/or MRI (intrinsic T1 mural hyperintensity on 2D fat-suppressed sequences) and were started on heparin (Table 1). Upon further review with our 3D VWI protocol, five demonstrated unilateral concentric mural thickening and enhancement more consistent with transient cerebral arteriopathy (TCA). Heparin was stopped and aspirin was
initiated in each case. In contradistinction, patients with confirmed dissection demonstrated eccentric wall thickening and enhancement. Of the 12 patients, two previously had undergone cranial radiation. One of these patients demonstrated circumferential thickening and enhancement and ultimately was diagnosed with radiation vasculitis and the other did not demonstrate any abnormality on VWI. One child demonstrated no vessel wall enhancement and was diagnosed with reversible cerebral vasoconstriction syndrome (RCVS) based on catheter angiography.

Conclusions
3D VWI can help distinguish among different etiologies of childhood AIS and thereby alter the course of treatment. In our series, children with TCA demonstrated unilateral circumferential mural thickening and enhancement, while children with dissections demonstrated eccentric thickening and enhancement with intrinsic T1 shortening. Radiation vasculitis also can be circumferential, but eccentric. Reversible cerebral vasoconstriction syndrome did not demonstrate wall enhancement.
<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age &amp; Gender</th>
<th>Arterial Wall Thickening</th>
<th>Arterial Wall Enhancement</th>
<th>Pattern</th>
<th>Vessels involved</th>
<th>Management</th>
<th>Outcome</th>
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<td>9 yrs Male</td>
<td>Yes</td>
<td>Yes</td>
<td>Concentric</td>
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<td>2</td>
<td>14 yrs Male</td>
<td>Yes</td>
<td>Yes</td>
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<td>3</td>
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<td>4</td>
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<td>5</td>
<td>10 yrs Male</td>
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<td>Yes</td>
<td>Concentric</td>
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<td>Initial: Heparin Final: Aspirin</td>
<td>1) Proj during hospit 2) Resolv</td>
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<td>6</td>
<td>15 yrs Male</td>
<td>Yes</td>
<td>Yes</td>
<td>Concentric</td>
<td>Rt. M1 MCA</td>
<td>Aspirin</td>
<td>Resolv</td>
</tr>
<tr>
<td>7</td>
<td>8 yrs Male</td>
<td>Yes</td>
<td>Yes</td>
<td>Eccentric</td>
<td>Lt. vertebral artery</td>
<td>Heparin &amp; aspirin</td>
<td>Resolv</td>
</tr>
<tr>
<td>8</td>
<td>7 yrs Male</td>
<td>Yes</td>
<td>Yes</td>
<td>Eccentric</td>
<td>Bilateral vertebral arteries</td>
<td>Lovenox &amp; aspirin</td>
<td>Resolv</td>
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<tr>
<td>9</td>
<td>13 yrs Male</td>
<td>Yes</td>
<td>Yes</td>
<td>Concentric</td>
<td>Lt. supraclinoid ICA, Lt M1 MCA</td>
<td>Initial: Heparin 2nd: Aspirin, Prednisone 3rd: STA-MCA bypass</td>
<td>Progr</td>
</tr>
<tr>
<td>10</td>
<td>6 yrs Female</td>
<td>Yes</td>
<td>Yes</td>
<td>Circumferential</td>
<td>Diffuse bilateral ACA</td>
<td>None</td>
<td>Stable</td>
</tr>
<tr>
<td>11</td>
<td>4 yrs Female</td>
<td>No</td>
<td>No</td>
<td>NA</td>
<td>NA</td>
<td>Plavix</td>
<td>Stable</td>
</tr>
<tr>
<td>12</td>
<td>14 yrs Male</td>
<td>No</td>
<td>No</td>
<td>NA</td>
<td>NA</td>
<td>Initial: Aspirin Final: Verapamil</td>
<td>Resolv</td>
</tr>
</tbody>
</table>
Intracranial 4D Flow Imaging for the Quantification of Age-Dependent Cerebral Arterial Inflow in Children from 7 Months to 18 Years

C Wu¹, S Schoeneman², R Kuhn², A Honarmand¹, S Schnell¹, S Ansari¹, M Markl¹, A Shaibani¹
¹Northwestern University, Chicago, IL, ²Ann & Robert H. Lurie Children’s Hospital of Chicago, Chicago, IL

Purpose
The association of cerebral arterial inflow with age in children remains incompletely understood. The purpose of this study was to quantify cerebral blood flow using 4D flow MRI in normal children with ages ranging from 7 months to 18 years. Our goal was to systematically investigate the age-dependent changes of cerebral arterial inflow in children.

Materials and Methods
This study included 30 children with no history of cerebrovascular disease (14 female, age=7.2±5.7 years, 0.6~17.2 years). ECG-gated 4D flow MRI (TR/TE=5.5/2.9ms, flip angle=15º, velocity sensitivity VENC=80cm/s, spatial resolution=1.2mm×1.2mm×1.4mm, temporal resolution=44ms, acquisition time around 10 minutes) with volumetric coverage of the major intracranial vessels was performed for all subjects on 1.5T or 3T MRI scanners (1, 2). Cerebral arterial inflow was calculated as the cumulative blood flow in manually positioned 2D analysis planes at the left and right internal carotid arteries (LICA+RICA) and basilar artery (BA) (Figure 1a). The study was approved by the local institutional review board and informed consent was obtained from all children's parents.

Results
Intracranial 4D flow data were acquired successfully for all 30 subjects. Figure 1a illustrates 3D blood flow visualization (time-integrated pathlines) of the intracranial vessels for an 8-month-old child. As shown in Figure 1b, quantification of cerebral arterial inflow demonstrated a marked age-related increase of blood flow by approximately three times for children at an early age up to 6 years (from 6.2 ml/cycle at 7 months to 25.1 ml/cycle at 6.1 years). After that, cerebral blood inflow started to gradually decrease until a relatively stable stage between 15 and 18 years (13.7±0.8 ml/cycle). The overall trend of the age-related cerebral blood flow changes was illustrated by a dotted line fitted by a third-order polynomial model (Figure 1b).

Conclusions
4D flow MRI was employed successfully to provide a systematic evaluation of cerebral arterial inflow in children over a large age range. Our findings demonstrate age-related changes in cerebral blood flow and indicate the importance of age-controlled control groups for the detection of abnormal intracranial hemodynamics in cerebrovascular diseases. In this context, the results of this study can provide a benchmark of normal cerebral arterial inflow for future studies in patients with cerebrovascular diseases (e.g., cerebral arteriovenous malformations, vein of Galen aneurysmal malformations, etc.). Further studies with larger cohorts more densely covering the spectrum of all ages are warranted for better understanding of the age-related cerebral blood flow changes.
Cerebral Arterial Inflow and Venous Outflow in Pediatric Patients with Vein of Galen Aneurysmal Malformations and Children Controls

C Wu1, S Schoeneman2, R Kuhn2, A Honarmand1, S Ansari1, M Markl1, A Shaibani1
1Northwestern University, Chicago, IL, 2Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, IL

Purpose
The association of cerebral venous outflow with arterial inflow remains incompletely understood. The purpose of this study was to quantify cerebral blood flow using 4D flow MR imaging (1), and to investigate the relationship between cerebral arterial inflow and venous outflow in pediatric patients with rare vein of Galen aneurysmal malformations (VGAM) and normal children controls.

Materials and Methods
This study included 3 VGAM patients (1 female; age=8±9 months, 10 scans) during staged embolization treatment and 11 children controls with no history of cerebrovascular disease under age of 3 years (6 female; 1.4±0.8 years). Electrocardiogram (ECG)-gated 4D flow MRI (TR/TE=5.5/2.9ms, flip angle=15º, velocity sensitivity VENC=80-100cm/s, spatial resolution=1.2mm×1.2mm×1.4mm, temporal resolution=44ms, acquisition time around 10 minutes) with volumetric coverage of the major intracranial vessels was performed for all
subjects on 1.5T or 3T MRI scanners (2). Cerebral arterial inflow was calculated as the cumulative blood flow in the left and right internal carotid arteries (LICA+RICA) and basilar artery (BA). Cerebral venous outflow was measured by adding the blood flow in the left and right transverse sinuses (LTS+RTS) (Figure 1a). Net flow (ml/cycle) over one cardiac cycle was quantified at manually positioned 2D analysis planes perpendicular to the vessels of interest.

Results
Figure 1 illustrates the 3D blood flow visualization of intracranial major vessels using time-integrated pathlines in an 11-month-old normal child and 6-month-old VGAM patient. Cerebral blood flow quantification demonstrated significant discrepancies between cerebral arterial inflow and venous outflow for both VGAM patients and children controls. Cerebral arterial inflow were 14.4±3.5ml/cycle and 9.5±2.1ml/cycle and cerebral venous outflow were 6.1±1.6ml/cycle and 5.5±1.7ml/cycle for VGAM patients and children controls, respectively. We also observed that the ratio of cerebral venous outflow to arterial inflow in VGAM patients was lower compared to children controls (0.46±0.12 versus 0.56±0.07), suggesting possible impairment of the venous draining system in VGAM patients.

Conclusions
Our findings in this study demonstrates significant discrepancies between cerebral arterial inflow and venous outflow in VGAM patients and children controls, indicating other venous pathways in addition to the transverse sinuses, such as occipital sinus, cavernous sinus, etc. Further studies with larger cohorts are warranted to better understand the underlying mechanisms of the flow discrepancies and the differences between normal subjects and patients with cerebrovascular disease.
O-283

Cost-Effectiveness of Screening for Blunt Cerebrovascular Injury in Pediatric Trauma Patients

X Wu¹, V Kalra¹, D Durand¹, C Matouk¹, J Schindler¹, H Forman¹, A Malhotra¹

¹Yale University School of Medicine, New Haven, CT

Purpose
Timely, accurate screening for blunt cerebrovascular injury (BCVI) is important to administer
appropriate anticoagulation therapy and prevent stroke in children. The recommended criteria for screening are not clear. We performed a systematic review of the literature for screening and management of BCVI in children, and designed a cost-effectiveness analysis in order to determine the optimal strategy of managing pediatric BCVI from a societal perspective.

Materials and Methods
Comprehensive review of the studies reporting incidences of BCVI in pediatric patients was carried out with data extraction and compilation. An economic evaluation of five possible screening strategies was performed by constructing a decision tree over a 1-year horizon using parameters derived from literature review. Base case calculations were made to compare cost-effectiveness of each strategy. Monte Carlo simulation and extensive sensitivity analyses were performed to examine the robustness of the conclusion against key variables.

Results
Selective anticoagulation therapy in patients with risk factors was found to be the most cost-effective strategy and selective CT angiography (CTA) in high-risk patients was the optimal imaging strategy. This conclusion was corroborated by a Monte Carlo simulation of 10,000 iterations. In all sensitivity analyses, selective anticoagulation and selective CTA continue to be the optimal strategy until the risk of anticoagulation complication was above 3.9%.

Conclusions
Our study demonstrated selective CTA to be the optimal imaging strategy to assess blunt cerebrovascular injury in children. Further studies are needed for more clearly defined screening criteria.
Incremental Cost-Effectiveness, Selective CTA v. CTA for all

(Filename: TCT_O-283_IncrementalCEScatterPlot.jpg)
Sensitivity Analysis (WTP=100,000)

Net Monetary Benefit vs. pCTA_Sen

- CTA for a
- DSA for a
- Selective
- Selective
- Selective

(File: TCT_O-283_1-WayCESensitivityAnalysis.jpg)
Sensitivity Analysis (WTP=100,000)

Net Monetary Benefit vs. pHighrisk

CTA for a
DSA for a
Selective
Selective
Selective

(Filename: TCT_O-283_1-WayCESensitivityAnalysis2.jpg)
Spectrum of cerebral arterial and venous abnormalities in pediatric patients with Alagille Syndrome

C Carpenter\(^1\), L Linscott\(^1\), J Leach\(^1\), S Vadivelu\(^2\), T Abruzzo\(^3\)
\(^1\)Cincinnati Children's Hospital Medical Center, Cincinnati, OH, \(^2\)Cincinnati Children's Hospital Medical Center, Cincinnati, OH, \(^3\)University Hosp./Univ. Cincinnati College Of Med., Cincinnati, OH

Purpose
Alagille syndrome is a pediatric multisystem disease best known for involvement of the liver,
pulmonary circulation, and eyes (1, 2). Less well known to most imaging professionals is the increased prevalence of cerebrovascular disease in Alagille syndrome. Cerebral vasculopathy is expressed in nearly 10% of all children with Alagille syndrome, and accounts for significant morbidity and mortality (3). The spectrum of cerebrovascular disease in Alagille syndrome includes cerebral aneurysms, moyamoya arteriopathy, and dolichoectasia (3, 4). In Alagille patients, moyamoya arteriopathy most often becomes symptomatic in young school age children, while cerebral aneurysms become symptomatic in teenagers. The purpose of this study is to validate previous studies by determining the prevalence of cerebrovascular disease in pediatric patients with Alagille syndrome and identify previously unreported venous abnormalities in this population.

Materials and Methods
An IRB-approved comprehensive search was performed of all patients treated for Alagille syndrome at a tertiary care Children's Hospital from January 2000 to January 2014. All imaging records for these patients were investigated to determine how many subjects underwent neuroimaging and the specific type of neuroimaging. These cases then were reviewed by a neuroradiology fellow to detect arterial and venous abnormalities. Positive findings were confirmed by an attending neuroradiologist with CAQ in neuroradiology. Prevalence of arterial and venous abnormalities was calculated.

Results
Our search yielded a total of 52 subjects with Alagille syndrome ranging in age from 11 months to 27 years. Of those 52 subjects, 23 (44%) subjects underwent neuroimaging and 19 had dedicated vascular neuroimaging. Among these 23 subjects there were six subjects with cerebral arterial disease, four subjects (7%) with dolichoectasia, three subjects (6%) with aneurysm(s), and two subjects (4%) with moyamoya arteriopathy. Three of the four patients with dolichoectasia also had aneurysm(s). Persistent falcine sinus was present in three (6%) patients.

Conclusions
Cerebral arterial vasculopathy is an important feature of Alagille syndrome and includes dolichoectasia, cerebral aneurysmal disease, and moyamoya arteriopathy at a rate (11%) similar to previously reported studies. However, given the relatively low rate (44%) of brain imaging, this may be an underestimate. Our study also suggests that alterations of venous development, specifically persistent falcine sinus, may be a feature of Alagille syndrome. An understanding of these cerebral vasculopathies in Alagille syndrome will help imaging professionals appropriately guide diagnostic and screening examinations in this patient population.

O-285
Use Flow Diverter Stents in Pediatric Patients

M BARBUROĞLU1, A Arat2
1İSTANBUL UNIVERSITY, İSTANBUL MEDİCAL SCHOOL, İSTANBUL, TN, 2Hacettepe University School of Medicine, ANKARA, Turkey

Purpose
To report clinical and angiographic results for treatment of complex pediatric intracranial aneurysms and carotid-cavernous fistulas (CCFs) with using flow-diverter stents (FDs).
Materials and Methods
Retrospective review of patient records to identify children (age 16 or less) who were treated with implantation of FDs between June 2011 and June 2014. Clinical and lab data as well as angiographic findings were extracted.

Results
Eight patients (seven male and one female, mean age 11.9 years, range 3 -16 years ) were included. Two presented with posttraumatic CCFs, two had previously treated CCFs with residual aneurysms. Other patients had traumatic aneurysms of distal vertebral artery and M1, A2 and M2 segments. All patients were premedicated with Clopidogrel (75 mg qd for patients above 45 kg, 37.5 mg qd for two small children less than 45 kg) and aspirin (300 mg qd for 45 kg and above, 100 mg qd for smaller children). Two CCFs were treated by deployment FDs into the arterial side and transvenous embolization of the fistula. Five patients were treated by implantation of one FD. In one patient occlusion of the aneurysm due to the placement of the scaffolding stent was noted during deployment of the FD so the FD was not released and retrieved. No clinical complications developed. Control angiograms performed at 3 to 6 months revealed complete occlusion of all except one aneurysm. One patient had asymptomatic occlusion of the parent artery otherwise no stent restenosis was observed.

Conclusions
In spite of the unavailability of antiaggregation protocols for intracranial placement of stents in children, FD placement appears to be safe and effective. Current sizes of FDs and delivery systems also cover the pediatric size range obviating a need for FDs specific to this age group.

Tuesday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Erie (Level 2)

12H-PARALLEL SCIENTIFIC PAPER SESSION-INFORMATICS
O-296

Subspecialty Virtual Impact Factors within AJNR

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¹University of Tennessee Health Science Center, Memphis, TN, ²University of North Carolina, Chapel Hill, NC

Purpose
Citation analysis is an important means of evaluating performance of journals as well as of authors with implications regarding promotions, grant funding, advertising sales, and library selections. The growing subspecialties within neuroradiology compete for journal pages with one another and citation profiles of these different subsections have not been evaluated. We performed a bibliometric analysis of the American Journal of Neuroradiology (AJNR) to identify citation patterns based upon subsections and article topics.

Materials and Methods
Articles published in AJNR during 2010-2 were evaluated. The journal section for each article (e.g., Brain, Head & Neck, Pediatrics, Spine, Functional) was recorded. Each article was evaluated for additional categories that applied (e.g., a pediatric head & neck article) and its
number of citations was evaluated using the Scopus database as of August 2014. Number of citations within the first 2 years after publication was evaluated and normalized to the 2012 journal impact factor (JIF, 3.675). This ratio was used to calculate a virtual impact factor (VIF) for journal subsections.

Results

Eleven hundred twenty-six items were published in AJNR during the 3 years evaluated. Articles obtained 5.65 citations within their first 2 years after publication and 86.6% of articles obtained at least one citation. Based on a JIF of 3.675, the VIF was determined to be \((\frac{\#\text{citations}}{5.65/3.675})\). Review articles had the greatest number of citations with 53 articles averaging 8.6 citations each (VIF 5.59). Virtual impact factors for other sections were: Interventional 5.01, Brain 3.85, Pediatrics 3.25, Functional 2.75, Head & Neck 2.61, Spine 1.88. Items selected for the "fellow's journal club" had a VIF of 4.00, and those selected as "Editor's Choice" articles had a VIF of 5.35.

Conclusions

Citation patterns of articles in AJNR varied widely based upon subsection topics with review articles having the greatest number of citations within the first 2 years after publication. Understanding the citation expectations of specific topics and subsections of a journal may aid editors in evaluating the appropriate balance between various topics and allow authors to determine if their article is being cited at a level expected for similar topics in a journal.

O-286  
5:08PM - 5:16PM

Citation Frequency of Head and Neck Manuscripts: Comparison of Accepted and Rejected Articles from the American Journal of Neuroradiology

H Kelly, A Choudri, M Castillo

1Massachusetts General Hospital/Massachusetts Eye and Ear Infirmary/Harvard Medical School, Boston, MA, 2University of Tennessee Health Science Center, Memphis, TN, 3University of North Carolina, Chapel Hill, NC

Purpose

Our purpose was to quantify differences in citation frequency between Head and Neck manuscripts published in the American Journal of Neuroradiology (AJNR) and those published after AJNR rejection.

Materials and Methods

An AJNR database query was performed to identify all Head and Neck original research manuscripts either accepted or rejected between January 1, 2012 and April 2, 2013. A MEDLINE search then was performed on the rejected manuscripts to identify subsequently published articles. Once identified, the citation frequencies of both groups were determined using SCOPUS. Citation data were used in comparative studies between AJNR rejected and accepted articles.

Results

Among 73 rejections from AJNR subsequently published elsewhere, 76 citations accumulated through December 2014 (mean = 1.1 citations; 0.6 citations/journal year), whereas 36 AJNR accepted Head and Neck articles accumulated 65 citations (mean = 1.8 citations; 0.9 citations/journal year, \(p = 0.11\)). Of the 73 articles rejected by AJNR and subsequently
published, 28 were cited at least once, with 45 not cited at all. Of the 36 AJNR articles, 26 were cited at least once, with 10 not cited. One-way analysis of variance did not suggest that rejected manuscripts published in radiology journals had significantly higher citation frequencies than other journal classifications (including surgical subspecialty and clinical medical journals).

Conclusions
Although there was a trend towards higher citations accumulated by AJNR published articles, this study suggests that Head and Neck publications initially rejected from AJNR do not have a significantly lower citation frequency than those accepted by AJNR.

O-288

Retrospective Review of Head CT Doses During a 6 Month Period: A Method for Identifying Opportunities for Improvement through the Prevention of Outliers

E Mugler¹, K Miller¹, A Goode², P Judy¹, T Altes¹, P Komlosi³, S MUKHERJEE⁴
¹University of Virginia Health System, Charlottesville, VA, ²University of Virginia, Charlottesville, VA, ³University of Virginia, Charlottesville, VA, ⁴UNIVERSITY OF VIRGINIA, CHARLOTTESVILLE, VA

Purpose
To assess the estimated effective dose of head CTs performed at our institution and identify causes for unusually high doses.

Materials and Methods
Using dose tracking software (Radimetrics Enterprise Platform, Bayer HealthCare), every head CT performed from December 2013 to June 2014 was identified. Patient demographics and dose parameters reported by the CT scanners (DLP, CTDIvol) were used to determine the mean estimated effective dose based on age. Outlier CT exams, defined as estimated dose greater or less than 1.5 standard deviations from the mean, were assessed individually and categorized. Multiple acquisition exams were excluded.

Results
A total of 261 pediatric head CT exams and 4791 adult head CT exams were identified. Use of a head holder was found to substantially increase the dose for young children. Sixty out of 261 pediatric exams were scanned under the adult protocol, 20 of which were < 16 years of age. Approximately 7% of the adult outliers were due to the selection of the incorrect protocol at the beginning of the exam. Patient hardware was observed to significantly increase dose, especially in the pediatric population. Following exclusion of the outliers, the maximum DLP to stay within 1.5 standard deviations from the mean was determined for each age group and is summarized in Table 1.

Conclusions
Dose tracking software can be invaluable in monitoring head CT effective doses and identifying causes for outliers. Identifiable outliers in our series were due to inappropriate head positioning, lack of dose modulation, patient hardware and wrong protocols. All of these are easily preventable using proper head stabilizers, patient selection, and appropriate protocoling. Use of the DLP data in the table during prescan planning may prevent outliers from occurring.
Quantitative Analysis of Diffusion in the “PACS population”

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Purpose
The "PACS population" is a heterogeneous collection of images representative of a wide variety of medical conditions as well as variation between individuals and populations stored within a given PACS. This "big" dataset is not annotated and not easily accessible given HIPAA restrictions. Accessing this dataset for quantitative image analysis and forming unbiased

<table>
<thead>
<tr>
<th>Age Range</th>
<th>DLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &lt;1</td>
<td>420 mGy-cm</td>
</tr>
<tr>
<td>Age 1-3</td>
<td>780 mGy-cm</td>
</tr>
<tr>
<td>Age 4-8</td>
<td>960 mGy-cm</td>
</tr>
<tr>
<td>Age 9-13</td>
<td>1290 mGy-cm</td>
</tr>
<tr>
<td>Age 14-18</td>
<td>1430 mGy-cm</td>
</tr>
<tr>
<td>Age 18+</td>
<td>1620 mGy-cm</td>
</tr>
</tbody>
</table>

Table 1: Maximum DLP by Age to Prevent Outliers (mean +1.5 standard deviation)
observations is challenging. We performed this study to demonstrate that quantitative image analysis on the PACS population is feasible.

Materials and Methods
A HIPAA compliant research protocol focused on data analysis, using multiple layers of encryption, on a single end-user workstation, was approved by the local institutional review board. A dataset comprising 10,000 individual Brain MRI examinations was retrieved from the PACS. Automated image analysis enabled the computation of an apparent diffusion coefficient (ADC) histogram for each brain MRI examination, as well as statistical analysis of the data pool. The data may be further correlated with DICOM metadata.

Results
We performed an automated analysis of diffusion data and compiled histogram based statistics on a sample of the PACS population. An automated analysis of large PACS datasets is feasible.

Conclusions
This proof-of-concept study was implemented using freely available tools and demonstrates that automated large-scale quantitative analysis on the PACS population is feasible and scalable. This approach builds on prior work using ideal populations and small sizes (1). This study highlights the potential and limitations of automated quantitative analysis of inherently heterogeneous data.
Novel IT Infrastructure for Enabling Global Teleneuroradiology

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Purpose
Opportunities for neuroradiologists to participate in global health have historically been limited by lack of local neuroradiology equipment and inability to provide remote interpretations. With increased global access to Internet and digital neuroimaging equipment, opportunity exists to develop international teleradiology infrastructure focused on countries that lack neuroradiology expertise. We describe an innovative PACS architecture for global teleneuroradiology in areas of limited Internet access.

Materials and Methods
For 27 years, Partners In Health (PIH) has provided medical care and training in Haiti. In response to the 2010 earthquake, PIH in collaboration with the Haitian Ministry of Health, constructed and staffed a 330-bed hospital in rural Haiti with a digital radiology department. This included a 32-slice CT, one of only five CTs in this country of 10 million and the only CT in a public hospital. Due to the absence of radiologists in the public sector, the PACS needed to support remote interpretation by North American radiologists. The configuration consisted of a full PACS in Haiti, with a second PACS hosted in Boston, MA, configured as a "mirror" of the Haiti PACS. The Boston PACS acted as a local instance of PACS with access to bandwidth suitable to support a web-enabled viewing application for remote radiologist interpretation and as backup/disaster recovery for the Haiti PACS. To accommodate the limited available bandwidth between Haiti and Boston, all studies were lossy compressed prior to transfer utilizing the concept of "diagnostically acceptable irreversible compression" as promulgated by the ESR and ACR, using the standard developed by CAR. Concise free text reports, created by radiologists, are transmitted to Haiti using an HL7 interface engine. After a few months of operation, the only available Internet connection began to experience severe (30%) packet loss, not uncommon in the developing world. DICOM transmission protocol would not function with this degree of packet loss. To allow continued study transfer, initially we employed a commercial data storage cloud service, manually exporting the studies and importing them into the Boston PACS. To reduce labor overhead, we migrated to an autonomously functioning radiology-specific data transfer/cloud service.

Results
Since April 2013, we have transferred successfully over 3500 neuroimaging studies performed in Mirebalais, Haiti. These have been interpreted by volunteer radiologists from the US and Canada. Our architecture allows for transmission of large volume, complex neuroimaging studies over a limited, poor quality Internet connection. It allows subspecialty consultation in a setting in which there are no radiologists and for a hospital that provides primary care to over 250,000 and tertiary care to a population of almost 3 million.

Conclusions
This project demonstrates that global teleneuroradiology can be implemented successfully in areas with low bandwidth and poor quality Internet. This architecture allows neuroradiologists to actively participate in global radiology without the need to travel.
Development of a Bayesian Network for Discriminating Diseases Affecting the Basal Ganglia and Thalamus on Neuroimaging

E Botzolakis\textsuperscript{1}, R Bryan\textsuperscript{1}, E Herskovits\textsuperscript{2}, I Nasrallah\textsuperscript{1}, H Kundel\textsuperscript{1}, S Mohan\textsuperscript{1}
\textsuperscript{1}University of Pennsylvania, Philadelphia, PA, \textsuperscript{2}University of Maryland, Baltimore, MD

Purpose
Bayesian networks (BNs) are a promising form of knowledge representation for clinical diagnosis support. To explore the potential utility of BNs for assisting brain-MR interpretation, we aimed to develop a BN that integrates imaging features with patient demographics and
pertinent clinical history to discriminate the challenging set of diseases affecting the basal ganglia and thalamus.

Materials and Methods

Using commercially available software (Netica), a naive BN was generated consisting of a parent "diagnosis" node connected to multiple child "feature" nodes. The diagnosis node contained a comprehensive list of 56 entities affecting the basal ganglia and thalamus. Feature nodes included MR signal and spatial characteristics, plus clinical features such as patient age and disease chronicity (24 total features). Conditional probabilities (i.e., P(Feature | Diagnosis) were generated from a combination of expert opinion and literature review. Bayesian network performance was evaluated using randomly generated test cases derived from the conditional probabilities of each feature node. By comparing BN prediction to ground truth for each case, a confusion matrix was generated and used to evaluate diagnostic performance.

Results

Overall BN sensitivity and specificity were 0.81 ± 0.17 and 0.98 ± 0.01, respectively, with sensitivity increasing to 0.97 ± 0.02 when the "top three" differential diagnosis was tested against ground truth. Sensitivity was highest for neoplastic disorders (0.88 ± 0.10) and lowest for toxic/metabolic disorders (0.76 ± 0.23). Receiver operating characteristic (ROC) analysis demonstrated an overall network AUC of 0.99. Based on sensitivity analysis, the five most discriminating imaging features were (in decreasing order of entropy reduction): mass effect, T1, diffusion, FLAIR, and contrast enhancement.

Conclusions

A comprehensive expert-based BN was developed successfully with high discriminatory capacity for diseases affecting the basal ganglia and thalamus. Although further validation with radiologist-extracted imaging features is needed, the results nevertheless demonstrate the potential utility of BNs for Neuroradiology diagnostic support.

O-292

Improving Performance of a Bayesian Network for Neuroradiology Differential Diagnosis with Structural Optimization

E Botzolakis¹, I Nasrallah¹, E Herskovits², H Kundel¹, M Tanwar¹, S Mohan¹, R Bryan¹
¹University of Pennsylvania, Philadelphia, PA, ²University of Maryland, Baltimore, MD

Purpose

Bayesian networks (BNs) represent a promising approach to radiologic diagnosis support, able to generate differential diagnoses based on reader-extracted imaging features. We previously have described development of a prototypical BN for assisting neuroimaging interpretation, including methods for parameter optimization. Here, we explore whether BN performance can further improve with structural optimization.

Materials and Methods

Mutually nonexclusive (M1) and mutually-exclusive (M2) "naïve Bayes" networks were generated. Each network was composed of a parent "diagnosis" node representing 11 neuroimaging entities and normal, and child "feature" nodes representing lesion MR signal and spatial characteristics. Conditional probabilities (CPs) for networks were obtained from an expert neuroradiologist (P1) and refined by expert consensus using a Delphi method (P2). Conditional
probabilities also were obtained from imaging features extracted by expert consensus from 101 representative MR examinations (six examples per disease, 35 normal examples) (P3). Extracted imaging features were used next to generate a tree-augmented network (TAN). Performance of the MxPx and TAN networks was compared using ROC analysis and other standard metrics (e.g., sensitivity, specificity). Network performance also was compared to trainees and attendings who reviewed the same representative MR examinations.

Results
M1Px and M2Px naïve networks performed similarly for a given CP set, noting a slight performance advantage for M2Px. Network performance improved with each CP optimization step, initially performing below the level of a radiology resident (MxP1/2), but ultimately performing near the level of a neuroradiology fellow (MxP3). The TAN network performed better than all naïve networks (p<0.01 for MxP1/2; trend toward significance for MxP3), with disease sensitivity (0.92), specificity (0.99), and AUC (0.99) indistinguishable from a neuroradiology attending.

Conclusions
Structural optimization improved performance of a prototypical neuroradiology Bayesian network, increasing discriminatory capacity for a limited set of neuroimaging entities to the level of an attending neuroradiologist.
Effect of Parameter and Structural Optimization on Bayesian Network Performance

(Filename: TCT_O-292_ASNRROCs.jpg)

O-293
5:56PM - 6:04PM

Using Social Media To Share Your Neuroradiology Research - How Effective Is A Blog Post?

J Hoang¹, A Dixon², R Fitzgerald³, J McCall⁴, F Gaillard⁵
¹Duke University Medical Center, Durham, NC, ²Alfred Hospital, Melbourne, Victoria, ³University of Arkansas for Medical Sciences, Little Rock, AR, ⁴Duke Clinical Research Institute, Durham, NC, ⁵Royal Melbourne Hospital, Melbourne, Victoria
Purpose
To compare the volume of individual readers reached by research articles in two peer-reviewed radiology journals to a radiology blog promoted by social media.

Materials and Methods
This is a retrospective case study that compares online analytic logs of pageviews from April 2013 to September 2014 for two research articles that appeared in the American Journal of Neuroradiology (AJNR) and the American Journal of Roentgenology (AJR), respectively, and a blog post on the website Radiopaedia.org. Both articles and the blog post discussed the same topic - reporting incidental thyroid nodules detected on CT and MRI - and the blog post (after updating) referenced both journal articles. We compared the total online pageviews for the research articles and the blog, and examined factors that could affect trends in pageviews, including an AJNR podcast about the article appearing in that journal in January 2014 and promotion of the blog post to followers of Radiopaedia.org via social media platforms including Facebook, Tumblr, and Twitter in February 2014 and August 2014.

Results
During the study interval, the AJNR article received 2421 pageviews and the AJR article received 3064 pageviews. The Radiopaedia.org blog received a total of 32,675 pageviews, which was 13.6 and 10.7 times greater than AJNR and AJR pageviews, respectively, and 6.0 times greater than for both journal articles combined. Months with activity above average for the blog (February and August 2014) and the AJNR article (August and September 2014) coincided with promotion by Radiopaedia.org on social media.

Conclusions
Dissemination of scientific material via some forms of social media may confer an advantage in reaching larger numbers of readers and increasing the visibility of research findings relative to peer-reviewed journal publication alone. Although the most authoritative and widely accepted measure of academic productivity remains the peer-reviewed publication, researchers in radiology may wish to consider opportunities for disseminating research findings via social media platforms.
Are dose monitoring programs a valid tool for organ dose calculation?

N Guberina\textsuperscript{1}, B Mukherjee\textsuperscript{2}, U Lechel\textsuperscript{3}, F Stecker\textsuperscript{4}, L Lenga\textsuperscript{4}, S Suntharalingam\textsuperscript{5}, M Schlamann\textsuperscript{6}, K Nassenstein\textsuperscript{3}, J Theysohn\textsuperscript{5}, M Forsting\textsuperscript{6}, A Ringelstein\textsuperscript{7}

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Purpose
In a retrospective "dose-alert"-procedure we observed that the dose-monitoring program eXposure (Bayer HealthCare, Germany) assessed identical effective-radiation-doses for the eye-lens in unenhanced cranial CT-protocols at our 128-multislice-single-source and the dual-source CT-scanner, viz. with (+nCT) and without (-nCT) gantry-angulation. Furthermore, contrary to our expectations we observed in some CT-examinations based on CT-protocol for pulmonary embolism with Flash mode and Safire (CTT) a very low level of estimated effective-radiation-doses for organs in the primary beam of radiation. The aim of this study was to verify the results of eXposure.

Materials and Methods
We performed phantom measurements with thermoluminescence-dosimeters (LiF:Mg,Ti; TLD-100) on an anthropomorphic phantom using different CT protocols (+nCT, -nCT, and CTT with varying pitch factor p<0.6, p>3.2). The phantom measurements served as a gold standard for radiation-dose-estimation. Effective-radiation-doses and overranging assessed with eXposure and measured on the anthropomorphic phantom were averaged and compared between the modalities.

Results
Our intermodality comparison shows a discrepancy between effective-radiation-doses estimated by eXposure and measured with TLDs in (CTT) and in (+nCT). Effective-radiation-doses are summarized as follows: (I) for the eye-lens in +nCT (a) eXposure 45mSv (b) TLD 5mSv; (II) for the eye-lens in -nCT (c) eXposure 41mSv, (d) TLD 35mSv; (III) total effective-radiation-doses in CTT (e) eXposure 1mSv (f) TLD 1.3mSv. Analysis of specific CT-protocol-features reveals an incorrect positioning of the localizer by exposure in CTT and lack of registration of gantry-angulation in +nCT. Ovrranging in CTT with varying pitch is assessed with high accuracy (IV) for p<0.6: 1cm and (V) p>3.2: 7cm, each time for eXposure and TLD.

Conclusions
The disregard of gantry-angulation leads to an overestimation of effective-radiation-dose for the eye-lens at single-source CT-scanners. Inaccurate positioning of the localizer may lead to an underestimation of effective-radiation-doses. In cranial CT-protocols without gantry-angulation and in CT-protocols with correct or corrected localizer positioning eXposure is a valid toolkit for dose calculation. The current data help to account protocol-specific influences and correct underlying software-algorithms.
Purpose
Our purpose was to determine reasons for rejections of Head and Neck submissions to the American Journal of Neuroradiology (AJNR) and the fate of these manuscripts.

Materials and Methods
Decision letters of 100 consecutive original research submissions in Head and Neck submitted to AJNR between January 1, 2012 and April 2, 2013 were reviewed to identify the major reasons for rejection. A search of MEDLINE was done to identify subsequently published articles. The submissions were analyzed as a function of publication delay, publishing journal and impact factor.

Results
In 81 of 100 submissions, decision letters cited multiple reasons for rejection. The most common reasons were methodology issues (49%) and lack of contribution to current knowledge and existing literature (37%). Additional reasons included conclusions not supported by results (29%), poor quality writing (27%), not clinically relevant or practical (24%), submission type more appropriate for an educational review or pictorial essay (11%), submission more appropriate for a nonradiology venue (9%), and lack of concordant purpose and conclusions (7%). Of the 100 rejected submissions, 73 subsequently were published in 38 journals, with the Journal of Computer Assisted Tomography publishing the greatest number [nine (12.3%)]. The mean publication delay was 12.4 +/- 3.9 months. Sixty-five percent (48/73) of these articles were published in imaging journals, and 21% (15/73) in surgical subspecialty journals. The mean impact factor of journals subsequently publishing rejected AJNR manuscripts was 1.8 +/- 1.0 (AJNR = 3.7), with only two manuscripts published in journals with higher impact factors than AJNR.

Conclusions
The most common reasons for rejection of Head and Neck submissions to AJNR include methodology issues, lack of originality/lack of contribution to current literature, unsupported conclusions and poor quality writing. Despite these limitations, rejection by AJNR did not preclude eventual publication, although articles generally were published in journals with lower impact factors.

Citation characteristics of the 100 most referenced Neuroradiology-related articles

Number of citations a publication receives may show its impact on a field of study, indicate the
interest in a given population or underline an educational gap. Our goal was to determine the type of journal and article features of top 100 cited neuroradiology articles as of 2014.

Materials and Methods
All radiology-related journals listed by Thomson Reuters Journal Citation Reports in 2011 were identified and then divided into categories of general radiology journals (GRJ), neuroradiology-focused journals (NFJ), and modality specific journals (MSJ) followed by identification of the top most cited 100 articles in each group. Articles then were scrutinized for neuroradiology-related topics and divided into two groups. One group included GRJ, NFJ, and MSJ and the other only clinically oriented journals (NFJ and GRJ). Characteristics then were recorded to find common themes.

Results
The most frequently cited neuroradiology articles appeared in 10 of 120 journals. Among all three journal groups, the top 100 articles were cited 525 ± 309 times (median 413; range 301 – 1871). If only the clinically oriented journals were included, the top 100 articles were cited 338 ± 118 times (median 299, range 233 – 739 citations). When all three journal groups were included, most citations came from Magnetic Resonance in Medicine (n=48), followed by Radiology (n=31) and AJNR (n=9). When only clinically oriented journals were included, most citations were from Radiology (n=59) and AJNR (n=28). Among all three journal groups there were 76 articles related to MRI with the most common topics being: brain (n=85), interventional (n=5), head & neck (n=5), and spine (n=3). In the clinically oriented journal group we found 59 articles related to MRI with the most common topics being: brain (n=68), interventional (n=19), head & neck (n=5), and spine (n=4).

Conclusions
Nearly one-half of the 100 most commonly cited neuroradiology articles appeared in modality-related journals and not clinical ones. Articles dealing with brain-related topics were most common among the 100 most cited neuroradiology publications.

Wednesday
7:00AM - 7:30AM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

13A - ASNR ANNUAL BUSINESS MEETING (MEMBERS ONLY)

Wednesday
7:30AM - 8:30AM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

14A - SAM SESSION: A POTPOURRI CASE BASED (AR) (SAM)
14A-1

Cerebral Venous Drainage Patterns: Veins Leading to the Verdict

Bello, J.
Montefiore Medical Center
Bronx, NY
14A-2

Encephalitis

Kucharczyk, W.
Toronto General Hospital
Toronto, ON

14A-3

You Might Have To Come In and Squirt an Angio

Pasquale, D.
Loyola University
MAYWOOD, IL

Wednesday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

15A - SNIS: ACUTE ISCHEMIC STROKE: MAXIMIZING PATIENT OUTCOMES
15A-1

Elevating Patient Outcomes to the Level of Arterial Recanalization "Time Metrics"

Loy, D.
Radiology Imaging Associations
Englewood, CO

15A-2

Patient Selection with Advanced Imaging

Chaudry, M.
Medical University of South Carolina
Charleston, CO

15A-3

Controversies in Measuring Patient Outcomes

9:10AM - 9:30AM
Khatri, P.
University of Cincinnati Medical Center
Cincinnati, OH

15A-4

Bringing the Treatment to the Patient with Mobile CT and Telemedicine

Rasmussen, P.
Cleveland Clinic
Cleveland, OH

15A-5

Questions and Answers

Wednesday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)

15B - ASFNR: ADVANCED IMAGING OF COGNITION: IMAGING THE MIND

15B-1

fMRI of Alzheimer’s Disease

Petrella, J.
Duke University Medical Center
Durham, NC

15B-2

PET of Alzheimer’s Disease: What is the Score?

Larvie, M.
Massachusetts General Hospital
Boston, MA
15B-3

How to Perform Functional MRI in Children

Burrowes, D.
Ann & Robert H. Lurie Children's Hospital of Chicago
Chicago, IL

15B-4

ADHD and Autism: Can Imaging Make the Diagnosis?

Mukherjee, P.
University California, San Francisco
San Francisco, CA

Wednesday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

15C - INTERNATIONAL SESSION: WFNRS PRESENTS THE BEST OF AOSNHR 2015: FROM BENCH TO BEDSIDE CLINICAL NEURORADIOLOGY

15C-1

Insights into Imaging Genetics: Phenotypes in Brain and Cognitive Aging

Lin, C.
Institute of Neuroscience, National Yang Ming University
Taipei, Taiwan

15C-2

Relationships Between Gene Polymorphism, Neurotransmitters, and Brain MRI in Major Depressive Disorder

Korogi, Y. · Nakamura, J.
University of Occupational and Environmental Health, School of Medicine · University of Occupational and Environmental Health
Kitakyushu-shi, Fukuoka-ken · Kitakyushu, Fukuoka
Arterial blood pressure but not serum albumin concentration correlates with ADC ratio values in pediatric PRES

A Furtado¹, A Hsu², L La Colla³, G Zuccoli²

¹Children's Hospital of Pittsburgh, Pittsburgh, PA, ²Children's Hospital of Pittsburgh of UPMC, Pittsburgh, PA, ³UPMC Shadyside, Pittsburgh, PA

Purpose
Posterior reversible encephalopathy syndrome (PRES) is a clinical-radiological entity affecting both adults and children characterized by neurotoxicity often in setting of hypertension coupled with distinct brain magnetic resonance (MR) imaging features. Decreased serum albumin level has been suggested to correlate with the presence of vasogenic brain edema in adult PRES. Serum albumin thus has been hypothesized to protect against neurotoxicity in PRES by reducing vasogenic brain edema through its role in maintaining plasma osmotic pressure and endothelial integrity. The purpose of our study was to investigate if such correlation between decreased serum albumin level and PRES-related vasogenic edema could be found in children.

Materials and Methods
We conducted a retrospective study of 25 pediatric patients diagnosed with PRES. Underlying clinical conditions, presenting symptoms, blood pressures and serum albumin levels at onset of symptoms were collected. Brain MR imaging studies were reviewed. We used a quantitative
method to evaluate the degree of vasogenic edema by measuring apparent diffusion coefficient (ADC) values of the T2-FLAIR hyperintense brain lesions.

Results
No significant correlation was found between serum albumin level and degree of PRES-related vasogenic edema. A significant correlation was found between elevated blood pressure (both systolic and mean) and degree of vasogenic edema in the temporal lobes (p=0.02 and 0.04, respectively) but not in the other cerebral lobes or cerebellum.

Conclusions
Our initial results suggest blood pressure, not serum albumin level, as a main biomarker for brain edema in children with PRES. Thus our study does not suggest a protective role of serum albumin against PRES-related neurotoxicity in children.

O-298 8:38AM - 8:46AM

Morphometric Differences of the Central Skull Base and the Foramen Magnum in Non-syndromic and Various Syndromic Craniosynostoses

A Vossough1, R Assadsangabi2, M Hajmomenian3
1University of Pennsylvania - Children's Hospital of Philadelphia, Philadelphia, PA, 2Children's Hospital of Philadelphia, Philadelphia, PA, 3Children's Hospital of Philadelphia, Philadelphia, PA

Purpose
Extensive calvarial and facial morphological changes are observed in patients with syndromic and various nonsyndromic craniosynostoses. It is thought that skull base development may be primarily or secondarily related to the better known calvarial and facial malformations. We investigated morphometric abnormalities of the central skull base and foramen magnum in patients with various syndromic and nonsyndromic craniosynostoses in comparison to normal controls in order to shed light on the relationship of skull base development in these varied disorders.

Materials and Methods
Morphometric assessments of the central skull base and foramen magnum were performed in patients with fibroblast growth factor receptor (FGFR) related syndromes (Apert, Pfeiffer, Crouzon) and TWIST-1 mutations (Saethre-Chotzen syndrome), and compared to nonsyndromic bicoronal synostosis patients and controls. Various morphometric assessments were made using thin section CT data on a 3D workstation. The minimum inner and outer intercarotid distances were measured in the central skull base. Grading of the degree of fusion of the spheno-ethmoidal synchondrosis (3 grades) and fusion of the spheno-occipital synchondrosis (4 grades) were determined for age. The diameters, surface area, and morphology of the foramen magnum also were assessed. LOESS plots of skull base development were plotted. Results were statistically compared with analysis of variance and nonparametric tests, with correction for multiple comparisons.

Results
Eighty-eight craniosynostosis patients (Apert, n=26; Pfeiffer, n=21; Crouzon, n=25, Saethre-Chotzen, n=9; isolated nonsyndromic bicoronal synostosis, n=9) were evaluated and compared to 30 normal controls. A significantly smaller intercarotid distance was seen in all syndromic and
nonsyndromic craniosynostoses compared to controls (p<0.005), but was most evenly pronounced in Pfeiffer and Crouzon compared to the other craniosynostoses (p<0.009 and p<0.3, respectively). The sphenethmoidal and sphenocital synchondroses were shown to fuse significantly earlier in Apert, Crouzon, Pfeiffer syndromes than in the bicoronal nonsyndromic synostosis, Saethre-Chotzen, or nonsynostotic patients, but there was no significant difference among the three FGFR related syndromes. No significant difference was seen among bicornal synostosis, Saethre-Chotzen, and normal patients. The surface area of the foramen magnum was smaller in Crouzon and Pfeiffer syndromes (p=0.002, p=0.017) and the relative transverse diameter of the foramen magnum was significantly smaller in Crouzon, Pfeiffer, Apert syndromes compared to controls (p=0.005, p=0.002, p=0.03 respectively), indicating changes in shape and size of the foramen magnum in these patients.

Conclusions
Significant changes in the morphology and development of the central skull base and foramen magnum is seen in FGFR-related syndromic craniosynostosis patients. There appears to be a more important role and effect of FGFR-related mutations on skull base development compared to TWIST-1 mutations or in nonsyndromic craniosynostoses.

O-299
8:46AM - 8:54AM

Brain and Vein Herniations into the Dural Sinuses Associated with Arachnoid Granulations: Prevalence in Clinical MRI Examinations in Children.

J Leach\(^1\), C Doyle\(^1\)
\(^1\)Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Purpose
Arachnoid granulations (AG) are normal anatomical structures that project into the dural sinuses and commonly are identified on MRI examinations (1). Prior studies have described direct vein (2) and much more rarely brain herniation (3) into the AG and dural sinus. Prevalence of these associations, particularly in the pediatric population, has not been well described. The purpose of this study is to describe the appearance and prevalence of intradural sinus herniations of brain and venous structures associated with clinically reported arachnoid granulations in the pediatric population.

Materials and Methods
The radiology report database at a large tertiary care pediatric hospital was reviewed for the term "arachnoid granulation" on brain MRI reports from 2001-2013. Reports and images were reviewed to document presence of arachnoid granulations, based upon typical imaging appearance (1). Location and size was documented. The presence or absence of brain and/or vein herniations (BH/VH) into the dural sinus related to the AG was assessed. BH/VH was defined as projection of brain parenchyma or cortical venous structure beyond the plane of the dural sinus margin into the AG within the sinus.

Results
Ninety-two brain MRI examinations with AG were reviewed in detail. Age range: 2 months – 22 years, 99 AG were identified. The majority (70) were in the transverse sinuses (TS). Thirty-seven AG had associated VH, nine had associated BH, and two had BH and VH into the AG and dural sinus. No difference in sex or age was noted between those with patients with BH/VH and
those without. The average size of AG with BH/VH was larger than those without (7.9mm versus 5.6mm, p<0.0001). AG with BH/VH were noted in the SSS (5), Straight sinus (4), TS (30), and torcular (5) similar in distribution to those without BH/VH (p=0.4). Arachnoid granulations with BH were noted in the TS (7) and torcular (2) with the inferior occipital gyrus protruding into the TS AG, and the cerebellum protruding into the torcular AG. In four patients with BH prior studies were available. In one subject, the AG was visible but BH was not identified on a study 2 years previously suggesting that BH can be acquired. No abnormal brain signal was identified in the herniated or adjacent brain. No symptoms could be attributed to the AG with BH/VH compared to those without.

Conclusions
BH and/or VH into the dural sinuses at sites of clinically reported AG is not rare in children, occurring in nine (9.1%) and 37 (37.4%) of 99 clinically identified AG respectively. No related clinical symptoms could be identified. Presumably these represent normal variations that relate to dural rents at the base of the AG, and are more common with larger AGs. They should not be mistaken for other pathologies. Although likely incidental, intra-dural sinus brain and venous herniation related to AG could potentially have clinical implications related to planned dural sinus stenting procedures. Further study is indicated.

O-300

Head Impact Exposure in a Season of Youth Football Increases MEG Low Frequency Brain Waves

E Davenport1, J Urban1, C Whitlow2, M Espeland1, Y Jung1, D Rosenbaum1, G Gioia3, A Powers1, J Stitzel1, J Maldjian1
1Wake Forest University School of Medicine, Winston-Salem, NC, 2Wake Forest University School Of Medicine, Winston-Salem, NC, 3Children'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 youth football produce magnetoencephalography (MEG) measurable changes in the brain in the absence of clinically diagnosed concussion.

Materials and Methods
Nineteen players from a youth football league (mean age=11.56; age range=10-13.7; no history of concussion) were instrumented with the Head Impact Telemetry System (HITs) during practices and games. The biomechanical metric computed from the HITs data was risk-weighted cumulative exposure (RWE) (1). 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. Structural anatomical MRI was acquired for coregistration with MEG. Using an in-house automated pipeline, MEG data were baseline corrected, band-stop filtered (60Hz), down-sampled to 100Hz, and band-pass filtered to 1-4Hz (delta spectrum). Head motion, and muscle artifacts were removed. Magnetoencephalography data were projected into standard source space using a scalar beamformer (2). The delta spectrum amplitude was recorded for each 2.5-second epoch, and averaged across epochs for each voxel. The group mean and standard deviation, of postseason minus preseason, were used to determine total number of abnormal voxels for each subject (>2SD). This was repeated for theta and alpha bands.
Results
Regression analysis revealed a significant relationship ($p = 0.0143$, $R^2 = 0.34$) between RWECP and mean delta wave amplitude. Secondary analyses demonstrated a significant ($p = 0.009$, $R^2 = 0.38$) association between RWECP during practices and delta waves. No relationship was found using theta or alpha bands.

Conclusions
We demonstrate that a single season of football can produce changes in the brain detectable by MEG in the absence of clinical concussion, especially associated when isolating head impact exposure experienced during practices. Similar MEG brain changes have been associated with traumatic brain injury (3). Biomechanical findings show youth players experience greater head impact exposure during practices (4).

Brain Structural Network Changes Related to Head Impact in Youth Football

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$^1$Wake Forest University, School of Medicine, Winston Salem, NC, $^2$Wake Forest, Winston-salem, NC, $^3$Wake Forest University School Of Medicine, Winston-Salem, NC, $^4$Wake Forest University School of Medicine, Winston-Salem, NC

Purpose
The purpose of this study was to determine if cumulative head impacts over a season of youth football affects brain structural network properties.

Materials and Methods
Twenty male football players (age: 8-12 years) without history of prior concussion or neurologic disease from local elementary school teams participated in the study. The head impact telemetry (HIT) system was used during practices and games for each individual. The HIT system uses sensors embedded in the helmet for kinematic data recording from head impacts. The biomechanical metric used was the risk-weighted cumulative exposure (RWECP) (1). All subjects received pre and postseason MRI, including structural and diffusion tensor imaging (DTI). The scans were acquired on a 3T Siemens Skyra MRI scanner using a high resolution 20-channel head/neck coil. Diffusion tensor imaging (DTI) data were obtained using a 2D single-shot EPI sequence ($2.2 \times 2.2 \times 3$ mm; 15 diffusion directions with $b=1000/2000$ each). Diffusion
tensor imaging probabilistic network processing was performed using FDT-FMRIB diffusion
toolbox in FSL2. For each subject, 116 nodes were determined based on 116 regions of interest
(ROIs) from the AAL atlas. For each seed region, $5000 \times n$ (where $n$ = number of voxels within the
region) fibers were measured. The connectivity probability from the seed region to each target
region was defined as the number of fibers passing through the target region divided by $5000 \times n$.
We created a $116 \times 116$ matrix representing the connectivity probability of all ROIs for each
subject. Network properties including local and global efficiency, small worldness, node degree,
transitivity, betweenness centrality, assortativity, triangles, and modularity were computed from
this matrix. Linear regression analysis was conducted to determine the association between
RWECP and network properties.
Results
Table 1 reports the regression analysis results demonstrating the association between structural
network metrics with respect to total RWECP. There was a statistically significant linear
relationship between the total RWECP and global efficiency, transitivity, and node degree ($p<
0.05$). Figure 1 demonstrates these network properties to have linear correlation with total
RWECP over the entire season.
Conclusions
These results indicate changes in structural network properties in nonconcussed subjects during a
single season of football. These findings demonstrate that cumulative subconcussive sports-
related impacts may have an effect on the brain.
Hemispheric Pattern of Maturation is Altered in Autism

J Berman¹, T Roberts²

Table 1. Associations between total RWE<sub>CP</sub> and Changes in structural network properties

<table>
<thead>
<tr>
<th></th>
<th>P-value</th>
<th>R&lt;sup&gt;2&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>Global Efficiency vs RWE&lt;sub&gt;CP&lt;/sub&gt;</td>
<td>0.0211*</td>
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<td>0.5267</td>
<td>-0.0239</td>
</tr>
</tbody>
</table>

*<p><sub> <i>p < 0.05</i></sub>

RWE<sub>CP</sub>, Risk Weighted Cumulative Exposure;
R<sup>2</sup> values with the negative sign illustrate the negative correlation between two designated variables.

Figure 1. Scatterplot: a) depicts the relationship between global efficiency and cumulative exposure; b) depicts the relationship between the transitivity and cumulative exposure; c) depicts the relationship between the node degree and cumulative exposure over the entire season.
Purpose
To establish differences between individuals with Autism Spectrum Disorder (ASD) and neurotypicals in the developmental trajectory of thalamocortical white matter and its functional sequelae. We used quantitative high angular resolution diffusion imaging (HARDI) of the auditory radiations and evaluated the impact of such maturation on the electrophysiological activity of auditory cortex, determined by magnetoencephalography (MEG) and characterized in terms of the latency of the auditory evoked ~100ms "M100" response component.

Materials and Methods
Twenty-five children (age 6-16 years) meeting diagnostic criteria for ASD (DSM-5, augmented by ADOS) were recruited to this study along with 15 age and nonverbal IQ (NVIQ)-matched typically developing control subjects. 2mm isotropic HARDI was performed using a 3T Verio(TM) MRI system using 64-directions with b=3000s/mm^2. Tractography of the auditory radiation was performed and diffusion metrics, (including fractional anisotropy, FA, mean diffusivity, MD, and radial diffusivity, RD) evaluated over the whole length of the tracts bilaterally. High angular resolution diffusion imaging tractography is necessary (compared to DTI) to traverse the complex white matter within the auditory radiation as they radiate from thalamus to cortex. Magnetoencephalography was performed using a 275-channel biomagnetometer with bilateral passive presentation of sinusoidal stimuli at 45dB sensation level. Evoked responses were modeled in bilateral auditory cortex and M100 latencies determined by consideration of peak amplitude and appropriate surface magnetic field topography.

Results
Diffusion evidence of maturation of white matter is revealed bilaterally by increasing FA, decreasing MD and decreasing RD. Differences in maturational rate between ASD and TD are significant for left hemispheric white matter measures of radial diffusivity (RD) and FA (p<0.05). Similarly M100 latency shows bilateral evidence maturation (shortening) in both groups. Interestingly, direct associations show a positive coupling of measures of white matter maturation with electrophysiological responses in both ASD and TD, with the steepness of the correlation being greater in the left hemisphere, which is demonstrating the greatest magnitude of maturational change.

Conclusions
Multimodal evidence for hemispheric differences in development of thalamocortical white matter and associated cortical electrophysiological responses are reported. High angular resolution diffusion imaging appears necessary to allow characterization of the full thalamocortical white matter structure. Maturation of this white matter tract appears to subserve, in part, maturation (shortening) of the cortical electrophysiological response. Other influences on M100 latency might include measures of synaptic transmission. The combination of advanced MRI and MEG offers insights into the neurobiology of typical and atypical development.
Purpose
Different scoring systems to classify severity of hypoxic ischemic encephalopathy (HIE) have been published in the literature, and have shown significant correlation with patient outcome. However, recent publications comparing scoring systems have used a central reader to apply the scoring system. We compared interobserver agreement for two of the three published scoring systems, the Barkovich combined basal ganglia/watershed (BG/W) and National Institute of Child Health and Human Development (NICHD) scoring systems.

Materials and Methods
Following IRB waiver, the brain MRIs of patients diagnosed and treated for HIE at a single institution between 10/2001 and 07/2013 were reviewed and scored independently by two pediatric neuroradiologists according to the BG/W and NICHD scoring systems. T1 TSE, T2 TSE, and DWI sequences were assessed in conjunction but scored separately. A final score for the exam was obtained from the highest score from T1, T2, or DWI. Concordance between reviewers for T1, T2, DWI, and final score was evaluated with weighted Cohen's kappa.

Results
Currently, 51 consecutive patients were evaluated out of 123 meeting inclusion criteria. Mean patient age at time of scan was 7.4 days (2-41 days, 25 females). All scores had at least substantial agreement with the BG/W final score demonstrating the highest agreement. Kappa results are detailed in Table 1.

Conclusions
We found substantial agreement for both scoring systems using T1, T2, and DWI sequences, with DWI demonstrating higher agreement for both scoring systems. The Barkovich BG/W final score has the highest interobserver agreement which may improve consistency in MRI scoring for HIE to predict clinical outcomes.

<table>
<thead>
<tr>
<th></th>
<th>Weighted Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BG/W T1</strong></td>
<td>0.88 (0.74-1.0)</td>
</tr>
<tr>
<td><strong>BG/W T2</strong></td>
<td>0.86 (0.72-0.99)</td>
</tr>
<tr>
<td><strong>BG/W DWI</strong></td>
<td>0.93 (0.87-0.99)</td>
</tr>
<tr>
<td><strong>BG/W Final</strong></td>
<td>0.95 (0.90-0.99)</td>
</tr>
<tr>
<td><strong>NICHD T1</strong></td>
<td>0.78 (0.61-0.95)</td>
</tr>
<tr>
<td><strong>NICHD T2</strong></td>
<td>0.72 (0.55-0.89)</td>
</tr>
<tr>
<td><strong>NICHD DWI</strong></td>
<td>0.81 (0.66-0.95)</td>
</tr>
<tr>
<td><strong>NICHD Final</strong></td>
<td>0.71 (0.53-0.88)</td>
</tr>
</tbody>
</table>

Table 1. Weighted Cohen kappa results for BG/W and NICHD MRI scoring systems.
The Utility of Transcranial Doppler Head Ultrasound Resistive Indices in Asphyxiated Neonates Treated with Hypothermia for Understanding Early Childhood Outcomes

T Bosemani\(^1\), A Poretti\(^2\), G Gerner\(^3\), V Burton\(^3\), E Cristofalo\(^4\), F Northington\(^1\), M Johnston\(^3\), T Huisman\(^1\)

\(^1\)The Johns Hopkins University School of Medicine, Baltimore, MD, \(^2\)Johns Hopkins University School of Medicine, Baltimore, MD, \(^3\)Kennedy Krieger Institute, Baltimore, MD, \(^4\)Johns Hopkins School of Medicine, Baltimore, MD

Purpose
Perinatal hypoxic-ischemic encephalopathy (HIE) is associated with long term neurologic morbidity. Therapeutic hypothermia (TH) was shown to reduce mortality and morbidity in perinatal HIE. Transcranial Doppler ultrasound with measurement of resistive indices (RI) is an inexpensive, noninvasive, bedside imaging modality that can measure cerebral perfusion. We aimed to determine the role of RI as a biomarker of outcome in neonates with HIE before and after TH.

Materials and Methods
Resistive indices were obtained for 15 males and 13 female neonates (mean gestational age 38.31 weeks) before TH and immediately following the rewarming phase of TH. Prior to obtaining postcooling HUS including RI, six neonates died. Neurodevelopmental assessment was conducted for a subset of all surviving children between 20 and 32 months using the Mullen Scales of Early Learning (n = 20) and the Gross Motor Function Measure (n = 18). Overall outcomes were categorized as death/severe disability, moderate/mild disability, and no disability and RI values were categorized by range (Low RI < .60, Moderate .60-.79, High >.79).

Results
Neonates with RI values < .60 before and after TH were most likely to have an outcome of death or severe disability. Children with either moderate/mild or no developmental disability were more likely to have neonatal RI values between .60 and .79 before and after cooling. There was a significant association between gross motor outcome and RI values after TH, but no association between overall cognitive development and RI values before or after TH.

Conclusions
Resistive indices values may be a useful early prognostic marker for neonates who are at high risk for mortality or later severe disability following perinatal HIE and TH. Additionally, it may provide useful prognostic information regarding gross motor outcome in early childhood. Further investigation of this preliminary work is warranted with a larger sample.

Apparent Diffusion Coefficient Z-score Maps Compared to Normative Atlas in Neonatal Hypoxic Ischemic Encephalopathy

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\(^1\)The Johns Hopkins University School of Medicine, Baltimore, MD, \(^2\)Johns Hopkins University School of Medicine, Baltimore, MD, \(^3\)Kennedy Krieger Institute, Baltimore, MD, \(^4\)Johns Hopkins School of Medicine, Baltimore, MD
Purpose
In neonates with hypoxic ischemic encephalopathy (HIE), construct Z-score overlays for ADC maps to quantify regional differences in ADC, compared to a normal ADC atlas.

Materials and Methods
IRB approval was obtained. We retrospectively identified 26 term neonates (16 male, 10 female) with moderate and severe HIE (Sarnat 2 and 3). Subjects were imaged in their first week of life (mean: 2 days). For each, we generated a standard (Z-score) map by coregistering and comparing each individual's ADC map to a normal control ADC atlas constructed by averaging geometry and intensity of 18 normative ADC maps (age: 0-7 days). MR imaging reports of HIE subjects were reviewed and regions of interest (ROIs) placed on ADC maps at sites where decreased diffusion was described. Voxelwise SD values (relative to the atlas) were calculated and overlaid on the HIE ADC/DWI images, with threshold adjusted to demonstrate pixels with SD values below -1. A radiologist reviewed the DWI/ADC images with overlay of the Z-score maps (Figure 1).

Results
Decreased diffusion was described in MRI reports of nine subjects (35%). Areas involved included lobar gray-white (GW) matter (n=6), deep gray nuclei (DGN)(n=7), cerebellum (n=2), brainstem (n=1), and deep white matter (WM) (n=1). The mean SD difference from the atlas in these areas was –0.91 SD, with measurements as low as -5.1 SD. Image review using DWI/ADC with overlay of Z-score maps demonstrated decreased diffusion in nine subjects. Areas involved include lobar GW matter (n=6), DGN (n=5), cerebellum (n=4), brain stem (n=2), deep WM (n=1). Seven of these nine subjects also had abnormalities on MRI report. In two cases, ADC/Z-score demonstrated regions of decreased diffusion in subjects without reported abnormalities in clinical reports. Two subjects with abnormalities in clinical reports did not have ADC/Z-score differences. In these two subjects, the ROI based SD (at sites described in the report) were -0.35 and -0.38, respectively.

Conclusions
Qualitative assessment of DWI/ADC images identifies regions with inconsistent ADC differences compared to normal, in routine clinical practice. Quantitative tools, such as Z-score maps derived from a normal ADC atlas could facilitate consistent identification of diffusion abnormalities.
DTI changes within the posterior centrum semiovale in acute neonatal hypoxic-ischemic injury after hypothermia therapy
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¹Johns Hopkins University School of Medicine, Baltimore, MD, ²Kennedy Krieger Institute, Baltimore, MD, ³The Johns Hopkins University School of Medicine, Baltimore, MD, ⁴Johns Hopkins School of Medicine, Baltimore, MD

Purpose
Thalamic and basal ganglia lesions have been shown as the neuroimaging pattern of acute neonatal hypoxic-ischemic injury (HII) before the introduction of hypothermia therapy. In our clinical routine, T2-hyperintense signal of the cerebral white matter is common in neonates with HII after hypothermia therapy. In this population, recent DTI studies showed white matter injury. Here we aimed to 1) explore potential DTI patterns of acute HII after hypothermia therapy and 2) correlate DTI changes with conventional MRI findings and neurodevelopmental outcome.

Materials and Methods
A region of interest-based DTI analysis was performed and FA, MD, AD, and RD values were calculated in the anterior and posterior centrum semiovale (PCSO), posterior limb of the internal capsule, basal ganglia, thalami, pons, and middle cerebellar peduncles. The T2-signal intensity of the cerebral white matter was qualitatively assessed as normal or increased in a diffuse or periventricular pattern. Neurodevelopmental assessment was performed with Mullen Scales of Early Learning between 20 and 32 months.

Results
We included 32 neonates (mean gestational age 38.9 weeks) with HII and hypothermia therapy and 10 full-term control newborns. In patients, we found significantly lower FA and higher MD and RD values in the PCSO compared to controls. The findings were predictive of T2-hyperintense signal of the periventricular white matter. In a subset of patients (n=13), a positive trend was found for FA in the PCSO and visual perceptual abilities (p=.075).

Conclusions
Hypothermia therapy seems to mitigate the classic neuroimaging pattern in acute neonatal HII. Our study suggests that injury of the cerebral white matter may be an important neuroimaging pattern of HII after hypothermia therapy. Decreased FA and increased MD and RD values support involvement of the myelin sheets as the potential microstructural background. Quantitative DTI analysis within the PCSO might predict visual perceptual abilities at 2 years.

Wednesday
8:30AM - 10:06AM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

15E - PARALLEL SCIENTIFIC PAPER SESSION-VASCULAR IMAGING TECHNIQUES

O-308
The value of arterial transit artifact with arterial spin labeling MRI in patients with internal carotid artery stenosis

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¹Seoul Veterans Hospital, Seoul, Korea, Republic of
Purpose
For clinical imaging, detection of the collaterals is very important in internal carotid artery (ICA) stenosis. Arterial transit artifact (ATA) with arterial spin labeling (ASL) imaging is a region compatible with collateral flow, showing multiple serpiginous high intensity structures. We evaluate the clinical value of ATA with ASL in ICA stenosis.

Materials and Methods
Seventeen patients with ICA stenosis (>70%) and normal 14 controls were enrolled in this study. Including pulsed ASL, magnetic resonance imaging (MRI) were acquired on a 3T system. Internal carotid artery stenosis was confirmed by computed tomography (CT) angiography. Images were interpreted for the presence of ATA. Of the 17 ICA stenosis patients, 11 underwent acetazolamide-stress single photon emission computed tomography (SPECT). The 11 patients were grouped as having reduced vascular reserve or normal vascular reserve from the SPECT results. Analysis of correlation of the ATA and reduced vascular reserve was performed.

Results
In seven of 17 of the ICA stenosis patients and 0/14 of the normal controls, ASL showed ATA in ipsilateral to the stenosis. Statistically significant rate of the presence of the ATA is noted in the ICA stenosis patients, compared with normal control subjects (chi-square test, p=0.02) (Tables 1, 2). In six of seven of the normal vascular reserve group and none of four of the reduced vascular reserve group from the SPECT results, ASL showed ATA in ipsilateral to the stenosis (Figures 1, 2). There is a statistically significant positive correlation noted between normal vascular reserve group and ICA stenosis patients with ATA (chi-square test, p=0.03)(Tables 3, 4).

Conclusions
Our results suggests that the ATA with ASL imaging as a noninvasive and no contrast demanding technique, can depict slow flow in excellent collateral vessels and has clinical utility in detecting reduced vascular reserve in patients with internal carotid artery stenosis.
### Table 1. Demographic characteristics of the ASL study population.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Normal control subjects (n=14)</th>
<th>ICA stenosis patients (&gt;70%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male / Female</td>
<td>11 / 3</td>
<td>17 / 0</td>
</tr>
<tr>
<td>Age (y)*</td>
<td>70.7 ± 7.7</td>
<td>71.5 ± 9.0</td>
</tr>
</tbody>
</table>

*Data are means ± standard deviations.

### Table 2. Results of the presence of arterial transit artifact (ATA) with ASL.

<table>
<thead>
<tr>
<th></th>
<th>No ATA</th>
<th>Presence of ATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal control subjects</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>ICA stenosis patients (&gt;70%)</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>7</td>
</tr>
</tbody>
</table>

Chi-square test (chi-square test, p=0.02)

### Table 3. Demographic characteristics of the SPECT study population.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>ICA stenosis patients with SPECT study (&gt;70%, n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male / Female</td>
<td>11 / 0</td>
</tr>
<tr>
<td>Age (y)*</td>
<td>69.8 ± 8.9</td>
</tr>
</tbody>
</table>

*Data are means ± standard deviations.

### Table 4. Results of the analysis of correlation of the ATA and reduced vascular reserve.

<table>
<thead>
<tr>
<th></th>
<th>Normal vascular reserve</th>
<th>Reduced vascular reserve</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ATA</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Presence of ATA</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>4</td>
</tr>
</tbody>
</table>

Chi-square test (chi-square test, p=0.03)

(Filename: TCT_O-308_4.jpg)
Figure 1. 70-year-old male, severe stenosis of the right proximal cervical ICA. A) 95% stenosis of cervical ICA is seen on the curved linear CT carotid angiography (arrow). B) Multiple serpiginous structures are seen in the right frontotemporal area on ASL (arrows). C) Basal resting SPECT image shows no change in the right frontotemporal area. D) Acetazolamide stress SPECT image shows no change in the right frontotemporal area.
Three Dimensional Stereotactic Surface Projection Rendering of Arterial Spin Labeling Data in a Clinical Population

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Purpose
Arterial spin labeling (ASL) provides robust, quantitative cerebral blood flow (CBF) measurement across a wide range of pathologies (1). While ASL can assess an individual's cerebrovascular status, visual inspection and/or region-of-interest analyses often are challenging to interpret, and a statistical brain mapping technique using a reference normative database from a disease-free control population is of potential benefit in the evaluation of intrasubject CBF changes. We investigated the diagnostic applicability and performance of three-dimensional stereotactic surface projections (3D-SSP) (2), as applied to ASL in clinical MR examinations.

Materials and Methods
A retrospective cohort of 10 consecutive patients who underwent ASL as part of a routine clinical MR exam on a 3T system was collected. Five additional subjects with normal cerebral perfusion served as a control group. All images were acquired with a pseudocontinuous ASL preparation, with voxelwise CBF quantification calculated, per subject, from parameter-matched M0 maps (1). Stereotactic anatomical standardization was performed by methods described previously (2, 3). 3D-SSP extracted maps were generated for the control group, and subsequently for subjects, from individual raw CBF data sets. A normal database was created from averaging the extracted CBF datasets of the control group. Subject 3D-SSP Z-score maps then were generated relative to the control group. Two fellowship-trained neuroradiologists, blinded to technique and all clinical information, evaluated the M0-corrected CBF maps and 3D-SSP maps, presented in random order, using the following metrics and a 3-point scale: 1) Image quality; 2) Ease of identifying abnormalities; 3) Location of abnormalities; 4) Confidence in not missing additional findings; and 5) Confidence in identifying the exact location of hypoperfusion. Metrics were compared using the Wilcoxon signed-rank test.

Results
Patterns and severities of reduced CBF were identified in tumor resection cavities, follow-up stroke regions, and in patients with notable regional hypoperfusion, seen in the standard 3D-SSP maps (four standard deviations, red color, Figure 1). Reader assessment demonstrated that image quality, ease of identifying abnormalities, and confidence in identifying the exact location of hypoperfusion were all significantly higher for the 3D-SSP maps (p = 0.026, 0.031, and 0.013, respectively). Expert neuroradiologist reader assessment demonstrated that 3D-SSP images were preferred, in general, over the traditionally displayed CBF maps and that 3D-SSP maps were never found to be inferior to the M0-corrected CBF maps, across all assessed imaging metrics.

Conclusions
Three dimensional-SSP statistical mapping is feasible in a clinical population and enables quantitative data extraction and reliable localization of perfusion abnormalities by means of stereotactic coordinates in a condensed display. This method can be applied easily to a variety of clinical populations for improved diagnostic confidence, and is a promising approach for interpreting ASL MR-derived cerebrovascular pathology.
M0-corrected CBF maps

Quantitative statistical Z-score maps
Effect of Slice Position on Quantitative CBF in Pulsed Arterial Spin Labeling

S Rajan¹, D Soltysik¹, D Thomasson², N Biassou³
¹FDA/CDRH/OSDL, Silver Spring, MD, ²NIH/NIAID, Frederick, MD, ³NIH, Bethesda, MD

Purpose
Arterial spin labeling (ASL) MRI permits quantitative perfusion evaluation. Although qualitative ASL protocols are used widely, clinical use of quantitative ASL is still hampered by the complexity of pulse sequence implementation and image processing, contributing to variability. A systematic comparison of results across the whole imaged volume has not been described using commercially available pulsed-ASL (PASL) protocol (1). The purpose of this study was to assess the variation of quantitative cerebral blood flow (qCBF) across imaged slices using PASL, to validate the technique for clinical translation.

Materials and Methods
Commercial PICORE Q2T PASL protocols with 2D-EPI were tested on two 3T scanners. Two healthy male subjects (age: 58) were scanned several times (TI1/TI2/TR/TE/FA: 675/1800/2700/13 ms/ 90°, voxel size: 3.3 x 3.3 x 5 mm³, NSA = 60). Motion corrected ASL images from the system were processed off-line. MPRAGE images were used to generate gray matter (GM) and white matter (WM) maps. The segmented maps were used to generate histograms of qCBF in GM/WM, corrected for relaxation effects, using MATLAB. The mean qCBF ± SD for each slice was plotted against the slice position. One subject was imaged with different order of slice acquisition.

Results
We found a decreasing trend of qCBF value with increasing slice distance from tag slab, for GM and WM, even after corrections for relaxation effects due to acquisition time delays (Figure 1). For example: The qCBF values decreased from a mean of 43±14/27±11 ml/gm/min (GM/WM) for the first slice to 29±10/17±9 for the twelfth slice. The qCBF drop-off with slice position was observed in all 10 scans. Ascending slice order yielded higher mean values compared to other slice orders. Table 1 shows a comparison of qCBF values for five central slices in one subject for different slice acquisition order. Moving the tag slab closer to the imaged slices increased the qCBF.

Conclusions
Our preliminary findings suggest qCBF is dependent upon slice position and acquisition order independent of relaxation effects, and should be considered when performing quantitative clinical interpretation of ASL data. Further research is needed to identify the source of this effect and to compare these findings with other ASL acquisition techniques as they become commercially available.
Measurement of Cerebral Blood Flow and Oxygenation Changes in Moyamoya Disease During Acetazolamide Challenge

W Ni¹, T Christen¹, Z Zun¹, M Moseley¹, G Zaharchuk¹
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Purpose
Prior work has demonstrated abnormal BOLD signal changes in cerebrovascular disease patients during gas challenges, suggesting poor reserve (1). Another method that identifies compromised autoregulation is the acetazolamide (ACZ) challenge (2). To fully understand these BOLD changes, we have measured both cerebral blood flow (CBF) and the relaxation parameter R2' (3), related to tissue oxygenation, in moyamoya patients.

Materials and Methods
Five patients (29-52 years old) with moyamoya disease (4 bilateral) were scanned at 3T pre- and post-ACZ with 2D multiecho GESFIDE (3) (TR/TESE/TE: 2000/100/5-130 ms, 40 echoes) and 3D multidelay pseudocontinuous ASL (pcASL) (4) (label time/post-label delay: 2/0.7-3 s, 5 delays). We fitted exponentials to GESFIDE data to calculate R2', and processed pcASL data to produce CBF maps in gray matter (GM), white matter (WM), and mixed-cortical ROIs representing the bilateral anterior and posterior circulations.

Results
Cerebral blood flow changes for all patients were consistent with disease extent (Figure): one subject demonstrated steal, one showed negligible change due to severe bilateral and posterior disease, and three had normal augmentation (GM ΔCBF=56±15%). Pre-ACZ whole-brain R2' was linearly correlated with CBF0.38 (p=0.03), consistent with the quantitative BOLD (qBOLD) (3) and Grubb models (5). However, post-ACZ R2' was not (p=0.68), possibly representing exhausted reserve. While CBF changes varied, we observed consistent R2' reduction for total GM (ΔR2'=-0.9±0.5 s-1 or -16±7%; p<0.05), suggesting elevated oxygenation following ACZ.

Conclusions
Cerebral blood flow and R2' mapping during ACZ challenge demonstrated overall GM R2' reduction as well as correlation between baseline R2' and CBF. Ongoing work focuses on focal
abnormalities related to specific vascular territories affected by moyamoya disease. These approaches are promising to study autoregulation in cerebrovascular diseases.
O-312

Measuring Venous Blood Oxygenation using Quantitative Susceptibility Mapping: A Study using Acetazolamide Challenge in Patients with Chronic Stenosis of Major Arteries

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1Emory University, Atlanta, GA

Purpose
Oxygenation extraction fraction (OEF) is an important measure of tissue metabolism (1). Its measurement at resting state as well as under pharmaceutical stress can predict tissue viability during stroke, and provide prognostic information for patients with chronic cerebrovascular diseases (2). Due to the paramagnetic property of deoxygenated hemoglobin, its concentration in larger veins is proportional to its magnetic susceptibility value that can be measured using quantitative susceptibility mapping (QSM) (3). In this study, we studied the feasibility of using QSM to measure the venous blood oxygenation level at baseline as well as under Acetazolamide (Diamox) challenge in a group of patients with chronic stenosis/occlusion of major feeding arteries of the brain.

Materials and Methods
Eleven patients (mean ± SD age = 50.1 ± 14.6 years; 7 females) with chronic stenosis of their internal carotid and/or middle cerebral arteries were included and scanned with a 3T MR imager. Before Diamox injection, a 3D flow-compensated multiecho gradient echo sequence was acquired for QSM with the following parameters (TR = 45ms, 6 echoes, first TE = 6.1ms, echo spacing = 5.7ms, flip angle = 12, FOV= 256 x 256mm, matrix = 256 x 256, slice thickness = 2mm, 80 slices, GRAPPA factor = 2). One gram of Diamox then was slowly infused over a period of about 3 minutes while patients were lying still in the scanner. The 3D GRE sequence then was repeated approximately 16 minutes after the completion of Diamox infusion, when the cerebrovascular response approaches plateau. Quantitative susceptibility mapping processing is performed using a software package developed in-house (4). The phase image from each echo was first unwrapped using a Laplacian method followed by spherical mean filtering to remove the background field. The filtered field maps from each echo then were averaged, and an L1-norm optimization based method was used to reconstruct susceptibility map from the mean field map. A ROI then was placed in the straight sinus in the mean susceptibility images, and mean susceptibility values then were measured.

Results
Since deoxygenated blood has high susceptibility value, veins show as high signal intensity on QSM images (Figure 1). Mean (SD) susceptibility value of the straight sinus among all the subjects was 0.16 (0.05) ppm and 0.13 (0.03) ppm before and after Diamox injection respectively. Among the 11 patients, eight of them have reduced susceptibility value in straight sinus after Diamox injection, suggesting reduced oxygenation extraction fraction. This is consistent with increased cerebral blood flow due to Diamox challenge under constant cerebral metabolic rate of oxygen.

Conclusions
Veins show as high signal intensity in QSM images due to paramagnetism of deoxygenated
hemoglobin in venous blood. Diamox challenge, which increases the cerebral blood flow, decreases the oxygen extraction fraction. Quantitative susceptibility mapping with Diamox challenge is feasible and may provide valuable information in patients with chronic stenosis of major arteries.

Fig 1. Veins with deoxygenated blood have high susceptibility values on MIP (maximum intensity projection) image of QSM. (Filename: TCT_O-312_OEFfigure1.jpg)

O-313

Measurement in the Angiography Suite: Evaluation of Vessel Sizing Techniques

P Yang1, S Schafer2, K Royalty3, A Ahmed4, D Niemann5, C Strother4
1University of Wisconsin-Madison, Madison, WI, 2Siemens Medical Solutions, Hoffmann Estates, IL, 3Siemens Medical Solutions, USA, Hoffman Estates, IL, 4University of Wisconsin, Madison, WI, 5University of Wisconsin, Madison, WI

Purpose
With increasing usage of intracranial stents and flow diverting devices, the need for accurate vessel size measurements has become important. Modern angiographic equipment offers a variety of 2D and 3D measurement methods that have not been systematically evaluated for accuracy or precision. Our study evaluates these 2D and 3D methods using anthropomorphic vessel phantoms.

Materials and Methods
Tubing of known sizes (2-5mm, 1mm increments) was embedded in 3D printed skulls to simulate the MCA, ICA and BA. Each phantom was placed in a water bath and imaged using a clinical C-Arm system. 3D DSA and 2D DSA images were acquired with 50% contrast agent, CBCT with 10% contrast. The 3D images were used to determine the working projections for 2D imaging. Edge enhancement and normal (3D DSA) and sharp (CBCT) kernels were used in the volumetric reconstruction. Three identical measurement locations were identified on each simulated vessel in the 2D and 3D images. 2D calibrations were made using automatic and manual (catheter based) methods. Vessel sizes were obtained using manual line drawing and automated measurement for 2D and 3D images; 3D measurements also were performed using an
overlay grid. Evaluations were performed by three experienced users resulting in 27 samples for each method.

Results
All methods displayed similar accuracy in determining the vessel size (<10% difference to vessel diameter). Automatic measurements on 3D DSA data supplied the most accurate and precise sizing results. Data variations across users increased for larger vessel sizes in 2D measurements. Manual sizing on CBCT suffered in small vessel sizes due to difficulty in determining vessel boundary.

Conclusions
All methods displayed similar accuracy in determining the vessel size (<10% difference to vessel diameter). Automatic measurements on 3D DSA data supplied the most accurate and precise sizing results. Data variations across users increased for larger vessel sizes in 2D measurements. Manual sizing on CBCT suffered in small vessel sizes due to difficulty in determining vessel boundary.
(a) Phantom image acquisition of B-mode ultrasound measurement indicated for resective lesions. (c) 3D DSA with CBCT overlaid. (d) Cross-sectional reformatted to CECT. Light grey boxes indicating 2D measurements (AC/MC: Automatic Calibration, AM: Automatic Measurement) background indicating 2D measurements (G), Manual Linear Measurement, Automatic Measurement and Manual Linear Measurement CBCT (H)]. Most precise result for each size is bolded.
Automatic Flow Analysis of Digital Subtraction Angiography by Independent Component Analysis

C Lin¹, Y Kao¹, C Chang², L Chiang³, M Teng⁴
¹National Yang Ming University, Taipei, Taiwan, Province of China, ²National Yang Ming University, Taipei, Taiwan, Province of China, ³Taipei Veterans General hospital, Taipei, Taipei, ⁴Cheng Hsin Hospital, Taipei, Taiwan, Province of China

Purpose
Cerebral circulation time (CCT) is defined as the difference in time to peak (TTP) between the parietal vein and cavernous independent component analysis (ICA) in digital subtraction angiography (DSA). It correlates with decreased velocity of intravascular blood flow in stenotic patients. However, manual selection of regions of interest (ROIs) is necessary to obtain CCT and this renders measurements susceptible to intraobserver and interobserver variation. The purpose of our study was to evaluate a potentially more accurate way of defining blood flow by using automatic independent component analysis.

Materials and Methods
Thirty-one patients with unilateral carotid stenosis greater than 70% by NASCET criteria were included retrospectively. Fixed contrast injection protocols and DSA acquisition parameters were used in all patients before and after stenting. Both AP and lateral views of DSA were processed by ICA after motion correction and de-noising. Three individual time density curves (TDCs) subsequently were generated: ICA1, representing the arterial phase; ICA2, representing the capillary phase; and ICA3, representing the venous phase. From each TDC, six parameters [area under curve (AUC), TTP, width, arrival time (AT), wash-in (WI), and wash-out (WO)] were generated and compared before and after stenting.

Results
The AUC (before stenting: 912.06±430.84; after stenting: 749.51±319.89), TTP (before: 2.74±0.96; after: 2.21±0.80), Width (before: 3.22±2.58; after: 2.38±1.47) and WO (before: -161.70±52.51; after: -205.64±52.35) were decreased significantly after stenting in ICA1 in both views. Area under curve (before: 1016.84±400.43; after: 936.03±246.73), TTP (before: 5.32±1.13; after: 4.58±0.76), Width (before: 6.93±1.69; after: 6.09±1.30) also were decreased significantly after stenting in ICA2 in both views. None of the parameters demonstrated significant improvement in ICA3.

Conclusions
ICA of TDC in DSA provides three components similar to arterial, capillary and venous phases. This process is completely automatic and provides immediate quantitative peri-therapeutic flow change during stenting.
Internal Carotid Artery Balloon Test Occlusion: Comparison of Angiographic Parameters to CBF by SPECT

G Christoforidis¹, D Kromrey¹, M Mayich²

¹University of Chicago, Chicago, IL, ²Miami Vascular Institute, Miami Florida
Purpose
Assessment for potential ischemic risk associated with internal carotid artery (ICA) sacrifice using various methods to assess cerebral perfusion during temporary balloon occlusion of the ICA. Tc99m-Exametazime Single Photon Emission Computed Tomography (HMPAO-SPECT) represents a commonly accepted method for this purpose but is time inefficient, whereas angiographic based methods are less accepted but time efficient. This study compares HMPAO-SPECT to angiographic parameters during balloon test occlusion (BTO).

Materials and Methods
Using an IRB approved protocol, aortic arch, selective internal carotid and vertebral artery arteriographic anteroposterior projections of the head obtained at six frames per seconds from 17 patients who underwent BTO with HMPAO-SPECT were analyzed on image J software (NIH). The mean hemispheric differences in contrast arrival time between four M5 branches of the middle cerebral artery ipsilateral to the occlusion and located in the watershed zone between the anterior and middle cerebral arteries and between the posterior and middle cerebral arteries (Figure 1). The interhemispheric difference in peak contrast density (PCD) within regions of interest (ROIs) in the watershed zones derived from aortic arteriograms were recorded. All patients underwent hypotensive challenge with a 20% drop in mean arterial pressure.

Results
Patients included 15 patients with neoplasm, and two with aneurysm with a mean age of 62 years (sd=16.3) of which 12 were male and eight underwent permanent sacrifice. Three patients who did not pass the test occlusion underwent carotid sacrifice. Measures of delay in contrast arrival time (AAT) between selective and aortic arch studies had a mean 0.12 (sd=0.52) second difference. Linear bivariate fit between interhemispheric differences in AAT and percent cerebral blood flow (CBF) on HMPAO SPECT resulted in an R-square of 0.68 (p<.0001). In eight patients with no interhemispheric CBF difference, AAT was under 0.5 seconds. Bivariate linear fit between peak contrast density difference and CBF on SPECT exam resulted in R-square of 0.25 (p<0.048).

Conclusions
Preliminary data indicate that during BTO, AAT derived from digital subtraction angiography images provides an ischemic risk assessment comparable to HMPAO-SPECT.
Figure legend: Interhemispheric difference in arterial arrival time calculated from time-density curves derived from the mean of branches in the watershed zones as shown. Peak contrast difference represents the difference between peak contrast density for each as shown.
Heart and Brain Connection: a one-stop quantitative peri-therapeutic study of cerebral parenchymal blood volume on aortic diseases using interventional C-arm CT

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Purpose
Aortic diseases impact both cardiac function and brain hemodynamics. Brain hemodynamics may change after aortic diseases being treated. Robust quantification of cerebral parenchymal blood volume (PBV) is crucial to determine therapeutic effects. The current study presents a method to evaluate the peri-therapeutic changes of PBV in patients with aortic diseases using interventional C-arm CT in one stop.

Materials and Methods
Fifteen patients (62, 49-86 years old, five type III aortic dissections and 10 aortic arch aneurysms) were recruited. Hybrid cervical de-branching of thoracic endovascular aortic repair procedure (TEVAR), combining cervical de-branching technique for aortic diseases, was performed on all patients in a hybrid operation suite equipped with robotic flat-detector interventional C-arm CT (Artis zeego®, Siemens Healthcare). Immediate pre- and post-TEVAR PBV measurements were obtained one-stop in the suite. Three transaxial slices covering anterior, middle and posterior cerebral arterial territories, were selected. On the slices, four aligned circular regions of interest (ROIs) located 8mm beneath the brain surface of each hemisphere (to avoid covering blood vessels) were placed. Whole brain/hemispheric measurements, and manual selection of regional circular ROIs also were used for comparative peritherapeutic analysis. Auto-segmentation for removal of skull and scalp components of these slices were applied and followed by calibrating histogram on whole brain, and hemispheres. 2 Way ANOVA, Chi-square tests and kurtosis were used.

Results
There are five (3/5 aortic dissection and 2/10 aneurysm) patients with global (whole brain/hemispheric) increase PBV after operation. The difference of peri-therapeutic PBV changes of the two groups may be mainly due to the presence of aortic dissection. For the rest of the 10 patients, their post-therapeutic PBV do not show global changes. Figure 1 shows histogram of one of the 10 patients calculated from whole brain. The difference between means of pre- and post-therapeutic histogram is 2.8 ml/1000ml. Figure 2 shows histogram of left and right hemisphere of the same patient; the differences between means of pre- and post-therapeutic histogram for left and right hemisphere are 2.4 and 3.2 ml/1000ml, respectively. On the contrary, regional PBV changes can be identified via local histogram analysis. Figure 3 shows the histogram computed from given ROI (as shown in Figure 4) of the same patient. The difference of mean PBV measurements between pre- and post-therapeutic distribution is 6.7ml/1000ml, larger than that of whole brain and hemispheric measurements. Figure 4 shows the corresponding images of Figure 3 with manual ROIs placement on PBV maps.
Conclusions

Brain PBV changes after aortic diseases being treated. Regional analysis provides insightful information of local/trivial PBV variations, which might be mollified in global analysis. This quantitative comparative approach may function both as indicator of therapeutic efficacy and locating changes that are not identified easily. It also may serve as a tool for using interventional C-arm CT to study brain hemodynamics in one stop.

Figure 1. Whole brain histogram

(Filename: TCT_O-316_figure_01_WholeBrainHistogram_UnitRevisedV2.jpg)
Figure 2. (A) Histogram of the left brain. (B) Histogram of the right brain.
Figure 3. ROI based histogram.

(Filename: TCT_O-316_figure_03_RegionalHistogram_UnitRevisedV2.jpg)
Topographic mapping of collateral Impact: effect of occlusion location and recanalization status

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Purpose
Few studies have demonstrated collateral topographical distribution differences stratified by vessel occlusion site and recanalization status. We sought to create probabilistic parametric maps of tissue infarction and salvage to study the topographic impact of collaterals in the presence and absence of recanalization.
Materials and Methods
Final infarcts (FI) of 349 patients with acute anterior circulation stroke were traced manually. Patients were dichotomized by recanalization (R-/R+), collateral (C-/C+) status. Vessel occlusion status was dichotomized to proximal (ICA) or distal (MCA). Voxel-wise probability maps were generated for each group by averaging the transformed FI masks. Relative sparing (RS) maps were constructed by voxel-wise subtraction of the probabilities of infarction (PI) for C-/+ groups for each vessel occlusion location. Voxel-wise Z-scores were calculated and only voxels reaching significance (Z ≥ 1.96) were maintained in the RS map.

Results
Mean age was 71 ± 14 years; 203 (58%) patients recanalized while 280 (80%) were C+. Highest FIV was observed in R- patients with ICA occlusion and inadequate collaterals (Median; IQR 324;140–454 cm3), while R+ patients presenting with M1 or distal occlusions and significant collaterals demonstrated the smallest FIV (Median; IQR 34;11–59 cm3). In all parameter-matched comparisons of patients with and without collaterals, there was significant reduction in FIV associated with C+ status (p < 0.023, Table 2). Weaker significance of proximal ICA comparisons likely relates to the smaller group comparison nevertheless significance was maintained. Total RS volume attributable to C+ status was larger (145.3 versus 47.9 cm3). RS for R- ICA versus MCA subjects was lower (51% versus 64%; p<0.05). R+ patients demonstrated nonsignificant RS volumetric differences irrespective of occlusion location although regional sparing favored functionally significant structures. Deep structures such as the putamen, globus pallidus, insular ribbon and Heschl's gyrus had little probability of salvage in the absence of recanalization but the cingulate, superior and middle frontal gyri and thalamus demonstrated a higher probability of salvage where collaterals were present. Similarly collaterals in the presence of recanalization had little effect upon putamen and globus pallidus infarction but reduced the probability of insular, Heschl's gyrus, perirolandic, frontal and thalamic infarcts.

Conclusions
We demonstrate the topographic distribution of collateral circulation recruitment and quantify its impact on final infarct determination and probability of tissue sparing.

O-318
9:50AM - 9:58AM

Evaluation of Blood Brain Barrier Permeability in Early Brain Injury in Aneurysmal Subarachnoid Hemorrhage Patients: Correlation with Clinical Outcomes.

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Purpose
Aneurysmal subarachnoid hemorrhage (SAH) is a devastating condition with high morbidity and mortality. Global cerebral edema (GCE), a main complication of SAH contributing to poor outcomes, is thought to be related to early brain injury from transient microcirculatory dysregulation, neuroinflammation and elevated neurotoxicity. Diagnosis of GCE remains challenging and currently relies on clinical examination and noncontrast CT. CT perfusion (CTP)
with extended pass technique allows measurement of blood-brain barrier permeability (BBBP). Multiple parameters representing BBBP have been described, including PS (permeability surface area product), VE [volume in the extravascular extracellular space (EES)], KEP [flow rate between the EES and the intravascular space (IVS)], and Ktrans (volume transfer constant from the blood plasma to the EES). However, there is limited understanding regarding the utility of these measures of BBBP in this clinical setting. We assessed whether BBBP parameters correlate with poor clinical outcomes in SAH patients.

Materials and Methods

IRB approval was obtained. A retrospective analysis was performed on 22 consecutive prospectively enrolled patients at our institution who underwent extended CTP on days 0-3 after aneurysmal rupture. CT perfusion scanning was performed using axial shuttle mode technique. Extended CTP data were postprocessed into BBBP quantitative maps of PS, VE, KEP and Ktrans using Olea Sphere software (Olea Medical, France). Clinical outcomes data on permanent neurologic deficit and modified Rankin scores (mRS) were collected at discharge. Univariate and multivariate analyses utilizing unpaired t tests and receiver operating characteristic (ROC) analysis were performed to determine statistical significance.

Results

The 22 patients were stratified based on their clinical outcomes as: 1). Permanent neurologic deficit (n = 9) and No permanent neurologic deficit (n = 13); and 2). mRS 3-6 (n = 5) and mRS 0-2 (n = 17). Clinical characteristics of the study population are shown in Table 1. PS and VE were increased in patients with poor outcomes (permanent neurologic deficit and mRS 3-6, respectively), while KEP and Ktrans were decreased (Figure 1). These results were statistically significant for all parameters. When the four parameters were combined in a multivariate ROC analysis, AUC was 0.80 for permanent neurologic deficit, and 0.89 for mRS 3-6 (Figure 2).

Conclusions

We found significantly elevated PS in SAH patients with poor outcomes indicating increased BBBP. Furthermore, patients with poor outcomes had significantly increased VE and decreased KEP suggesting persistent interstitial edema, which has been implied in the underlying mechanism of early brain injury. Ktrans was significantly decreased in patients with poor outcomes; however, Ktrans is less reliable in this patient population since it is flow-dependent. Blood-brain barrier permeability dysregulation after SAH has not been demonstrated previously in a clinical setting. Using BBBP parameters in a multivariate analysis allows differentiation of SAH patients with poor outcomes in order to prompt early treatment intervention.
Table 1. Clinical Characteristics of the Study Population. Patients were stratified by presence of a permanent deficit (poor outcome) versus absence of permanent deficit (favorable outcome), and mRS 3-6 (poor outcome) versus mRS 0-2 (favorable outcome). P-values were calculated using Chi-square test for frequency distributions and Student t-test for mean values.

Figure 1. BBBP Parameters in SAH Patients stratified by clinical outcomes. Patients were stratified as described in the legend for Table 1.

Figure 2. Univariate and Multivariate ROC Analysis of PS, VE, KEP and Ktrans in SAH Patients with Poor Clinical Outcomes compared to Patients with Favorable Clinical Outcomes.
Decade of Diffusion: Evolution of ADC Imaging of a Single Lesion and Lessons Learned

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Purpose
To review the diffusion and apparent diffusion coefficient (ADC) imaging of a single lesion over 10 years to evaluate the imaging techniques and compare image evaluation techniques.

Materials and Methods
A patient with a large plexiform neurofibroma within the left maxilla was imaged repeatedly over 10 years from 2005 to 2014 with contrasted MRI, including diffusion and ADC evaluation. The diffusion and ADC series were evaluated for lesion imaging characteristics, and imaging technique was reviewed to better understand the use of ADC imaging in the head and neck.

Results
Twenty-five MRI studies were performed over the 10-year period. All studies were done with diffusion and ADC evaluation on a Siemens 1.5T MRI scanner at a single institution. The b values used of images scanned in 2005 and 2006 were 0, 500, and 1000. The b values used for studies done from 2007 onward were 0 and 1000. The ADC values obtained ranged from both standard range small field of view images and free hand region of interest. The raw values were compared to internal standard calculations of the medulla on the same image. The ADC values of the lesion ranged from 143.57 to 173.34 (in the 2005 and 2006 studies prior to software upgrade, which changed the calculated ADC values), and 1200.10 to 1779.17 (for the 2007 studies onward). The ADC values of the internal standard ranged from 80.39 to 302.45, and 704.79 to 947.84, respectively over the same time periods.

Conclusions
Although the MRI diffusion and ADC techniques evolved and changed over this time period, the importance of an internal standard, such as the medulla is shown by this case. The evolution of imaging techniques and the calculated ADC values will change with a change in the tesla field strength of the magnet, the MRI vendor, and the b values used for the diffusion imaging. Apparent diffusion coefficient calculated values should be compared to an internal standard such as the medulla, and not evaluated in isolation, just as the ADC values should not be interpreted without evaluation of the accompanying cross-sectional images. This important series of images shows the stability of the ratio of ADC values over time when this internal standard is used.
Severity Of Blast Exposure Predicts White Matter Injury And Functional Outcomes In Combat Veterans

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Purpose
Blast-related mild traumatic brain injury (mTBI) is common among Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) veterans. Poor cognitive/psychosocial outcomes and white matter diffusion abnormalities have been identified in this population. However, few studies have attempted to characterize the relationship of these outcomes to the degree of blast exposure. In order to better understand the role of blast, we evaluated magnitude of blast exposure as a predictor of white matter diffusion abnormalities and psychosocial outcomes.

Materials and Methods
Twenty male OIF/OEF veterans exposed to blasts underwent a structured interview to characterize blast exposure, including the number, severity, and proximity of unique blast exposures, and time since last blast exposure. Twenty male relatives (mostly first-degree) served as controls. Concussion-related symptoms, behavior (depression, stress, anxiety, etc.) and cognition were assessed in all subjects. Linear regression was used to assess the relationship of blast exposure magnitude to symptomatic, behavioral and cognitive outcomes relative to controls. 3.0T diffusion tensor imaging (DTI) was performed using a 32-channel head coil. After registration to the JHU template, voxelwise linear regression of the veteran fractional anisotropy (FA) volumes (p<0.01; cluster size 100 mm3) was performed against blast exposure magnitude, controlling for age, education and control (i.e., estimated baseline) FA.

Results
Veterans reported more symptoms and demonstrated worse performance across all behavioral and cognitive assessments compared to their relatives. Blast exposure severity was a significant predictor of health status (p=0.037) and impulsiveness (p=0.03). Blast exposure severity was a significant predictor of low FA at multiple white matter locations, including anterior corona radiata, corpus callosum, and internal capsule.

Conclusions
We demonstrate that severity of blast exposure scales with white matter abnormalities and with functional outcomes in a continuous manner. These findings suggest that the magnitude of exposure, not simply the binary determination of prior exposure may explain the degree of brain abnormality and clinical dysfunction in veterans with blast-mTBI. The differential role of severity versus number of repeated blasts, the causal relationship between blast and outcomes as well as the mediating role of white matter changes should be pursued in longitudinal studies of warriors.

O-320

Longitudinal Assessment of Diffusion Tensor Imaging Metrics with Voxelwise Analysis in Patients with Traumatic Brain Injury
Purpose
Traumatic brain injury (TBI) is an important cause of severe disability, cognitive dysfunction and mortality worldwide (1). The main goal of this study is to longitudinally assess white matter (WM) microstructure with diffusion tensor imaging (DTI) in patients with moderate to severe traumatic brain injury (TBI). Correlations with clinical and cognitive parameters also will be held.

Materials and Methods
Twenty adults with moderate to severe TBI (Glasgow Coma Scale < 13) were evaluated with a 3.0T magnetic resonance imaging (MRI) in the acute (t1 < 3 months), subacute (6 < t2 < 9 months) and chronic stages (12 < t3 < 15 months) following trauma. Twenty age- and sex-matched healthy controls also were scanned. Diffusion tensor imaging was obtained in the axial plane with 32 directions and b-value of 1000 s/mm2. Imaging processing was performed using FMRIB software library (FSL) (2) to yield fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (AD) and radial diffusivity (RD). Voxelwise differences were assessed with tract-based spatial statistics (3) using general linear modeling and a randomized algorithm with 5000 permutations and threshold-free cluster enhancement (4). Clusters > 200 voxels with a significant familywise error corrected p-value < 0.05 were identified anatomically using the probabilistic JHU WM atlas (5). Patients also were evaluated with a prospective neuropsychological battery.

Results
In comparison to controls, patients exhibited one large cluster with lower FA values (p < 0.001) at all stages (t1, t2, t3), but the number of affected voxels decreased over time by 2% at t2 and 7.2% at t3. Patients also exhibited significant increases in MD, RD and AD in extensive areas of the brain, except for the corpus callosum, that showed increased AD at t1. In comparison to t1, patients at t3 exhibited significant increases of FA in the anterior thalamic radiations, forceps major and minor, corticospinal tracts, cingulum, uncinate, inferior fronto-occipital, superior and inferior longitudinal fasciculi (Table 1). Patients' performances on cognitive measures were suboptimal in all stages, but also improved over time.

Conclusions
Diffusion tensor imaging provides valuable insights about the progression of WM microstructural changes in TBI. Abnormalities of DTI metrics in TBI patients may be explained by a combination of myelin disruption and axonal degradation. Our results suggest that WM damage in TBI patients are not stationary and may reverse to some extent, likewise partial cognitive improvement.
The Relationship Between Gray Matter and White Matter Abnormalities in Acute Mild Traumatic Brain Injury: A Diffusion Kurtosis MRI Study

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Purpose
Mild traumatic brain injury (mTBI) is a growing public health problem, which represents more than 80% of all TBI (1). It is known that both gray matter (GM) and white matter (WM) abnormalities can occur in mTBI and contribute to long term behavioral and cognitive symptoms (2-3). However, it still remains unclear whether indirect abnormalities related to WM drive GM atrophy. Here, we investigate the relationship between GM atrophy and WM abnormalities, particularly in the precuneus and the splenium of the corpus callosum (sCC), in terms of compartment specific WM tract integrity (WMTI) metrics derived from diffusion kurtosis imaging (DKI) (4).

Table 1 – Clusters with group differences⁴ of FA values in moderate-to-severe between the chronic (t₃) and acute (t₁) stages, p-values of the peak of the coordinates

<table>
<thead>
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<th>Cluster</th>
<th>Size (mm³)</th>
<th>p-value FWE⁴</th>
<th>X (mm)</th>
<th>Y (mm)</th>
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<td>1</td>
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<td>0.016</td>
<td>-32</td>
<td>-6</td>
</tr>
<tr>
<td>2</td>
<td>3582</td>
<td>0.013</td>
<td>30</td>
<td>-5</td>
</tr>
</tbody>
</table>

Note: ⁴Paired t-test with contrast t₃> t₁, ⁵MNI = Montreal Neurological Institut = familywise error corrected.
Materials and Methods
Seven patients (mean age 34±11) with mTBI within 2 weeks of injury and seven age and sex-matched normal controls (NC) (mean age 31±9 years) were scanned on a 3T MR scanner (Skyra, Siemens). A 3D magnetization prepared rapid gradient echo (MP-RAGE) acquisition (TR/TE/TI=2100/3.19/900ms,FA=8°, image resolution=1×1×1mm^3) was performed to obtain structural images. Diffusion kurtosis imaging acquisition was performed with 6 b-values (0,0.25,1,1.5,2,2.5 ms/µm^2) along with 3,6,20,20,30,60 diffusion encoding directions. Localized gray matter atrophy was identified with FSL-VBM, and both diffusion and kurtosis parametric maps of mean, axial and radial diffusion coefficients (MD, D∥ and D⊥), fractional anisotropy (FA), and mean, axial and radial kurtosis (MK, K∥ and K⊥) were calculated in this region of interest (ROI) for GM which has significant atrophy within precuneus. Region of interest analysis of 27 WM regions were performed after we nonlinearly registered the individual FA maps to the FA template on the basis of the JHU WM label atlas using FSL. In addition to the diffusion and kurtosis parametric maps, WM tract integrity of Daxon, D∥, D⊥ and AWF also was derived within the regions of FA≥0.4 to restrict analysis to WM regions consisting of single-fiber orientations (4). Spearman's rank correlation coefficients were computed to assess the relationship between GM (e.g., precuneus) and WM (e.g., splenium) abnormalities.

Results
Figure 1(a) shows the GM ROI which has significant volume decreases (atrophy) within precuneus regions in the mTBI group from FSL-VBM analysis (P<0.05). Figure 1(b) shows representative maps of Daxon indicating decreased Daxon in sCC. High correlations were found between FA in precuneus and FA, MD, D⊥, MK, K⊥, Daxon, D⊥, AWF in sCC (rho = 0.736, -0.569, -0.741,0.534,0.609,0.622,-0.640,0.604, respectively; p<0.05 for all). In the GM ROI, only FA is highly correlated with WM parametric maps in sCC.

Conclusions
In this study, we demonstrate high correlations between precuneus and sCC regions in terms of using both diffusion and kurtosis maps, as well as WMTI metrics, suggesting indirect abnormalities related to WM possibly drive GM abnormalities (e.g., atrophy). Detecting and understanding both GM and WM abnormalities after mTBI is critical for further investigating the mechanisms that underlie tissue damage and recovery. Longitudinal follow up may provide insight in the different acute and chronic processes altering GM and WM after mTBI.
Figure 1.

(a) GM FSL-VBM analysis
(b) WM Daxon

Figure 2.
Diffusion magnetic resonance imaging and anatomically-constrained tractography for detecting injuries associated with poor outcome after severe traumatic brain injury

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Purpose
To quantify injury to 18 white-matter pathways in patients with severe traumatic brain injury (TBI), and to assess which pathways are most important in determining patients' outcome.

Materials and Methods
We processed T1-weighted (T1W) and diffusion MRI (dMRI) images of 35 patients affected by severe TBI and 30 controls. Using Glasgow Outcome Scale-Extended (GOSE) evaluated 12 months after TBI, we categorized patients into good (GOSE >5) and poor (GOSE <4) outcome groups. We used FreeSurfer (1) to process T1W images for segmentation of brain substructures. Then we used tracts constrained by underlying anatomy (TRACULA) (2) to reconstruct 18 white matter pathways in each subject. Tracks constrained by underlying anatomy reconstructs each pathway by following the diffusion orientations extracted from dMRI, but it constrains the anatomical location of the pathway using segmented brain structures extracted in the previous step. Then we registered the extracted pathways of all subjects in the MNI common space, and compared the fractional anisotropy (FA) values of the patients and the controls along each pathway. The points along each pathway with an FA value of more than 2SD away from the controls' mean FA were marked as injured (Figure 1). The percent of injury to each pathway then was computed and compared between patients with good and poor outcome.

Results
Twelve patients had good outcome, and 23 patients had poor outcome. The percent of injury in six white-matter pathways was significantly different (P <0.05) between patients with good and poor outcome: forceps major and forceps minor of corpus callosum, left and right corticospinal tracts, and left and right inferior longitudinal fasciculi.

Conclusions
Traumatic injury to six white matter pathways, listed above, was associated with poor patient's outcome 12 months after TBI.
Figure 1. Steps of marking injured points along forceps major of corpus callosum. First, the Fractional anisotropy (FA) values along the pathway are extracted in each subject. After registering all subjects in the MNI common space, the distribution of FA values in controls is used to define a "normal envelop" for FA values. Then in each patient, the points along the tract with FA values outside this normal envelope are marked as injured.
Quantitative diffusion tensor imaging for prediction of long-term disability in survivors of severe traumatic brain injury

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Purpose
To evaluate the prognostic value of acute-phase diffusion tensor imaging (DTI) for predicting long term disability in survivors of severe traumatic brain injury (TBI).

Materials and Methods
This prospective study was approved by Institutional Review Board and included 15 long term survivors from a cohort of severe TBI patients. Diffusion tensor imaging images, acquired in the acute phase after TBI, were analyzed to calculate diffusion parameters in 20 predefined white matter (WM) regions of interest (ROIs). These parameters were normalized using DTI data from 50 healthy controls. All long term survivors underwent neuropsychological evaluations at 2 and 5 years post-TBI. The level of disability was assessed using Disability Rating Scale (DRS) and five other standard disability scales. The association of DTI parameters with scores on these scales was evaluated.

Results
In long term survivors of severe TBI, when compared with controls, fractional anisotropy (FA) was significantly lower and/or axial diffusivity (Lt) was significantly higher in eight white matter ROIs (Figure 1). Fractional anisotropy and/or Lt in all these ROIs were significantly different between the patients with a DRS $\geq 4$ and the ones with a DRS $<4$ at year 5 (Figure 2). Fractional anisotropy and Lt in the body of corpus callosum had the highest correlation with the Disability Rating Scale (FA: $r = -0.82$ and Lt: $r = 0.91$, P value of both $<0.01$). A normalized acute-phase FA $<0.86$ or a normalized Lt $>1.13$ in the body of corpus callosum were $80\%$ sensitive and $80\%$ specific in predicting a DRS $\geq 4$ at year 5 (Figure 3). The scores on all other scales also were correlated significantly with acute phase DTI parameters in some of the eight selected ROIs.

Conclusions
Changes in diffusion parameters of specific white matter structures measured in the acute phase after traumatic brain injury can predict the severity of long term disability in surviving patients.
Figure 1. The eight white-matter ROIs in which the acute-phase Lt and/or significantly correlated with the disability scores at year 5; 1: anterior brain, 2: left cerebral peduncle (CP-L), 3: left posterior limb of internal capsule, 4: left sagittal stratum (SS-L), 5: genu of corpus callosum (gCC), 6: body of callosum (bCC), 7: right corona radiata (CR-R), 8: left corona radiata (CR-L)
Figure 2. Comparison between patients with higher and lower disability (DRS ≥4 vs. <4) at 5 years: acute-phase normalized fractional anisotropy (FA) [A], and radial diffusivity (Lt) [B] values in selected regions. * indicates statistically significant difference (corrected p < 0.05) between the two groups.
Figure 3. ROC curve for acute phase Lt and FA (dotted and solid lines, r discriminator between high and low DRS scores in severe TBI survivors. the curve = 0.88, standard error = 0.11, P <0.05; For FA: area under the standard error = 0.10, P<0.05).
Decreased Connectivity in the Ventrolateral Preoptic Area-Tuberomamillary Nucleus Pathway in Patients with Sleep-Wake Disturbances After Mild Traumatic Brain Injury

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Purpose
The ventrolateral preoptic area (VLPO) promotes sleep by inhibiting the tuberomamillary nucleus (TMN) arousal center primarily during non-REM sleep (1). Our purpose was to determine if there is decreased connectivity in the VLPO–TMN pathway on diffusion tensor imaging (DTI) in mild traumatic brain injury (mTBI) patients with sleep-wake disturbances (SWD) and if the degree of connectivity correlates with symptomatology or outcome.

Materials and Methods
Diffusion tensor imaging (DTI) and serial neurocognitive testing utilizing the Immediate Post-Concussion Assessment Cognitive Test (ImPACT) were performed in 43 mTBI patients. Markov Chain Monte Carlo sampling was performed using BEDPOSTX (Bayesian Estimation of Diffusion Parameters Obtained Using Sampling Techniques) from the FMRIB software library (FSL) to accumulate distributions of diffusion parameters for each voxel and allow for modeling of crossing fibers within a given voxel. Probabilistic tractography from FSL then was used for fiber tractography of the VLPO-TMN pathway. Diffusion tensor imaging metrics, including fractional anisotropy (FA) and tract volume/connectivity (TV) were extracted in an automated fashion in the VLPO-TMN pathway in each patient. Comparison of demographics, FA and TV between mTBI patients with and without SWD was performed with Fisher's exact or an unpaired t-test. Correlation of FA and TV with patient symptomatology, neurocognitive test performance, and time to recovery was performed with Pearson's correlation coefficient.

Results
Twenty-four mTBI patients with SWD and 19 without SWD demonstrated no significant difference in age (p=0.50), gender (p=0.17), time from trauma (p=0.76), or prior concussions (p=0.23). Patients without SWD were more likely to have had a sports-related trauma (p=0.03). Tract volume/connectivity in the VLPO-TMN pathway was decreased significantly in patients with SWD (mean 61016 tracts, range 424-92341) compared to those without (129142 tracts, range 1106-1000044, p=0.046) and FA trended towards decreased values in patients with SWD (0.324, range 0.216-0.483) compared to those without (0.367, range 0.247-0.559, p=0.07). Tract volume/connectivity significantly correlated with performance on tests of verbal memory (r=0.446, p=0.03) and visual memory (0.421, p=0.04), but not other neurocognitive tests, overall symptom severity, or time to recovery.

Conclusions
The VLPO is important for sleep initiation through inhibition of the TMN and maintenance of non-REM sleep, which is central in reinforcing memory circuits (2). Decreased connectivity in the VLPO-TMN pathways in mTBI patients with SWD correlates with decreased memory performance on neurocognitive tests, which may suggest a focal injury to this region underlying both the sleep symptomatology and resulting cognitive sequela.
Leveraging microstructural white matter changes to guide investigation of resting-state functional network connectivity.

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Purpose
Prior research has examined the relationship of diffusion measures of structural white matter integrity to cognitive outcomes. Additionally, resting-state functional connectivity (rs-FC) is correlated with behavioral outcomes. These parallel approaches have revealed important observations regarding the role of connectivity in brain disorders. However, the methodology is inherently limited by the essentially separate nature of structural and functional arms. We propose a method that uses abnormal structural integrity to guide investigation of rs-FC, in a cohort of patients with mild traumatic brain injury (mTBI)

Materials and Methods
Twenty-three mTBI patients who presented to the emergency department within 48 hours of injury and 43 normal controls were recruited with IRB approval and gave informed consent. DTI and resting fMRI were performed at 3T. All individual FA maps were matched to the brain volume of a healthy volunteer for group analysis. A voxelwise t-test comparing mTBI and control subjects was used to identify regions of abnormally low FA (p < 0.01, cluster extent > 100 mm³). Regions of low FA were used as seeds for tractography with the entire cortex serving as the termination point. Gray matter regions thus reached then served as seed ROI for voxelwise analysis of rs-FC.

Results
A region in the left external capsule showed lower FA in mTBI subjects. Tractography delineated a fiber tract, which projected to both frontal and occipital cortical regions. The intersection of the fiber tract and frontal gray matter, which included the frontal eye field region, served as the seed for rs-FC analysis. Voxel-wise comparison of the correlation maps from the mTBI and control groups identified gray matter clusters in visual cortex and superior temporal gyrus where connectivity in mTBI subjects was stronger than in controls. (Cluster volume 116 mm³ and 315 mm³; average Fisher correlation at each clusters -0.26 and -0.20 for controls and 0.70 and 0.99 for mTBI subjects).

Conclusions
Our results demonstrate a new approach to rs-FC analysis where diffusion tractography based on abnormal structural connectivity findings is used to delineate cortical regions of interest for assessment of functional connectivity. The proposed method avoids the use of a priori seed region of interest (ROI) in rs-FC analysis to more directly interrogate the functional consequences of white matter injury.
Fig. 1. Cluster (blue) of abnormally low FA in mTBI group compared to controls and fiber tract (yellow) seeded by it.
Diffusion Tensor Tract Analysis of TBI Patients: Stratification by SWI Findings.

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Purpose
Traumatic brain injury (TBI) can permanently damage white matter tracts with increasing severity resulting in persistent neurological impairments. Diffusion tensor imaging (DTI) may be a more sensitive technique than conventional MRI in assessing the degree and presence of TBI, though mixed results have been published. The purpose of this study was to determine whether presence of microhemorrhage on susceptibility-weighted MRI (SWI) can be a determining factor in DTI tract analysis in patients with past head trauma.

Fig. 2. Clusters 1 (green) and 2 (red) of increased functional connectivity in mTBI.
Materials and Methods
In this retrospective study, 60 patients with history of trauma underwent 3.0T MRI including DTI and SWI. They were divided into two groups: (A) 30 patients with demonstrable microhemorrhages on SWI (SWI+) and (B) 30 with normal SWI (SWI-). Multimodal analysis including connectivity and tractography was performed generating average fractional anisotropy (FA) values, average mean diffusivity (MD) values, and average tract volume for 6000 tracts. Analysis of variance and receiver operating characteristic (ROC) analysis determined the optimal parameter(s), anatomical connection tract(s) and thresholds for predicting TBI.

Results
Preliminary data analysis demonstrated 300 connection tracts with significant difference (p<0.05) between SWI+ and SWI-. Of these, four connection tracts showing the most significant difference (p<0.03) in both FA and MD were selected. The mean ± SD of imaging FA within these tracts for SWI+ versus SWI- were: (1) right middle temporal and inferior temporal gyri; FA: 0.37 ± 0.02 versus 0.40 ± 0.02 (p=0.03), MD (x 10-6 mm2/s): 784 ± 27 versus 748 ± 32 (p=0.03). (2) left middle orbital-frontal gyrus and gyrus rectus: FA: 0.35 ± 0.05 versus 0.41 ± 0.04 (p=0.02), MD (x 10-6 mm2/s): 856 ± 69 versus 787 ± 41 (p=0.02.). (3) left post-central gyrus and pre-cuneus: FA: 0.45 ± 0.03 versus 0.50 ± 0.05 (p=0.02), MD (x 10-6 mm2/s): 790 ± 32 versus 740 ± 39 (p<0.01). (4) right angular and middle temporal gyri: FA: 0.38 ± 0.04 versus 0.41 ± 0.02 (p=0.02), MD (x 10-6 mm2/s): 779 ± 36 versus 744 ± 30 (p=0.02). Receiver operating characteristic (ROC) analysis revealed area under the curve (AUC), best threshold value, and corresponding sensitivity/specificity of 0.75, 0.38, 0.70/0.70 for (1), 0.75, 0.40, 0.67/0.80 for (2), 0.77, 0.49, 0.40/0.90 for (3), and 0.79, 0.41, 0.60/0.90 for (4), respectively. The best diagnostic power was obtained utilizing FA values in all four tracts with threshold values of 0.36, 0.35, 0.45, and 0.39, yielding an AUC of 0.98 and sensitivity/specificity of 100/92%.

Conclusions
The utility of DTI in head trauma has yet to be fully evaluated. We found that the DTI FA and MD values of selective white matter tracts are significantly lower in SWI (+) versus SWI (-) TBI patients. This is likely a consequence of TBI. Comparison to a normative database and geographic correlation with SWI microhemorrhages are ongoing.
Alteration of hippocampal subfield volume and thickness in contact-sport athletes
Purpose
Sport-related head trauma may cause long term brain injury. One of the key complaints of concussed athletes is memory problems (1, 2, 3). Given the associate of concussion and mnemonic function, we sought in this study to determine the baseline and longitudinal differences in hippocampal subfield volumes comparing a cohort of contact-sport with noncontact sport athletes.

Materials and Methods
Forty-seven high contact and 21 low contact collegiate athletes were enrolled in accordance with IRB and HIPAA over a 2-year period. The 3T scanning protocol included high resolution oblique coronal FSE scans (0.4x0.4x2.2mm) and 1.0mm isotropic IR-FSPGR. The data were processed with Automated Segmentation of Hippocampal Subfields, which automatically segments the hippocampal head, posterior body, CA1, CA2, CA3, and dentate gyrus. These segmentations were edited manually in a blind fashion by two experienced hippocampal segmentation specialists. In addition to volume tabulation, a novel algorithm computed the mean thickness of all subfields. Linear regression was performed separately for baseline and longitudinal studies to assess for differences at baseline and changes over time, respectively.

Results
At baseline, the right and left hippocampal heads were smaller in the contact-sport group (p=0.031 and 0.002, respectively). In the longitudinal analysis, thickness of the hippocampal tail demonstrated a subtle interaction between sport and time (p=0.01), with thickness increasing in the low contact sport and decreasing in the high contact sport.

Conclusions
Hippocampal subfield volumes may be affected by a sustained history of contact-sport exposure, in particular in the hippocampal head. The more posterior hippocampus may be more involved at a later stage of contact exposure. Hippocampal subfield volumetry may reflect mnemonic components of sports-related cumulative mild traumatic brain injury.
Alteration of cerebral blood flow in contact-sport athletes


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Purpose
Cumulative head trauma may cause long term brain injury. Brain injury and subsequent neurodegeneration may be measurable by reduced perfusion. In this study, we sought to determine the baseline differences in perfusion in conjunction with volumetry throughout the brain comparing a cohort of contact sport with noncontact sport student athletes.

Materials and Methods
Forty-seven high contact and 21 low contact collegiate male athletes were enrolled in accordance with IRB and HIPAA. A 3T MRI scan included T1-weighted IR-FSPGR and noncontrast pseudocontinuous arterial spin labeling (ASL) sequences. Brain segmentation was performed with FreeSurfer with subsequent blinded manual editing. Arterial spin labeling (ASL) perfusion images were divided by the proton-density images to deliver maps of cerebral blood flow (CBF) in mg/mL/min. FreeSurfer's segmentations were extracted for volume calculation and used to calculate mean regional CBF across subjects. Volume and CBF was regressed against sport and age for each region.

Results
Mean volumes of the cortex, white matter, basal ganglia, thalami, and hippocampi were statistically equivalent (Table 1). Total hippocampal volume trended towards being smaller in high contact sports (p=0.11). Mean CBF of the entire cerebral cortex, white matter, and basal ganglia (BG) were statistically equivalent (Figure 1). The thalami and hippocampi demonstrated significantly reduced CBF in high contact compared to low contact sports (p=0.006 and 0.003, respectively).

Conclusions
Recent data has suggested that hippocampal volumes are reduced in high contact sports (1). In this study the total hippocampal volume trended towards being lower in contact sport athletes, but this difference failed to achieve statistical significance. Cerebral blood flow, however, was clearly reduced in the hippocampi and thalami. If such findings are a consequence of brain trauma, this may represent a more sensitive metric for brain injury than whole-hippocampus volumetry. This presents a new line of data indicative of abnormalities in the hippocampus in contact sports. Future work will examine hippocampal subfield perfusion.
Magnetic Resonance Spectroscopy Abnormalities in Traumatic Brain Injury: A Meta-Analysis

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Purpose
Traumatic brain injury (TBI) is one of the most common neurologic disorders, but clinical assessment presents many challenges. Magnetic resonance spectroscopy (MRS) shows promise in detecting changes of brain metabolite concentrations following TBI. However, the literature
consists of small studies with conflicting results regarding the technique's efficacy. The purpose of this systematic review and meta-analysis was to analyze the existing literature to determine whether MRS abnormalities are present in patients with TBI.

Materials and Methods
A comprehensive literature search was performed by a medical librarian looking for studies reporting NAA/Cr or Cho/Cr levels in both TBI and control subjects. Cumulative and subgroup meta-analyses stratified by TBI severity defined by Glasgow Coma Score and time since TBI were performed using a random effects model.

Results
The literature search returned an initial 375 studies, of which 23 studies with 459 unique subjects met inclusion criteria. Cumulatively, NAA/Cr ratios in TBI patients showed a significant decrease as compared to controls [standardized mean deviation (SMD) = -0.88, 95% CI (-1.30, -0.47), p<0.0001]. Subgroup analyses revealed that the severe and mixed severity TBI subgroups both showed decreases in NAA/Cr ratios, but the mild TBI (mTBI) subgroup did not (Figure 1). When stratified by time, significant decreases in NAA/Cr ratios were seen in the subacute and chronic phases but not the acute phase (Figure 2). Post-TBI Cho/Cr levels were increased compared to controls [SMD = 0.69, 95% CI (0.32, 1.07), p=0.0003]. Similarly to NAA/Cr, significant differences in TBI versus controls were seen in all subgroups except the mTBI subgroup and the acute phase subgroup (Figures 3 and 4).

Conclusions
The literature shows strong evidence of changes to NAA/Cr and Cho/Cr ratios following TBI, but not in mTBI or in the acute stage.


Diffusion Tensor Imaging Shows Subclinical Atherosclerosis is Associated with Brain Structure in Obese Subjects

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Purpose

Obesity and atherosclerosis in the common carotid artery are associated with greater risk of ischemic stroke. We aimed to analyze the relation between intima-media thickness in the common carotid and structural parameters in diffusion tensor imaging (DTI) in obese subjects.

Materials and Methods

Twenty-two obese (body mass index \( \geq 30 \text{kg/m} \)) and 20 age- and sex-matched control subjects underwent DTI coded in 15 directions. We determined fractional anisotropy (FA) and radial, axial, and mean diffusivity in volumes of interest in eight brain regions. We determined intima-media thickness by ultrasonography. We recorded blood pressure, waist circumference, HOMA index of insulin resistance, and lipid profile.

Results

Intima-media thickness was greater in obese subjects \((p<0.001)\). Intima-media thickness correlated with FA in the lenticular nucleus \((r=0.440, p=0.004)\) and in the frontal white matter \((r=0.354, p=0.021)\) as well as with axial diffusivity in subcortical white matter \((r=-0.454, p=0.003)\). Axial diffusivity in subcortical white matter was higher in obese subjects \((p=0.002)\). After controlling for age, sex, and waist circumference, intima-media thickness predicted FA in the lenticular nucleus. The best predictor of axial diffusivity in subcortical white matter was waist circumference.

Conclusions

Obesity and subclinical atherosclerosis are associated with structural changes in the lenticular nucleus and subcortical white matter. Our preliminary results point to a potential role for DTI in monitoring obesity-related structural changes in the brain.
MR Imaging of Subcallosal Artery Infarct Causing Amnesia after Surgery for Anterior Communicating Artery Aneurysm

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Purpose
During surgery to treat an aneurysm in the anterior communicating artery, injury to the subcallosal artery, a perforator of the anterior communicating artery, may lead to infarction that produces basal forebrain amnesia after surgery. Our purpose was to examine whether 3D MR imaging can detect subcallosal artery infarction in patients with amnesia after surgery for an anterior communicating artery aneurysm.

Materials and Methods
We evaluated 3D–T2-weighted MR images obtained a median of 4 months after treatment of anterior communicating artery aneurysm for the presence of infarcted foci in 10 consecutive patients with postoperative amnesia. Because the subcallosal artery and its neighboring perforator, the recurrent artery of Heubner, were considered the most easily affected vessels during that surgery, we focused mainly on eight regions of the subcallosal artery territory per hemisphere and five regions of the recurrent artery of Heubner territory per hemisphere.

Results
All 10 patients had infarcts in the territory of the subcallosal artery (median, 9 regions per patient), and most were bilateral (9 of 10 patients). Five patients had additional infarcted foci in the territory of the recurrent artery of Heubner (median, 1 region per patient), all unilateral. Among the regions perfused by the subcallosal artery, the column of the fornix was involved in all patients; the anterior commissure, in nine; and the paraterminal gyrus, in eight patients.

Conclusions
3D MR imaging revealed subcallosal artery infarction, the distribution of which was mostly bilateral, presumably owing to the unpairedness of that artery, in patients with postoperative amnesia after anterior communicating artery aneurysm repair.

O-332
8:46AM - 8:54AM

Structural and Multi-modal Magnetic Resonance Imaging Provides No Useful Diagnostic Information in Isolated First Episode Psychosis

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Purpose
Previous studies demonstrate that with computed tomography (CT) and magnetic resonance imaging (MRI) pathology is no more prevalent in patients with first episode psychosis (FEP) than a normal volunteer population (1, 2, 3). We aimed to evaluate the further information provided by multimodal MR.
Materials and Methods
MR imaging for psychosis performed between February 2013 and July 2014 was analyzed. Thirty adult patients underwent structural and multi-modal 3T MR with an FEP protocol. Twenty-one of these presented with symptoms and signs of FEP. Two further patients had clinical information detailing FEP but had undergone an alternative MR protocol. Seventeen patients underwent standard psychosis protocol including T2, diffusion-weighted imaging, arterial spin labelling, and susceptibility-weighted imaging. Two patients underwent a cognitive decline protocol including T2, diffuse-weighted imaging and T2 gradient echo (GRE). One patient only tolerated T2-weighted imaging whilst another did not have GRE because of reduced compliance. Two did not have gadolinium as they declined cannulation.

Results
Eleven males and 12 females. Age range 20-94 years. Twelve had normal imaging. Eight had chronic small vessel ischemic change with no other pathology. One had a slight excess number of white matter hyperintensities within the white matter of both cerebral hemispheres. This was considered slightly excessive for age but consistent with a patient who had vascular risk factors. One patient had mild cortical frontal atrophy, another had atrophy over the high cerebral convexity and parietal lobes bilaterally. One patient had imaging findings consistent with a cavernoma. Multimodal imaging contributed no further diagnostic information.

Conclusions
In patients who underwent structural and multimodal MR imaging for FEP, none had pathology which could directly explain their psychiatric symptoms. This suggests that multimodal imaging yields no further diagnostic information for isolated FEP, and imaging protocols should be limited to reflect this.

O-333
8:54AM - 9:02AM

Minimum Vascular Malformation Size Resulting in Decreased CVR Signal in Surrounding Eloquent Tissue

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Purpose
Cerebrovascular reserve (CVR) is important for quality assurance, estimating reliable BOLD FMRI signal, and thoughtful preoperative planning around vascular malformations particularly arteriovenous malformations (AVM) and cavernomas. These lesions can alter hemodynamics, impose susceptibility, and disrupt CVR and effective BOLD signal in adjacent brain, confounding survey for eloquent cortex and comprehensive mapping. While some lesions significantly alter CVR leaving large gaps, some do not. We propose that size of AVMs and cavernomas impacts CVR integrity, and a threshold size for absent CVR, and unreliable local BOLD signal, exists.

Materials and Methods
This is a retrospective study of patients receiving preoperative functional MRI (fMRI) assessment of AVMs (n=9) and cavernomas (n=11). Vascular malformations were measured in longest diameter and categorized into size groups: <3 cm, 3-6 cm, >6 cm. Cerebrovascular reserve images derived from block design breath hold were compared to averaged echo planar
signal to discern if lost CVR was due to hemodynamics or simply absent EPI signal. Scans were determined to be CVR "intact" (CVR-in), or compromised (CVR-out) if gaps in CVR encompassed local eloquent cortex. Chi-square analysis was used for statistical significance.

Results
Twenty patients, 35% male and 65% female, were included with an average age of 39.3 ± 6.4 years. The association between lesion sizes <3 cm (n=16), 3-6 cm (n=3), and >6 cm (n=1) and CVR-in and CVR-out states was statistically significant (p=0.025). When dividing all lesions into 3 cm, CVR-out states were associated more with the >3 cm group (p=0.028). Average size of vascular malformations causing decreased CVR in surrounding brain was 4.43 cm: two AVMs (22%) caused decreased surrounding CVR, average size 6.3 cm, and one cavernoma (9%) caused decreased surrounding CVR with a size of 0.7 cm.

Conclusions
Larger and high flow vascular malformations are associated with greater potential for causing decreased CVR in the surrounding brain, and 3 cm is the threshold at which CVR reduction shifts from intralesional to diminished CVR in surrounding tissue. The size at which AVMs cause surrounding CVR alterations is larger than cavernomas.

O-334
9:02AM - 9:10AM
When the Right (‘Wrong’) Hemisphere Kicks in: Re-Reading Words in the Context of a Memory Task Activates the non-Dominant IFG and hippocampus.

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Purpose
To compare the lateralization of anterior language areas and hippocampus in a verb generation (VG) task and a subsequent memory word recollection (MWR) task.

Materials and Methods
Thirteen right handed healthy men underwent a functional MRI (fMRI) examination using a 3T MRI (GE, HDxt). Functional MRI acquisition: T2* weighted, GRE sequence TR/TE 4000/35, FOV 22cm, matrix 64X64, 3.4mm3 resolution. Tasks: Stimuli were presented visually. First, a VG task on a list of mid-frequency common nouns - participants were instructed to think of a verb associated with each noun. Twenty minutes latter a similar list of nouns was used in the MWR task, with half of the blocks comprising novel words - participants were instructed to decide whether the noun was presented during the VG task. Data analysis: Following preprocessing, contrasts of interest were produced for each subject and task, using general linear models. Data were analyzed with SPM8. The threshold used to define clusters was p<.001, uncorrected for multiple comparisons, with (K)>10.

Results
In the VG task brain activation was significantly (p=0.00) left lateralized (M, SE= 0.41, 0.30), compared to that of the MWR task's (M, SE= -0.00, 0.32). A two-factor analysis of variance for Broca's area showed no main effect for task, F(1,26)=0.89, p =0.35; a main effect for laterality, F(1,26)=36.77, p=0.00; and an interaction between task and laterality, F(1,26)=35.29, p<0.001 (Figure 1). A two-factor analysis of variance for the hippocampus showed no main effect for
task, F(1,26)=0.01, p=0.92; or laterality, F(1,26)=1.87, p=0.67; but there was a significant interaction between task and laterality, F(1,26) = 16.58, p<0.001 (Figure 2).

Conclusions

Switching from a VG to MWR task, resulted in the relative disengagement of the left Broca's area as well as the hippocampus and the recruitment of their right hemisphere counterparts. The results suggest that the lateralization of the same set of nouns may be task and experience dependent.

O-335 9:10AM - 9:18AM

Microstructural abnormalities of the trigeminal nerve in trigeminal neuralgia elucidated by quantitative-diffusion-tensor MRI.

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Purpose

To correlate the various quantitative diffusion parameters with microstructural tissue abnormalities of trigeminal nerve (TGN) in patients with unilateral trigeminal neuralgia (TN) by diffusion tensor imaging.

Materials and Methods

A prospective study of 10 patients of trigeminal neuralgia (mean age, 46.8 years; range- 37-70 years; M:F ratio – 1:1) were imaged with a 3.0T MRI system using eight-channel head colli
A single shot axial diffusion tensor echo planar sequence was used with b value-1000 sec/mm², slice thickness 3mm, interslice gap 0 and 15 diffusion directions. Small region of interest was placed over the root entry zone of the TGN on affected and unaffected site (as control). Various quantitative diffusion parameters were measured - fractional anisotropy (FA), apparent diffusion coefficient (ADC) and radial diffusivity (RD). The mean values of FA, ADC and RD were compared between the affected and unaffected sides in the same patient using paired t-test. For anatomical correlation, 3D time-of-flight (TOF) magnetic resonance angiography and fast imaging employing steady-state (FIESTA) and basic MRI sequences also were acquired to show neurovascular compression.

Results

Compared with the unaffected side, the affected side showed significantly decreased FA (Mean FA of affected - .3202 and unaffected site .4786) (P = <.05) and increased RD and ADC (P = <.05).

Conclusions

Our results suggest that DTI can quantitatively assess the microstructural abnormalities of the affected TGN in patients with TN.

O-336

Imaging of the Digital Nerves of the Finger: Feasibility of 3T MRI

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Purpose

MR imaging (MRI) can demonstrate normal anatomy as well as pathologies of the digital nerves of the finger with high spatial and contrast resolution. The purpose of this investigation was to demonstrate the feasibility of digital nerve imaging with 3T MRI to detect and characterize traumatic and nontraumatic pathologies of the digital nerves.

Materials and Methods

This IRB approved, HIPAA-compliant retrospective study reviewed clinical data of 13 consecutive patients with pathologically proven digital nerve abnormalities; 92 proper digital nerves (PDN) (73 normal, 19 abnormal) and 18 common digital nerves (CDN) (11 normal, 7 abnormal) were reviewed by two readers. 3T MRI protocols generally consisted of axial T1, axial fluid-sensitive sequences (T2 FS or STIR) and DWI; 10/13 patients received IV contrast. Nerve size for the normal and abnormal nerves in addition to exam diagnostic quality (1-4, semi-quantitative scale), was recorded. Injury patterns, medical and surgical history, and pathologic findings were reviewed. Descriptive statistics were reported.

Results

Digital nerve abnormalities were due most commonly to tumor 54% (7/13), postoperative complications 31% (4/13), vascular malformations 8% (1/13), and traumatic injury 8% (1/13). The average age was 48±17 years and 85% (11/13) of patients were female. Normal PDN size was 1mm, with abnormal nerves measuring 6±7mm, p<0.0001, 95% CI (3.5, 6.8). Normal CDN size was 2mm, with abnormal nerves measuring 18±6mm, p<0.01, 95% CI (2.4, 28.9). Exam diagnostic quality was excellent with an average score of 3.8/4.
Conclusions

Imaging of the digital nerves with MRI at 3T is feasible with high diagnostic quality for a variety of pathologies. Given that MRI is playing an increasingly central role in the assessment of peripheral nerve injury, its accurate use for digital nerves is important for guiding treatment (1–3).

1: Invasive cutaneous squamous cell carcinoma

2: Post operative numbness; ulnar nerve neuroma

T1

2a: Thickened ulnar digital neurovascular bundle

T1 + C

Enhancing tumor encases the index and long finger radial and ulnar proper digital neurovascular bundles

2b: Focally hyperintense digital nerve
Non-Invasive Cerebral MR Thermometry Utilizing the Proton Resonance Frequency Chemical Shift: Impact of Advanced Field Shimming and Acquisition Strategies on In Vivo and In Vitro Temperature Monitoring

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Purpose
Demonstrate the utility of the semi-localized by adiabatic selective refocusing (semiLASER) multi-voxel magnetic resonance spectroscopic imaging (MRSI) sequence with improved shimming for in vivo brain MR thermometry (MRT).

Materials and Methods
Measurements were acquired on a Siemens Magnetom Trio 3.0 T MRI scanner from a brain phantom and three healthy volunteers. Both the point-resolved spectroscopy (PRESS) sequence and the semiLASER sequence (TR = 1700 ms; TE = 35 ms; 10 mm x 10 mm x 15 mm voxels) were used to acquire an 8x8 voxel grid. Either vendor-supplied standard advanced shim (SAS) or the newly developed 3D gradient refocused echo (GRE)-based protocol (GREshim) were applied to shim the static magnetic field. Temperature was calculated from the temperature-sensitive water-N-acetylaspartate (NAA) chemical shift difference reflecting fluctuations in the water hydrogen bonding equilibrium.

Results
In vitro and in vivo narrowing of the full width at half maximum (FWHM) line width and longer T2* values were observed with GREshim versus SAS indicating enhancements to shimming conditions. Comparing the PRESS sequence using SAS, the current clinical spectroscopy standard, with our protocol combining the semiLASER sequence with GREshim, a significant increase in the T2* (PRESS, SAS: 25.7 ± 0.6 ms; semiLASER, GREshim: 30.7 ± 0.6 ms; p<0.05) and FWHM narrowing (PRESS, SAS: 24.3 ± 1.5 Hz; semiLASER, GREshim: 20.3 ± 1.3 Hz; p<0.05) were observed in vivo. A decrease in NAA Cramer-Rao lower bounds was observed with semiLASER using GREshim versus the standard PRESS with SAS (p<0.001).

Conclusions
In vitro temperature maps acquired with semiLASER and GREshim may improve accuracy of brain MRT compared with conventional approaches. Reproducible in vivo cerebral temperature maps obtained in healthy volunteers highlight the utility in brain thermometry (Figure 1). Improved MRSI localization profile and spectral quality using semiLASER combined with fast higher-order shimming prove superior towards the development of real-time, near-absolute cerebral MRT.
Figure 1. *In vivo* cerebral temperature map calculated.

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O-338

A Comparative Study of White Matter Fiber Tractography Using DTI, DKI and DSI

J Helpern¹, G Glenn¹, L Kwo², Y Chao³, J Jensen¹
Purpose
The diffusion kurtosis imaging (DKI) (1) approximation of the diffusion orientation distribution function (dODF) recently has been derived, enabling DKI-based white matter (WM) fiber tractography (FT) (2). Using the dODF reconstructed from diffusion spectrum imaging (DSI) (3), the dODFs from DKI and diffusion tensor imaging (DTI) are compared and their effects on WM FT are examined qualitatively.

Materials and Methods
Diffusion spectrum imaging and DKI datasets were acquired for a single subject on a 3T MRI system (Tim Trio, Siemens, Erlangen, Germany), using a twice-refocused balanced spin-echo diffusion echo-planar imaging sequence with fat suppression. Acquisition parameters for both sequences were: voxel size=2.7×2.7×2.7mm^3, matrix=82×82, slices=45, bandwidth=1356 Hz/Px, and a 32-channel head coil with GRAPPA and adaptive combine coil combine mode. Additional parameters for DSI were TR/TE=8300/151 ms with 515 diffusion encoding gradient directions with a maximum b-value of 6000 s/mm^2 resulting in a total acquisition time of ~ 1 hour and 12 min. For DKI, TR/TE=6100/102 ms, 64 diffusion encoding gradient directions with b-values of 1000 and 2000 s/mm^2 and 20 independent acquisitions with b=0, resulting in a total acquisition time of 15.6 min. Diffusion tensor imaging results were obtained using the b=0 and b=1000 s/mm^2 images from the DKI dataset. The DSI dODF was calculated using DSI Studio (http://dsi-studio.labsolver.org/). The DKI and DTI dODFs, as well as all other analyses, were calculated using in-house software. Regions of interest (ROIs) with crossing fibers were defined as regions with multiple fiber bundle orientations detected with DSI with quantitative fractional anisotropy (FA) values >0.15 (4). White matter ROIs were segmented from the DKI dataset in regions with both the mean kurtosis >0.9 and mean diffusivity <1.5 mm^2/s. White matter FT was performed using the FACT algorithm with 100,000 randomly generated seed points, FA threshold=0.15, and a minimum track length=20 mm. White matter fiber tracts were visualized with TrackVis (http://trackvis.org/).

Results
Example dODFs in a region with a single-fiber orientation (corpus callosum) as well as in a region with multiple-fiber orientations are shown in Figure 1. The dODFs of DKI and DTI are similar to the DSI dODF in single-fiber orientation, whereas only the DKI dODF is similar to the DSI dODF for multiple-fiber orientations. As shown in Figure 2, the DKI dODF has lower angular differences throughout the WM compared to DTI, and in crossing fiber regions the average angular differences for the DKI and DTI dODFs are 13.2 and 25.3 degrees, respectively. As shown in Figure 3, DKI-based WM FT is qualitatively more similar to DSI-based WM FT than is DTI-based WM FT.

Conclusions
We have demonstrated that the DKI dODF can resolve WM crossing fibers with an angular accuracy comparable to the DSI dODF. Both DKI and DTI are capable of mapping the single predominant orientation, but the angular accuracy of DTI decreases substantially in complex fiber orientations due to its theoretical limitation under the assumption of Gaussian diffusion. With a shorter typical scan time than DSI, DKI is potentially more suitable for a variety of clinical applications.
Figure 1. Example dODFs from regions with one predominant fiber bundle orientation, such as the corpus callosum, as well as a region where DSI identifies 3 fiber bundle orientations.

(Filename: TCT_O-338 ASNRFig1.jpg)

Figure 2. Angular difference in the WM ROI for DKI (A) and DTI (B). (C) Angular difference histogram for all voxels in which DSI detects multiple fiber bundle orientations for DKI (blue) and DTI (red), where the dashed line is the mean angular difference.

(Filename: TCT_O-338 ASNRFig2.jpg)
Functional MRI Texture analysis: can it identify true cortical brain activity?

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Purpose
To identify areas of true functional MRI (fMRI) activation (true active fMRI blobs) by using a texture feature derived from raw EPI data. Functional MRI maps usually show multiple activation blobs that might not be truly activated. Currently, we depend on individual experience in qualitatively determining the appropriate threshold between true and false activity. This approach usually does not effectively eliminate all false (nonexpected) activity and might eliminate true activity with stringent statistical threshold.

Materials and Methods
Twelve right-handed healthy volunteers were recruited for this study (IRB was obtained). All scans were performed on a 3.0T GE MR scanner. Functional MRI consisted of a high resolution 3D T1-weighted structural scan and a gradient-echo EPI functional scan. Functional MRI data analysis was performed using SPM8 software for a sentence completion block design task. The resultant T-map for each individual then was displayed using xjview toolbox and thresholded individually to optimize visualization of language area. Then, each cluster of activity was selected and saved as a separate mask. A board-certified neuroradiologist and a cognitive neuroscientist classified different clusters into two separate groups: Expected (E) and Non-Expected (NE) based on their anatomical locations. Texture analysis was performed using the mean EPI volume for each individual, and 20 invariant texture features were obtained. To assess the efficacy of texture analysis in fMRI, we constructed a decision tree and we validated it using...
a 10-fold cross validation of the training data. The accuracy, sensitivity and specificity were calculated.

Results
We were able to identify fMRI blobs in individual scans based on their texture features with 94% accuracy, sensitivity 80% and specificity 100%. Variance, Cluster shade, Correlation and Auto-correlation were the most important texture features. Texture features were able to identify all the nonexpected blobs, however three expected activation blobs were misclassified. This can be related to individual variations or to the limited sample size of our pilot study.

Conclusions
We implemented texture analysis on EPI MR images and demonstrated that the extracted features can be used to discriminate expected from nonexpected fMRI that are reflective of true versus unlikely true areas of fMRI activation. Qualitative analysis of functional MRI using texture feature can enhance the accuracy and sensitivity of the test to true activity and help eliminate false activation.
Figure 1: Activation map obtained from a subject overlaid on the mean EPI volume. Red blobs of activity represent expected activation of language related activity while Blue blobs are Non-expected activity. All blobs survived a very stringent threshold with a P-value of $10^{-13}$. 
Morphological Features of Human Perivascular Space Using 7T MRI

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Purpose
Several lines of evidence have suggested that the brain perivascular space (PVS) serves as part of the brain "lymphatic" system through which waste materials are cleared from the brain. While enlarged PVS has been reported in a number of neurologic disorders, normal PVS typically is not visible in MR images. Our goal was to characterize the morphologic features of normal PVS using a 7T whole body MR scanner.

Materials and Methods
All images were acquired using a 7T whole body MR scanner (Siemens, Erlangen, Germany) with a gradient strength of 70mT/m. A 32-channel rf and one transmit head coil was used (Nova Medical). The study was approved by local IRB and a total of six subjects (ages 25-37 years) were imaged after written informed consent. Two sequences, 3D MP-RAGE (0.65 mm\textsuperscript{3} isotropic or 0.2x0.2x0.8mm\textsuperscript{3}) and 3D TSE (0.5mm\textsuperscript{3}, 0.2x0.2x0.8 mm\textsuperscript{3}, or 0.4 mm\textsuperscript{3}) were employed. Both sequences have similar acquisition times (9:39 (0.653 mm\textsuperscript{3}) or 12:08 (0.2*0.2*0.8 mm\textsuperscript{3}) for T1-weighted and 11:58 for T2-weighted). In addition, three TEs (537, 707, and 859 ms) were evaluated for TSE at the above three resolutions, respectively. Contrast-to-noise ratio (CNR) between selected PVS [3-5 regions of interest (ROIs) each subject] and white matter was obtained. In addition, segmentation of PVS using a novel three step approach was employed, including extracting white matter, enhancing tubular structures using Hessian-based vessel enhancement approaches, and finally, imposing physiological constraints.

Results
Figure shows maximum intensity projection images (6 adjacent slices) from a representative subject where 3D TSE with 0.4mm\textsuperscript{3} isotropic resolution images were acquired. Normal PVS are apparent throughout the entire brain. Regarding CNR, 3D TSE exhibits a much higher CNR when compared to that obtained using MP-RAGE (38.7±13.5 versus 9.6±1.3). For 3D TSE, a CNR of 33.3±6.1 (n=4), 34.5 (n=1), or 64.6 (n=1) was obtained for the resolution of 0.5mm\textsuperscript{3}, 0.2x0.2x0.8 mm\textsuperscript{3}, or 0.4 mm\textsuperscript{3}, respectively, suggesting an improved CNR with increased resolution.

Conclusions
Characterizing normal PVS has been extremely difficult owing to the required spatial resolution. We demonstrated that morphological features of normal PVS can be discerned on 7T, which in turn will pave the way for future studies of abnormal PVS.
Wednesday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Erie (Level 2)

15H - PARALLEL SCIENTIFIC PAPER SESSION-INTERVENTIONAL: CANCER/EMBOLIZATION
O-341
8:30AM - 8:38AM

In-vitro and In-vivo Capture of Iron Oxide Nanoparticles with an Endovascular Magnetic Filter: A novel paradigm for chemoembolization with potential applications to head and neck cancer.

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Purpose
Iron oxide nanoparticles when conjugated to chemotherapy agents could play an important role in intra-arterial therapy for head and neck cancers and other tumors. We eventually propose to infuse high doses of iron oxide particles conjugated to chemotherapy agents into a tumor bed and temporarily deploy an intravenous magnetic filter within the vein(s) draining the target organ to capture excess particles thereby decreasing systemic distribution of particles and conjugated chemotherapy agents. This would allow higher local doses of therapy agents to be administered with fewer systemic effects. Here, we aim to demonstrate intravascular magnetic capture of iron oxide nanoparticles in a physiologic flow chamber and in a pig model.

Materials and Methods
A prototype rare earth magnet filter device was constructed for directed intravascular use on an 0.014" wire (C). This magnetic filter was tested in vitro in a physiologic flow model containing 500 cc porcine serum and approximately 0.5 mg/ml of 50-100nm (3 times) iron oxide particles. The flow model reservoir constantly was mixed and the model was allowed to come to equilibrium over 5 minutes. The magnet filter was introduced to the circuit and samples were taken at 0, 1, 3, 5, and 10 minutes. Sample concentrations were determined by Prussian blue colorimetric methods with spectrophotometry following treatment with aqua regia (A). The prototype magnet was introduced into the inferior vena cava of a living pig through a common femoral approach via an 18F sheath (B). A venogram was performed and 500 mg of 50-100nm iron oxide nanoparticles were infused through a 5F catheter positioned in the common iliac vein. Following the procedure photographs (D) and photomicrographs of the magnetic filter were obtained to demonstrate adherent nanoparticles.

Results
The magnetic filter demonstrated efficacy in the physiologic flow model as evidenced by adherent particles, visual clearing of the solution, and decreasing iron particle concentration over time. Mean decrease in concentration for three runs in the flow chamber were 71.6% at 1 minute, 77.0% at 3 minutes, 81.5% at 5 minutes, and 93.8% at 10 minutes. Feasibility was demonstrated in vivo as evidenced by adherent iron oxide nanoparticles on the magnetic filter following the
infusion. The magnetic filter was maneuvered easily in the venous system and venography demonstrated a patent inferior vena cava with normal flow around the filter.

Conclusions
Iron oxide nanoparticles can be removed effectively from serum in vitro and from flowing venous blood in vivo by a prototype magnetic filter. This may be combined with conjugated therapeutic agents in the future as an oncologic treatment allowing dose escalation in transarterial chemotherapy.
Head and Neck Malignancy related Carotid Blow Out Syndrome (CBS): Long term Clinical Outcome after Active Interventions.

S Lee, J Eliyas-Khader, D Ginat, J Collins, L Portugal

Purpose
To evaluate long term clinical outcomes of head and neck malignancy-related carotid blow out syndrome (CBS) after either surgical and/or endovascular intervention.

Materials and Methods
A total of 23 patients (M:F=20:3, median age=60 years) who received active intervention (surgical or endovascular) due to malignancy-related CBS were included. Underlying malignancies include squamous carcinomas of the tongue (n=8), tonsil (n=5), larynx (n=5), pyriform sinus (n=2) and other sites including metastatic cancer (n=3). Indications for active intervention were: Threatened (carotid artery exposure due to wound dehiscence or radiologic evidence of tumoral carotid invasion, n=6), Impending (episode of brisk arterial bleeding but controlled with simple pressure or surgical packing, n=9) and Ruptured carotid artery (n=8).

Results
Surgical interventions were performed in three patients (ECA branch ligation = 2, ICA ligation = 1). Performed endovascular interventions (n=20) included 1) Carotid artery occlusion in eight (8/20, 40%), 2) Covered stent deployment in six (6/20, 30%), 3) ECA branch embolization in three (3/20, 15%), and 4) Uncovered stent in three (3/20, 15%). Immediate hemostasis was achieved in all cases. However, there were nine patients (9/23, 39.1%) experienced re-bleeding episode (same site = 4, same side but different location = 3, opposite side = 1, same side ECA bleeding through collaterals = 1). Median interval between initial intervention and re-bleeding was 1.6 months. Among 15 patients who had either carotid scarification or covered stent deployment, there were four patients who had re-bleeding episode (4/15, 26.7%). On the other hand, 50% (n=4/8) of either surgical ECA branch ligation or embolization patients had experienced re-bleeding. Median the latest documented clinical follow-up period after intervention was 7.5 months (range 5 days to 6.8 years). Missing on clinical follow up or confirmed mortality within 3 months after intervention was 39.1% (9/23) and those of 1 year was 69.5% (16/23). There was only one active interventional procedure-related symptomatic complication (acute stroke) in 32 procedures (1/32, 3.1%; initial intervention = 23, intervention for re-bleeding = 9).

Conclusions
Active interventions (surgical and endovascular procedures) are safe and effective for immediate hemostasis of CBS. However, there is not an insignificant re-bleeding risk after active interventions within short time period and overall clinical prognosis of CBS patients seems to be extremely poor.

O-343

Third Generation Magnetically Assisted Remote Controlled Endovascular Catheter for Interventional MR Imaging: Navigation at 1.5T/3T versus X-ray Fluoroscopy
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Purpose
To compare in vitro navigation in a vascular phantom using a new third generation magnetically-assisted remote controlled (MARC) catheter under real-time MR imaging versus x-ray guidance in endovascular catheterization procedures.

Materials and Methods
A custom 2.7 French clinical grade microcatheter prototype with a double saddle coil manufactured with custom 3D laser lithography at the distal tip was deflected with a foot pedal actuator used to deliver ± 300 mA (Figure 1). Inexperienced and experienced operators navigated the catheter into branch vessels in a custom cryogel abdominal aortic phantom. This was repeated under conventional x-ray fluoroscopy. MR imaging experiments were performed at 1.5T and 3T using a b-SSFP sequence. The mean procedure times and percent success of selecting a vessel within 60 seconds were determined and analyzed with a linear mixed effects regression analysis.

Results
The catheter tip was clearly visible under real-time MRI at 1.5T and 3T. Among inexperienced operators, magnetically-assisted MR guidance was equivalent to x-ray guidance at 1.5T [67/100 (67%) successful vessel selection turns with 1.5T MRI versus 76/100 (76%) with x-ray p=0.157] and at 3T (75% turns with 3T MRI versus 76% with x-ray p=0.869). Among experienced operators, x-ray guidance was successful more frequently at catheterizing a branch vessel within 60 seconds than MRI at 1.5T [98/100 (98%) successful turns with x-ray versus 65/100 (65%) with MRI, p<0.001]. However, at 3T, MRI guidance among experienced operators improved (75% successful turns), but was less frequently successful than x-ray guidance. Among inexperienced operators, overall mean procedure time was equivalent between magnetically-guided assistance (31 seconds) and x-ray guidance (34 seconds) (p=0.436). Among experienced operators, overall mean catheterization time was faster with x-ray (20 seconds) compared to MRI at 1.5T (42 seconds) (p<0.001), but magnetically-assisted guidance improved at 3T (31 seconds). When stratified by branch vessels, magnetically-assisted MR guidance was equivalent to x-ray guidance for the celiac artery, superior mesenteric artery (SMA) and (IMA). Only the renal arteries (small diameter, 60 degree angle) were easier to navigate with x-ray for experienced operators.

Conclusions
We have developed and tested a third generation MARC catheter for endovascular navigation in multiple planes under real-time MRI guidance. Magnetically-assisted navigation is feasible at 1.5T, improves at 3T, and is comparable to x-ray guidance for a variety of vessels. Furthermore, this technology is used easily by inexperienced operators. This work further strengthens the foundation for endovascular catheter navigation under MRI guidance, 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.
O-344

Upper Extremity Access for Neurointerventions

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Purpose
To describe a series of neurointerventions performed via transradial and transbrachial access with a focus on indications, access technique, devices and complications.

Materials and Methods
With IRB approval we reviewed the cases of neurointervention performed via transradial or transbrachial access by a single operator at three institutions from a prospectively maintained database. A retrospective review of the patient's medical records, procedure and imaging was performed to record demographics, procedure indication and type, reason for upper extremity access, vessel accessed, puncture method and devices (sheath and catheter type), closure, technical outcome and access-related complications.

Results
Over a 5-year period, 2010-2014, there were 11 upper extremity accesses (8 radial, 3 brachial) in 9 patients (M:F 4:5, mean age 62 years) undergoing 10 procedures [4 cerebral angiograms, 1 stroke thrombectomy, 2 intracranial aneurysms (1 with balloon remodeling, 1 with stent assistance), 1 spinal aneurysm (with balloon remodeling), 1 craniofacial tumor embolization and 1 vertebral artery stenting]. Indication for upper extremity access was 2 patients with irreversible anticoagulation, 4 with iliofemoral arterial occlusions, 2 with failed access due to arch anatomy and 1 with severe aortic coarctation. A Brachial access generally was reserved for probable interventions. One procedure required bilateral brachial access. One case (brachial) was performed from the left side to access the left vertebral artery. A positive Allen's test was documented prior to radial access. Ultrasound guidance using a standard 021 micropuncture set was used in all cases. Angiography was performed after access and spasmolytic injected through the micropuncture sheath in transradial cases. 4Fr tapered sheaths were used for diagnostic angiography and interventions were performed either through a short 6Fr sheath and 6Fr guide combination or a long 6Fr sheath. The 6Fr 088" Neuron Max ID sheath was used for the majority of interventions. A 4Fr angled glide catheter was used for ipsilateral angiography and a 4Fr Sims 3 glide catheter for contralateral vessels. 2 cases were unsuccessful, 1 due to oxygen desaturation downstream to the access site occurring during the procedure and in another case an acute angulation of the right common carotid artery from the innominate resulted in kinking of the catheter. Manual compression was used in all cases with additional use of an external radial balloon tamp in 4 cases. There was 1 access complication, a brachial artery thrombosis occurring at the puncture site 12 hours postprocedure requiring immediate open surgical thrombectomy with excellent recovery.

Conclusions
Upper extremity access can be performed reliably for neurointerventional procedures of all types. Although locally occlusive, 6Fr access via the radial artery is well tolerated in the presence of ulnar collateral supply and can be monitored with downstream oxygen saturation monitoring. The transbrachial approach may be preferable with unfavorable radial artery anatomy but is more difficult to manage postprocedure.

O-345
9:02AM - 9:10AM

Technical Factors Affecting Outcomes Following Stent Deployment for Vertebrobasilar Atherosclerosis
Purpose
Stenotic atherosclerotic disease of the vertebrobasilar system causes significant morbidity and mortality. Aggressive medical management is appropriate for all patients with this disease, but the role of endovascular interventions is not settled. This study examines interventions performed for posterior circulation lesions.

Materials and Methods
Retrospective review was performed of prospectively maintained procedure logs at three hospitals with comprehensive neurointerventional services. Patients with angiographically-proven stenosis undergoing elective angioplasty or stent placement were selected for analysis of demographic factors, lesion characteristics, and treatment details. Technical success was defined as residual stenosis <50% without complication. Multivariate analysis was performed to evaluate for associations with ischemic stroke, death, and functional status as measured by modified Rankin scale at 30 days, 90 days, 1 year, 2 years, and point of last contact.

Results
One hundred twenty-three lesions were treated in 110 patients with mean age 62.4 years. Forty-three (58.1%) lesions caused stroke, while 66 (89.2%) caused TIAs. Forty lesions (32.5%) were at the vertebral origin; 97 (60.2%) were intracranial. Mean stenosis was 81.6%, and mean lesion length was 7.7 mm. Sixteen (13.0%) lesions were treated with angioplasty, 109 (88.6%) with stenting. One hundred twelve (91.1%) were treated successfully. Four (3.3%) of 10 (8.1%) procedural complications were symptomatic. Intracranial lesions were associated with death at 1 and 2 years (OR 24.91, p<0.001) and mRS>2 at last contact (OR 12.83, p<0.001). Stenting treatment with conjunctive angioplasty had lower rates of death (OR 0.303, p=0.046) and mRS>2 at last contact (OR 0.234, p=0.018) when angioplasty was performed with a device other than that packaged with the stent.

Conclusions
Endovascular treatment of vertebrobasilar atherosclerosis can be performed safely. Treatment of vertebral origin lesions was exceedingly safe. Higher rates of technical failure and complication may be acceptable for certain intracranial lesions due to their refractory nature and the morbidity caused by such lesions.

O-346
9:10AM - 9:18AM

A new model of middle cerebral artery occlusion in nonhuman primates using an endovascular trapping technique

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Purpose
Current nonhuman primate stroke models are limited by either stroke variability or survivability. A new nonhuman primate stroke model was developed using endovascular trapping techniques to limit collateral vessels with serial MRI and neurological assessments.

Materials and Methods
Eight adult rhesus monkeys (female, 7-13 years old) underwent MRI scanning and Spetzler neurological assessment followed by endovascular stroke induction consisting of superselective endovascular placement of surgical silk suture into the right MCA using a trapping technique. Two initial subjects were euthanized immediately following postocclusion MRI scanning. The subsequent six subjects were recovered and underwent follow-up MRI and Spetzler neurological assessments at 48 hours, with four being followed to 96 hours. Stroke infarct volumes were measured and the longitudinal Spetzler clinical neurological scores were assessed. The brain tissues were harvested and prepared with H&E staining.

Results
Focal permanent cerebral ischemia was induced in the targeted right MCA territory in all subjects. The volumes of the ischemic lesions at 6, 48 and 96 hours were 3.18 cc +/- 1.007 SEM (n=8), 6.70 +/- 1.666 SEM (n=6), and 7.23 +/- 1.371 SEM (n=4). For the survival animals, the immediate postsurgical Spetzler Grading score improved from 60.7 at 24 hours to 68.7 at 48 hours.

Conclusions
We report a new minimally invasive endovascular stroke technique that yielded reproducible ischemia and clinically quantifiable neurological deficits with no strokes in nontarget areas. This technique may be useful in evaluating translational stroke and penumbral imaging research in addition to preclinical testing of neuroprotective therapies.
Thrombectomy of Small Intracranial Vessels with pREset-Lite – Safety and Efficacy

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Purpose
Distal vessel occlusion is encountered occasionally during endovascular stroke procedures. It
may affect branches supplying eloquent brain tissue and recanalization could potentially improve patient outcome. On the other hand few devices are approved for the treatment of vessels < 2 mm and their safety and efficacy has not yet been investigated. We present our experience with pREset Lite a retriever approved for vessels > 1.5 mm.

Materials and Methods
From a prospectively maintained database we selected patients treated with pREset-Lite alone or in combination with other devices between August 2013 and October 2014 (n=51). Average age was 73 years (46-91), the median initial NIHSS was 14 (2-27) and the proportion of posterior circulation strokes 14.7%. Time from symptom onset to treatment was 290 min (112-835) with an unknown onset in 14 subjects. End of procedure mTICI ≥2b was achieved in 85.2% and 33.3% of patients were functionally independent (mRS 0-2) at 90 days. Within this population we identified target branches treated with pREset-Lite and their diameter. Efficacy was assessed analyzing the recanalization status of the target branch after thrombectomy with pREset-Lite applying the mTICI score. Intraprocedural complications associated with pREset-Lite and hemorrhages on postprocedure follow-up imaging were reported.

Results
Sixty-two target vessels were treated with pREset-Lite: 42 middle cerebral artery, 13 anterior cerebral artery and seven posterior circulation branches. The average diameter was 1.7 mm (1.3-3.0). 95.2% of targets were ≤2mm and 37.1% ≤ 1.5 mm. mTICI ≥2b was achieved in 44 vessels (71.0%) with an average of 1.3 (1-4) passes. One self-limiting extravasation and one thrombus dislocation were observed. Follow-up imaging revealed parenchymal hematoma type I in two (3.9%), type II in four (7.8%), focal subarachnoid hemorrhage in five (9.8%) and diffuse subarachnoid hemorrhage in one (1.9%) patients.

Conclusions
Thrombectomy of small vessels with pREset-Lite is similarly safe and effective compared to reported data for thrombectomy of larger vessels and can be recommended in thromboembolic occlusion of distal branches supplying eloquent brain tissue.

O-348

MR susceptibility artefact associated with the use of Barricade coils for treatment of intracranial aneurysms

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Purpose
Magnetic resonance angiography (MRA) is a common imaging modality used to follow up patients undergoing endovascular treatment for intracranial aneurysms. Magnetic resonance artifacts from coil constructs should be minimal, allowing for evaluation of the effectiveness of treatment and review of adjacent vasculature. We present here a technical note on the usage of Barricade coils (Blockade Medical LLC, Irvine, CA) recently introduced at our institution.

Materials and Methods
Barricade coils (Blockade Medical LLC, Irvine, CA), were used at our institution, either on their own or in combination with other coils, from September 2013 to April 2014. Follow-up MRAs
were scheduled 6 months postembolization according to local protocol. All patients were scanned on 3T MRI scanners (Achieva, Philips Medical Systems, Best Netherlands or Discovery MR 750, GE Medical Systems). Both authors reviewed all MRAs for aneurysmal closure, artifacts and parent vessel/distal branch patency.

Results
Sixteen cases of intra-aneurysmal coil embolization were performed. Eight patients have been followed up so far with imaging. Endovascular metal stent was used in two patients. Of the other six patients, five had varying degrees of halo artifact on T2, blooming artifact on MR angiogram TOF sequence and loss of adjacent vessel visualization.

Conclusions
The use of Barricade coils has led to significant susceptibility artifacts on routine follow-up MRA in most patients. This clearly hinders visualization of the parent vessels and branches around the aneurysm rendering MRA follow up futile in most cases treated with these coils. Most of our patients will be recalled for invasive digital subtraction angiography (DSA) with its inherent discomfort and risks in order to confirm aneurysm closure and patency of adjacent vessels. With Barricade coils, the artifact appears to be related to the use of a 304V stainless pusher material, comprising 70% Fe+, 0.020" of which is implanted with the coils. The company is developing a new material with reduced iron content to eliminate the unwanted MRA artifact.
Treatment of anterior choroidal artery aneurysms: complication risk factors

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Purpose
Anterior choroidal artery (AChoA) aneurysms are rare vascular malformations (<5% of all intracranial aneurysms). Their treatment is challenging due to the particular conformation of the parent artery, its small size and eloquence of the territory that it supplies.
Materials and Methods
Forty consecutive patients (13 males, 27 females, median age = 50 years), with 47 AChoA aneurysms were treated in our institution (Pitié-Salpêtrière Hospital) between 1999 and 2014. Forty-two aneurysms were treated by endovascular means (regular coiling: n = 33, remodeling: n = 5, stent: n = 4); five aneurysms were treated by clipping. Complications were recorded systematically; major and minor sequelae were recorded systematically on the clinical follow up (average follow up: 66 months). The stability of the treatment was assessed on sequential angiographies (average follow up: 32 months). We tested the influence of age, gender, great axis of the aneurysm, aneurysm volume, shape of the sac and aneurysmal exclusion technique on the occurrence of complications.

Results
Eleven patients (23.4%) had treatment-related complications. Among these patients, six (12.8%) presented transient complications and five (10.6%) had major complications, including three severe sequelae and two deaths. The bilobulated shape of the aneurysm was associated significantly with major complications (p = 0.04). We observed a strong trend (p = 0.1) for the association between small aneurysm volume and severe complications. The angiographic follow up showed a recanalization in 10.6% of the cases.

Conclusions
The treatment of AChoA aneurysms has an acceptable morbidity and mortality rate, that still remain higher compared to the other intracranial aneurysms' locations. We did not show a significant difference in terms of morbidity and mortality between the two techniques of aneurysmal exclusion (surgery and embolization). Bilobulated aneurysms have an excess risk of serious complications. A small aneurysm volume also may be a risk factor for complications.

O-350 9:42AM - 9:50AM
Safety and Effectiveness of Middle Cerebral Artery Aneurysms Treatment (Endovascular and Surgical): Retrospective Analysis of a Single Center Series with 362 Consecutive Patients

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Purpose
Middle cerebral artery (MCA) aneurysms account for 20% of intracranial aneurysms. They are eligible for both treatment options (microsurgery and embolization). The purposes of our study were 1) to evaluate the morbi-mortality rate related to endovascular and microsurgical treatments of ruptured and unruptured MCA aneurysms and 2) to study the effectiveness of endovascular and surgical treatments for these aneurysms in terms of recanalization/recurrence and bleeding/rebleeding at short and long terms angiographic and clinical follow ups.

Materials and Methods
Our study is a mono-centric retrospective observational study performed at the Pitié-Salpêtrière-Charles Foix Hospital, reporting clinical and angiographic follow up of consecutive patients treated for MCA aneurysms (ruptured and unruptured) treatment under the procedure judged the most optimal view point efficacy/safety. From 2002 to 2012, 362 consecutive patients were admitted at our institution for the treatment of 390 MCA aneurysms (255 ruptured and 135
unruptured). Among the procedures, 127 aneurysms were treated by endovascular means (32.5%) and 263 (67.5%) by microsurgery. Procedure-related death and complications (major/minor) were assessed systematically. The per-procedural rupture rate also was evaluated. The quality of the aneurysms exclusion was evaluated according to the Roy-Raymond scale in postprocedure and at long term angiographic follow up (mean delay = 36 months).

Results

Procedure-related death rate was 1.9%. This rate was slightly higher in the group of ruptured aneurysms treated by endovascular (EV) means [3.2% versus 1.2% in the group S (Surgery)], but this difference was not significant (p = 0.23). The procedure-related major complication rate was slightly higher in the group S (5.6% versus 2.4% for the group EV; p=0.19, nonsignificant). Minor complications were slightly more frequent in the group S (5.6% versus 4.8% for the group EV), but this difference also was not statistically significant (p=1). Per-procedure rupture rate was 14.4%; per-procedure ruptures were observed more frequently for ruptured aneurysms treated by microsurgery. During the hospital stay, 69% of the patients with ruptured aneurysms had a favorable outcome (mRS ≤ 3); this rate increased to 72.9% at 6 months and 72.3% at 12 months follow up. In postprocedure, Roy-Raymond grade A or B occlusion rate was 94.8% for the overall population; this rate was similar for the group S and the group EV (95.6% for the group S versus 92.2% for the group EV; NS). However, long term angiographic follow up showed a higher Roy-Raymond grade A or B for the group S [94.2% for the group S versus 78% for the group EV (p<0.01)]. Recurrence rate was 15.1% in the overall population: 0% in the group S versus 28.6% in the group EV (p<0.001). Nevertheless, no bleeding or rebleeding was noticed during the long term (mean delay = 83.5 months) imaging and clinical follow up in both groups S and EV.

Conclusions

Both microsurgical and endovascular techniques are safe for the treatment of MCA aneurysms, with an acceptable complication rate (overall morbi-mortality rate: 5.6%). The two techniques allow for a satisfactory exclusion of aneurysm. However, long term angiographic follow up showed more stable results for the surgical treatment, but without bleeding/rebleeding event observed during the long term clinical follow up for both techniques.

O-351

Some statistical facts about evaluation of effective radiation doses in trauma patients

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Purpose

The purpose of our study was to assess the effective radiation dose of trauma patients who
needed a multidisciplinary treatment in a shock room setting and underwent a whole body CT scan.

Materials and Methods
We included 1254 consecutive examinations between October 1, 2013 and December 1, 2014 in our study. In order to achieve a homogenous, comparable group of trauma patients our focus lied on CT scans of the whole body, viz. (I) cranial CT-scans and (II) combined chest and abdomen CT scans. We made a differentiation of trauma patients according to time of scan (a) by day (n=510; daily shift from 7:30 - 19:30 ) or (b) by night (n=744; night shift from 19:30 - 7:30 ). Effective radiation doses (ICRP103) and important information of the CT protocol (mGy/cm, CTDIvol, scan length, VOI, mAs and kV) were collected. The effective dose was estimated with the dose monitoring program eXposure (Bayer HealthCare, Germany).

Results
Following effective radiation doses were imparted to trauma patients during combined CT-examinations of the body: (I) cranial (a) by day 7.6mSV (177mAs; 116kV) (b) by night 8.8mSV (181mAs; 118kV); (II) chest and abdomen (a) by day 13.2mSV (141mAs; 111kV) (b) by night 14.6mSV (147mAs; 111kV). Analysis showed that effective radiation doses are 10% higher for trauma patients during the night shift.

Conclusions
Our results show a significant discrepancy of effective radiation doses of trauma patients according to the time of scan. We assume that during night and in cases of a very heavy polytrauma a series of factors contribute to a more "easy-going" handling of CT parameters: stress, time-factor, overestimation of patient weight, segmented acquisition, multiple scanning phases, scan length and nonappliance of iterative reconstruction techniques.

Wednesday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

16A - ASSR: THE SPINAL CORD (AR) (SAM)

16A-1
Inflammatory/Demyelinating Diseases of the Spinal Cord

Gasparetto, E.
CDPI-Clinica de Diagnostico por Imagem
Rio de Janeiro

10:30AM - 10:45AM

16A-2
Neurodegenerative Diseases of the Spinal Cord and ALS

Woo, J.
University of Pennsylvania
Philadelphia, PA

10:45AM - 11:00AM
16A-3

Cervical Spondylotic Myelopathy

Flanders, A.
Thomas Jefferson Univ. Hosp.
Philadelphia, PA

16A-4

Novel Techniques in Spine Imaging

Law, M.
University of Southern California, Keck School of Medicine
Los Angeles, CA

16A-5

Questions and Answers

Wednesday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)

16B - STROKE: BEYOND THE CLOT
16B-1

Clot Imaging

Meyers, P.
Columbia University
New York, NY

16B-2

Beyond the Clot: Collateral Imaging
Menon, B.
Foothills hospital, University of Calgary
Calgary, Alberta

16B-3
Perfusion Imaging: Challenges & Controversies

Vagal, A.
University Hospital/University of Cincinnati College of Medicine
Cincinnati, OH

16B-4
ER Imaging Triage in Acute Stroke

Wintermark, M.
Stanford University
Stanford, CA

Wednesday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

16C - ASFNR: RESTING STATE FMRI ON THE MOVE

16C-1
Resting State fMRI: Why Do We Need This?

Holodny, A.
Memorial Sloan-Kettering Cancer Center, Weill Medical College Of Cornell Univ.
New York, NY

16C-2
Resting State fMRI of Language Function

Stufflebeam, S.
Massachusetts General Hospital
Charlestown, MA
16C-3

**Resting State fMRI in the Preoperative Setting**

Shimony, J.
Washington University School of Medicine
Saint Louis, MO

16C-4

**Resting State fMRI of Neurodegenerative Disorders**

Sair, H.
Johns Hopkins Medicine
Baltimore, MD

**Wednesday**

10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)


16D-1

**Tips and Tricks to Overcome Image Degradation from Artifacts**

Rassner, U.
University of Utah
Salt Lake City, UT

16D-2

**MR Imaging of Patients with Pacemakers and ICDs: Best Practices and What You Need to Know**

Litt, H.
Penn Medicine
Philadelphia, PA

16D-3
Imaging Patients with Programmable Shunts

Mamourian, A.
University of Pennsylvania
Philadelphia, PA

16D-4

High Field MR Effects on Otologic Implants

Mosier, K.
Indiana University School of Medicine
Indianapolis, IN

Wednesday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

16E - Subspecialty and Regional Society papers, Dyke Award, Foundation of the ASNR Papers

16E-1

Awards Announcements

16E-2

Gold Medal Award Recipient

Dillon, W.
University of California, San Francisco
San Francisco, CA

16E-3

2015 Louis A. Gilula, MD Mentor Award- (ASSR) - The Needle and the Damage Done - Does Approach Predispose to Inadvertent Penetration During Lumbar Interlaminar Epidural Steroid Injection?
Koontz, N.
University of Utah School of Medicine
Salt Lake City, UT

16E-4
11:10AM - 11:20AM

Gabriel H. Wilson Award- (WNRS) - MR neurography and Tractography for Quantification of Birth-Related Brachial Plexus Injury

Ho, M.
UCSF
San Francisco, CA

16E-5
11:20AM - 11:30AM

Southeastern Neuroradiology Society (SENRS) - MR-Guided Focused Ultrasound in The Brain

Druzgal, T.
University of Virginia
Charlottesville, VA

16E-6
11:30AM - 11:40AM

2015 Cornelius G. Dyke Memorial Award - Cost Effectiveness of Plaque MRI as a Risk Stratification Tool to Guide Medical verses Surgical Management for Asymptomatic Carotid Stenosis

Gupta, A.
NY Presbyerian Hosp./Cornell Univ.
New York, NY

16E-7
11:40AM - 12:00PM

Questions & Answers
Wednesday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

17A - SNIS: DURAL VENOUS SINUS THROMBOSIS (DVST)

17A-1

DVST: Diagnostic Imaging, Pitfalls and Mimics

Ansari, S.
Northwestern University Feinberg School of Medicine
Chicago, IL

147A-2

Endovascular Treatment of Dural Venous Sinus Thrombosis

Satti, S.
Christiana Care Health Center
Newark, DE

17A-3

DVST: Imaging in the Selection of Patients for Endovascular Therapy and Predicting Unfavorable Outcomes

Frei, D.
Radiology Imaging Assoc.
Lakewood, CO

17A-4

Treatment Options in Idiopathic Intracranial Hypertension (IIH)

Hui, F.
Cleveland Clinic
Cleveland, OH

Wednesday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)
17B - ADVANCED IMAGING SEMINAR: METABOLIC NEUROIMAGING BIOMARKERS OF PSYCHIATRIC DISORDERS (PART III)

17B-1  
Neuroreceptor Imaging of Neurotransmitter Abnormalities  
1:15PM - 1:45PM

Kegeles, L.  
Columbia University  
New York, NY

17B-2  
1:45PM - 2:15PM

13C MRS Investigation of Glutamatergic Dysfunction in Major Depression  
Abdallah, C.  
Yale University School of Medicine  
West Haven, CT

17B-3  
2:15PM - 2:45PM

1H MRS of Amino Acid Neurotransmitter Abnormalities in Psychosis  
Rowland, L.  
Maryland Psychiatric Research Center  
Baltimore, MD

Wednesday  
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

17C - EVIDENCE BASED MEDICINE: SPINE IMAGING: SHOW ME THE MONEY: WHAT IS THE EVIDENCE

17C-1  
1:15PM - 1:35PM

Low Back Pain Imaging – Indications and Reporting  
Jarvik, J.  
Univ of Washington  
Seattle, WA

17C-2  
1:35PM - 1:55PM
Spine MR Imaging - Standardization and Nomenclature

Modic, M.
Cleveland Clinic Foundation
Cleveland, OH

17C-3
Spine Interventions: Evidence Based Recommendations

Kallmes, D.
Mayo Clinic
Rochester, MN

17C-4
Advanced Spine MRI– New Approach and Current Evidence

Andre, J.
University of Washington
Seattle, WA

Wednesday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)

17D - SAFETY SYMPOSIUM: NEUROIMAGING GENTLY: CREATING A SAFE AND QUALITY ENVIRONMENT FOR NEURODIAGNOSTICS & NEUROINTERVENTIONS: SAFETY SESSION 2: MODERN MEDICINE AT OUR SCANNERS

17D-1
Controlling CT Radiation Dose

Tanenbaum, L.
Mount Sinai Medical Center
New York, NY

17D-2
Pediatric Sedation: Best Practices
Sawardekar, A.
Northwestern Medicine
Chicago, IL

17D-3
1:55PM - 2:15PM

Rapid Response: Evaluating and Managing Codes and Emergencies at Our Scanners

Meyer, J.
Northshore University Health System
Evanston, IL

17D-4
2:15PM - 2:35PM

Imaging Safely: Expert Review of the Evidence

Blitz, A.
Johns Hopkins Hospital
Baltimore, MD

Wednesday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

17E - CSF: VENTING OUT FLOW DYNAMICS
17E-1
1:15PM - 1:40PM

MRI of Normal Pressure Hydrocephalus

Bradley, W.
University of California San Diego
San Diego, CA

17E-2
1:40PM - 2:05PM

Classification of Hydrocephalus Based on the Point of Restriction of Flow

Rekate, H.
The Chiari Institute
Manhasset, NY
17E-3

Time-SLIP: Applications in the Brain

Yamada, S.
Toshiba Rinkan Hospital
Sagamihara, Kanagawa

17E-4

Discussion

Wednesday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Michigan AB (Level 2)

17F-3D PRINTING IN NEURORADIOLOGY: PATIENT SPECIFICS
17F-1

3D Printing for the Radiologist: A Primer and Clinical Application

Morris, J.
Mayo Clinic
Rochester, MN

17F-2

Craniosynostosis and Individualized Medicine: 3D Printed Patient Specific Templates

Wetjen, N.
May Clinic
Rochester, MN

17F-3

Printing

2:05PM - 2:30PM

2:30PM - 2:45PM

1:15PM - 1:45PM

1:45PM - 2:15PM

2:15PM - 2:45PM
ANATOMICALLY ACCURATE, PATIENT-SPECIFIC INTRACRANIAL ANEURYSM MODELS

J Anderson¹, O Diaz², R Klucznik², Y Zhang², G Britz², R Grossman³, C Karmonik²

¹Houston Methodist Research Institute, Houston, TX, ²Houston Methodist Hospital; Cerebrovascular Center, Houston, TX, ³Houston Methodist Hospital, Houston, TX

Purpose
Aneurysm models have been used previously for patient education, for surgery training/planning, and as visual aids during surgery. Some models have reflected actual patient anatomy, but often are constrained to a small number of representative patients. Methods have not been developed yet to allow clinicians to rapidly and in-house produce patient-specific aneurysm models. The purpose of this research was to develop and validate a method for the 3D printing of patient-specific, intracranial aneurysm models.

Materials and Methods
3D surface reconstructions were derived from digital subtraction angiography images. The surface reconstructions were used to create anatomically accurate models. Models were made in-house using a consumer-grade printer with both polylactic acid (rigid models) and MakerBot Flexible Filament (flexible models). In order to validate model accuracy, the largest aneurysm inner diameter was measured by three independent observers in both the source images and on the 3D printed phantoms. Flow images, using phase contrast MRI, from phantoms were compared with in vivo results.

Results
3D printed aneurysm models were created for all 10 subjects. Good agreement was seen between the models and the source anatomy. No statistically significant group difference (p = 0.4) or bias was observed between aneurysm diameter measurements of the printed models and source images. The standard deviations of the measurements were 0.5 mm and 0.2 mm for source images and 3D models, respectively. Flow images from phantoms compared well with paired in vivo images.

Conclusions
The 3D printed aneurysm models presented are accurate and able to be produced in-house. These models can be used for previously cited applications, but their anatomical accuracy also enables
their use as MRI flow phantoms for comparison with ongoing computational fluid dynamics studies.
Figure 1. A - 3D model, B - 3D print of model, C - 3D print out cut-away, D - MRI flow
Ultra-Short TE MRA in Evaluation of Cerebral Aneurysm Post Treatment Imaging Follow Up

R Shivashankar¹, T Miller², G Jindal², J Simard³, E Aldrich³, D Gandhi³

¹University of Maryland Medical Center, Baltimore, MD, ²University of Maryland Medical Center, Maryland, Baltimore, MD, ³University of Maryland Medical Center, Baltimore, Maryland, Baltimore, MD

Purpose
Imaging follow up of treated cerebral aneurysm is an essential component of continued clinical care. Options include CT angiogram, MR angiogram (MRA) or digital subtraction angiography (DSA). They have limitations including need for contrast, artifacts from coils, stents and clips obscuring the region of interest. Purpose of this study was to compare ultra-short TE MRA to 3D TOF and postcontrast MRA in evaluating the aneurysm for posttreatment imaging follow up.

Materials and Methods
Cohort included six patients postendovascular treatment of aneurysm by coiling, stent-assisted coiling or Pipeline flow diversion. All of them underwent concomitant DSA followed by MRA of the brain including 3D TOF, postcontrast and ultra-short TE MRA on 3T system. 3D TOF and postcontrast MRA scan parameter was standard proprietary. Ultra-short TE MRA scan volumetric imaging slab in sagittal plane was to include the area of interest: parameters include: TR/TE (ms) 700/0.016; slice thickness 1 mm, slice thickness 1 mm/0.5 mm. Images were presented, on a commercial imaging workstation to two experienced neuroradiologists who analyzed images.

Results
Ultra-short TE MRA had least amount of artifact degrading images and allowed improved visualization of the stented segment compared to postcontrast MRA. 3D TOF MRA showed very poor visualization of the stented segment. Postcontrast and silent MRA were equally good in demonstration of residual aneurysm. The 3D TOF MRA did not demonstrate the residual aneurysm to satisfaction.

Conclusions
Ultra-short TE MRA has reduced susceptibility effect from the coils and stents and helps better visualization of the stented vessel, and also equally good in demonstration of residual aneurysm compared to postcontrast MRA. Even though very few cases have been examined in this study the results are promising and need further validation in large number of cohort. The advantage of able to better visualize the stented segment of the vessel without any contrast administration may be very useful for posttreatment imaging follow up of cerebral aneurysms.
Purpose
Understanding the dynamics of aneurysm growth is critical for the appropriate follow up of patients after coil embolization and the need for retreatment. The purpose of the study was to assess growth dynamics of aneurysm recurrences after coiling quantitatively by volumetric analysis of coregistered 3D time-of-flight (TOF) magnetic resonance angiography (MRA) follow-up datasets and to determine factors predicting the occurrence and dynamics of residual flow.

Materials and Methods
Source images of each follow-up TOF MRA scan were compared to the first postinterventional TOF MRA scan and analyzed for residual flow after registration using ANALYZE-software. In case of incomplete occlusion recurrence volume was segmented and calculated. Growth dynamic was determined for each aneurysm after embolization.

Results
In total 388 patients with 416 aneurysms from three centers were analyzed. Each of them had at least two TOF MRA exams (Mean 4) after endovascular therapy. The mean observation interval was 97 months. Volumetric analysis of 1513 follow-up MRAs revealed that two thirds of treated aneurysms were completely occluded at first follow-up imaging, thereof 94% remained stable. One fourth showed a predominant steady increase of recurrence volume (27.9%), whereas a decrease (4.4%) and an undulant dynamic (5%) were rare.

Conclusions
Our multicenter study confirms the stability and efficacy of endovascular treatment for cerebral aneurysms. The volumetric analysis of registered 3D TOF MRA follow-up datasets in an independent core laboratory represents a promising approach for future studies analyzing more complex aneurysm- and patient-related predictors of the occurrence and the dynamics of residual flow.

O-355
3:39PM - 3:47PM

High Resolution MRI Vessel Wall Imaging Technique for Localizing the Ruptured Aneurysm

D Gandhi1, T Miller2, N Beaty1, J Simard1, E Aldrich1, R Shivashankar3
1University of Maryland Medical Center, Baltimore, Maryland, Baltimore, MD, 2University of Maryland Medical Center, Maryland, Baltimore, MD, 3University of Maryland Medical center, baltimore, MD

Purpose
Subarachnoid hemorrhage (SAH) is a common clinical condition. At presentation, multiple aneurysms may be detected in up to 30% of patients. Localizing signs such as asymmetric blood distribution and presence of cranial neuropathy may help direct treatment towards the ruptured aneurysms. However, in many cases, such signs are not present and subarachnoid blood pattern
is diffuse. We present the largest to-date experience with high resolution MR vessel wall imaging technique in localizing the ruptured aneurysm.

Materials and Methods
Thirteen consecutive cases of diffuse SAH and multiple aneurysms on CTA underwent contrast-enhanced vessel wall imaging (vWI) at our institution. TSE T1W black blood sequence with and without contrast was utilized on 3T magnet. The following information was recorded on chart and imaging review: demographics, aneurysm location and number, size, presence and characteristics of wall enhancement on vWI, treatment and outcomes.

Results
Cohort included 12 female and one male patients. There were two aneurysms in six patients, three in three, four in three and five aneurysms in one patient. Vessel wall imaging identified robust wall enhancement in all ruptured aneurysms and, mild enhancement of part of the dome in one unruptured aneurysm (false positive). Presumed source of hemorrhage was targeted for therapy in all patients other than one with very poor clinical grade. Ten index aneurysms were treated endovascularly and three were clipped. There was no instance of re-rupture or delayed SAH. Ten additional aneurysms have been treated since in the follow-up period, six with clipping and four endovascularly.

Conclusions
High resolution vWI is a promising tool for detecting ruptured aneurysms (as well as rupture site), demonstrating circumferential focal wall enhancement after contrast. In one case, there was false positive focal enhancement of an MCA aneurysm. In that case, both aneurysms demonstrating enhancement were targeted at the same admission.

O-356
3:47PM - 3:55PM
Follow-up of intracranial aneurysms treated by stent-assisted coiling: preliminary results comparing time-of-flight MR angiography (TOF-MRA) and contrast-enhanced MR angiography (CE-MRA) with digital subtraction angiography (DSA) as gold standard

D IANCU1, N Larocque2, A Quateen3, S Patro4, R Thornhill4, C Lum5
1THE OTTAWA HOSPITAL, OTTAWA, UT, 2The University of Ottawa, Ottawa, Ontario, 3Neuroradiology Section, University of Ottawa, Ottawa, Ontario, 4The Ottawa Hospital, Ottawa, Ontario, 5University of Ottawa, Ottawa, Ontario

Purpose
Follow up of intracranial aneurysms treated by stent-assisted coiling with MRI is complicated by imaging artifacts produced by stents in addition to coils. This study compares the diagnostic accuracy of three-dimensional time of flight MR angiography (3D TOF MRA) and contrast-enhanced MRA (CE MRA) for the evaluation of aneurysm occlusion and parent artery patency after stent-assisted coiling, with digital subtraction angiography (DSA) as the gold standard.

Materials and Methods
Patients treated with stent-assisted coiling at the University of Ottawa between July 2006 and November 2014 followed by MRA (3D TOF MRA and CE MRA) and DSA within a 6-week period were reviewed retrospectively from a prospective single-center database. Images were presented randomly to two independent blinded neuroradiologists. Aneurysm occlusion was
assessed with full and simplified Montreal scales and parent artery patency using two-grading scales.

Results
There were 65 patients with 66 aneurysms and 109 sets of imaging included. The stents used were LVIS Jr. (n=26), Neuroform (n=20), Solitaire (n=10) and Enterprise (n=10). Intermodality agreement for aneurysm occlusion and vessel patency was higher for CE MRA (0.85 and 0.93) than for TOF MRA (0.86 and 0.67). For aneurysm occlusion detection, CE MRA had comparable performance to TOF MRA (sensitivity 75%, 95% CI 0.53-0.90 versus 69%, 95% CI 0.39-0.91; specificity 88%, 95% CI 0.78-0.94 versus 91%, 95% CI 0.79-0.97). There was no difference in the evaluation of aneurysm remnant with CE MRA or TOF MRA for LVIS Jr stents (82.40% and 84.2%) versus other stent types (87% and 81.2%) (P=0.51). Although none of the six instent stenoses visualized on DSA were detected with either TOF MRA or CE MRA, the CE MRA was more specific than TOF MRA for parent vessel patency (93% versus 67%). There were fewer substantial artifacts on TOF MRA and CE MRA for LVIS Jr stents (7.2% and 0%) compared with other stents (31% and 6%) but this did not reach statistical significance (P=0.07 and P=0.08 respectively).

Conclusions
Contrast-enhanced and TOF MRA are comparable for evaluation of stent-assisted aneurysm occlusion. Contrast-enhanced MRA has a higher specificity for ensuring parent artery patency. LVIS Jr stents produced fewer artifacts than other stents on TOF MRA.

O-357

Follow-up of intracranial aneurysms treated by SILK flow diverter: comparison of three-dimensional time-of-flight MR angiography (3D-TOF-MRA) and contrast-enhanced MR angiography (CE-MRA) with digital subtraction angiography (DSA) as the gold standard

DIANCU1, S Patro2, R Thornhill2, N Larocque3, A Quateen4, C Lum5
1THE OTTAWA HOSPITAL, OTTAWA, UT, 2The Ottawa Hospital, Ottawa, Ontario, 3The University of Ottawa, Ottawa, Ontario, 4Neuroradiology Section, University of Ottawa, Ottawa, Ontario, 5University of Ottawa, Ottawa, Ontario

Purpose
Followup of intracranial aneurysms treated by flow diverter stents with MRI is complicated by imaging artifacts produced by these devices. This study compares the diagnostic accuracy of three-dimensional time-of-flight MR angiography (3D TOF MRA) and contrast-enhanced MRA (CE MRA) for the evaluation of aneurysm occlusion and parent artery patency after flow diversion treatment, with digital subtraction angiography (DSA) as the gold standard.

Materials and Methods
Patients treated with SILK flow diverter between August 2012 and October 2014 followed by MRA (3D TOF MRA and CE MRA) and DSA within a 3-week period were reviewed retrospectively from a prospective single-center database. Images were presented randomly to two independent blinded readers. Aneurysm occlusion was assessed with full and simplified Montreal scales and parent artery patency with two-grade scales.

Results
There were 23 patients with 27 aneurysms and 39 sets of imaging included. For the assessment
of aneurysm class, there was very good agreement between the two readers on DSA (Kappa =0.97, 95% CI 0.92-1.00), CE MRA (Kappa =1.00, 95% CI 1.00-1.00) and TOF MRA (Kappa =0.82, 95% CI 0.59-1.00). There was moderate agreement (Kappa =0.51, 95% CI 0.28-0.74) between CE MRA and TOF for the assessment of aneurysm class. For the instent stenosis assessment, there was very good agreement between the two readers for DSA (Kappa =0.94, 95% CI 0.82-1.00), CE MRA (Kappa =0.93, 95% CI 0.79-1.00) and TOF MRA (Kappa =0.93, 95% CI 0.79-1.00). There was good agreement (Kappa =0.69, 95% CI 0.41-0.97) between CE MRA and TOF for the assessment of instent stenosis. With respect to aneurysm occlusion, CE MRA conferred similar performance to TOF (sensitivity 91% versus 96%; specificity 79% versus 62%). While both CE MRA and TOF provided 100% specificity for detection of instent stenoses, CE MRA provided greater sensitivity than TOF (60% versus 35%).

Conclusions
Time of flight and CE MRA are comparable and seem appropriate in lieu of DSA for assessment of aneurysm occlusion in patients treated with SILK flow diverters. However, stent artifact on MRI prevents adequate assessment of in-stent stenosis. The clinical relevance of lower sensitivity for stenosis detection is not yet known.

O-358

4:03PM - 4:11PM

Is visual evaluation of aneurysm coiling a reliable study endpoint? Systematic review and meta-analysis

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¹Neuroradiology, Hamburg, Germany, ²Department of Medical Psychology, Hamburg, Germany, ³Massachusetts General Hospital, Boston, MA, ⁴Department of Diagnostic and Interventional Neuroradiology, Hamburg, Hamburg

Purpose
Angiographic occlusion as a surrogate marker of satisfactory aneurysm treatment is commonly used in clinical trials. To investigate the interrater reliability of visual rating of aneurysm recurrence as study endpoint we performed a systematic review and meta-analysis.

Materials and Methods
Electronic databases (MEDLINE, EMBASE, PubMed and the Cochrane Library) were searched up to June 2014. Assessment of risk for bias was based on the Quality Appraisal Tool for Studies of Diagnostic Reliability and the Guidelines for Reporting Reliability and Agreement studies. Interrater reliability estimates were pooled across studies using meta-analysis and the influence of several factors (e.g., imaging methods, grading scales, and occlusion rate) was tested with meta-regression.

Results
From 1193 titles, 644 abstracts and 87 full-text versions were reviewed. Twenty-six articles met the inclusion criteria and provided 77 reliability estimates. Twenty-one different rating scales were used, and statistical analysis varied. Mean interrater agreement of the pooled studies was substantial [kappa=0.65 (95% CI 0.60 to 0.69)]. Reliability varied significantly as a function of imaging methods, grading scales, occlusion rates, and their interaction. Observer agreement substantially increased with increasing occlusion rate in DSA but not in MRA. Reliability was higher in studies using 2- or 3-value grading scales than in studies with 4-value grading scales.
Conclusions
There is significant heterogeneity within studies evaluating the reliability of visual evaluation of aneurysm coiling. Based on our analysis, the combination of MRA, 3-value-grading scale and two trained raters seems most promising for future studies.

O-359
4:11PM - 4:19PM
Clinical and Angiographic Outcomes of Stent-assisted Coiling of Intracranial Aneurysms

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Purpose
Despite the increasing use of stent-assisted coiling (SAC), data on its long term clinical and angiographic results are limited. We sought to assess the long-term clinical and angiographic outcomes in SAC in our single center practice.

Materials and Methods
Retrospective analysis of intracranial aneurysms treated with detachable coils period 2003-2012. Patients were divided in SAC and non-SAC were analyzed for aneurysm occlusion, major recurrence and clinical outcome. Logistic regression analyses identified factors associated with clinical/angiographic outcomes (p-value <0.05 was statistically significant).

Results
A total of 516 procedures met inclusion criteria; 63(12.2 \%) underwent SAC of which 56(89\%) had an elective procedure whereas 286(63.1\%) aneurysms from the non-SAC group were ruptured. In the unruptured subcohort, baseline class I was achieved in 24(38\%, p=0.91), pre-discharge modified Rankin Score (mRS) 0-2 was obtained in 96.4\% of cases in the SAC group versus 90.4\% in the non-stent group. The major recurrence was 9.5\% versus 11.3\% in the SAC and non-SAC group, respectively (p=0.003). At last clinical assessment, 98.2\% of the patients from the unruptured SAC group had mRS 0-2 (mean follow up, 58 months) versus 93.6\% (mean follow up, 56 months) in the unruptured non-SAC group (P=0.64). Periprocedural vasospasm was associated with long-term poor outcome in the unruptured SAC subcohort (p=0.0008).

Conclusions
Stent-assisted coiling and non-SCA techniques show comparable safety and clinical outcome. Stent-assisted coiling technique significantly decreases retreatment rates. Periprocedural vasospasm resulting from vessel manipulation is associated with poor outcome in SAC of unruptured aneurysms.

O-360
4:19PM - 4:27PM
The effects of packing density on the clinical and angiographic outcome after coil embolization of unruptured intracranial aneurysms.
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Purpose
To identify the impact of two arbitrarily established packing density thresholds in the angiographic and clinical outcome of unruptured intracranial aneurysms (UIA) treated with endovascular coiling.

Materials and Methods
Retrospective analysis of all patients with spherical, ellipsoid and bilobed unruptured intracranial aneurysms (UIA) treated with coil embolization in our institution. Parent artery occlusion and flow-diverter cases were excluded. Packing density was obtained using AngioCalc software application (www.angiocalc.com) and was classified in <20% versus ≥20%. We collected demographic (age, gender, co-morbidities), procedural (technique of coiling), angiographic (no residual/neck residual versus sac residual) and modified Rankin score (mRS) data at pre-discharge and at last clinical assessment. Angiography class results were assessed at baseline postcoiling and yearly postcoiling. Statistical analysis used frequency analysis, logistic regression models and comparative frequencies (a significant p value was set at <0.05).

Results
From a total of 536 consecutive patients treated with endovascular coiling from 2002 to 2011, 102 patients met our inclusion criteria. Our preliminary analysis showed that a packing density threshold at <20% was significantly associated with higher predischarge and long term mRS, increased length of hospital stay, procedural vasospasm, retreatment, and recurrence. There were no observable ruptures postcoiling, during our follow up. Technique of coiling was not associated with the two thresholds of packing density. Over the course of this study, one patient had a delayed death (packing density >20%).

Conclusions
Packing density may play a role in the clinical and angiographic outcome after coil embolization of unruptured aneurysms. Our results require validation in prospective studies.

O-362

Long-Term Clinical And Angiographic Outcome In Intracranial Aneurysms Treated With Parent Artery Occlusion

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Purpose
Parent artery occlusion (PAO) has an important role in intracranial aneurysms nonamenable to standard endovascular techniques. We reviewed the long term clinical and angiographic outcomes in patients treated with parent artery occlusion (PAO). We assessed the outcomes
relative to aneurysm morphology, location, rupture status along with clinical presentation and angiographic result.

Materials and Methods
We retrospectively reviewed the clinical and angiographic outcomes of patients treated with PAO from March 2005 to December 2013. Pearson's chi squared analysis was used to determine the variables predictive of occlusion status and clinical outcome according to modified Rankin Score (mRS).

Results
Of the 30 patients who underwent PAO, 14 (46.6%) presented with aneurysms in the anterior circulation. Sixteen (53.3%) aneurysms were ruptured, 12 (40%) had a fusiform configuration, 15 (50%) had maximum length > 10 mm, 23 (76.6%) had a neck size < 10 mm, and 19 (63.3%) of the patients had an unfavorable (< 2) dome-to-neck ratio. Twenty-five (83%) patients had complete baseline occlusion. We found two (6.6%) recurrences after PAO (mean follow up 22.1 months). We found no peri-procedural deaths, and no ruptures post-PAO.

Conclusions
Parent artery occlusion was demonstrated to be a safe and effective procedure in selected complex intracranial aneurysms.
Erectile dysfunction (ED) is a common complication of all forms of prostate cancer treatment due to damage to the neurovascular bundles. There are strong indications from many studies that preservation of the neurovascular bundles avoids post-treatment ED. The cavernosal nerve is the main nerve supply mediating erectile function, and its preservation is critical to the prevention of ED.
treatment-induced 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 or TTc790 in a total volume of 20 µl in the tunica albuginea of the left corpus cavernosum. Animals were imaged at open surgery at 1 hour postinjection with a Near-Infrared capable intra-operative microscope. Tissues were harvested and the cavernosal nerves, prostates, nerve plexi were dissected, followed by ex vivo imaging and histological analysis.

Results
We were able to image the exposed genital nerves. We were able to show fluorescent TTc-related signal uptake along the expected course of the nerve tracts ipsilateral to the injection site. Both intra-operative imaging and histological assessment confirmed visualization of the pelvic nerve ganglion, a key structure in nerve preserving surgery of the prostate.

Conclusions
We show that TTc could be used as a nerve imaging agent to demonstrate the cavernosal nerves by imaging. This suggests that molecular imaging 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.

Wednesday
3:15PM - 4:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

18C - PARALLEL SCIENTIFIC PAPER SESSION-DEGENERATIVE AND METABOLIC DISEASES
O-363 3:15PM - 3:23PM

Imaging Predictors of Memory and Non-memory Decline Amongst Cognitively Normal Individuals

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Purpose
Brain amyloidosis and hypometabolism derived from PET scans, as well as volumetric and cortical thickness measures derived from MRI have been shown to be useful in differentiating Alzheimer disease from other forms of dementia (1, 2). However, it is unclear whether these measures are useful predictors among normal individuals. The purpose of our analysis was to determine which imaging measures best predict cognitive decline in a normal cohort.

Materials and Methods
Two hundred sixty-seven cognitively normal elderly individuals from the Alzheimer's Disease Neuroimaging Initiative (ADNI) were included in this analysis. All subjects underwent
florbetapir amyloid and FDG PET scans per ADNI protocol. One hundred forty-two of the 267 also underwent a volumetric 3D T1-weighted MRI scan for derivation of volumes and cortical thickness measures. Memory decline was defined as conversion from 0 to at least 0.5 on the Clinical Dementia Rating memory subscore (3). Nonmemory decline was defined as conversion from 0 to at least 0.5 using the sum of the five nonmemory subscores of the Clinical Dementia Rating scale. Cox proportional-hazards regression models were used to determine which PET or MRI measures best predicted decline, adjusting for demographics and APOE2/APOE4 status.

Results
Forty-seven (18%) and 52 (19%) of the 267 subjects demonstrated memory decline and nonmemory decline, respectively, during follow up. Adjusting for covariates, amyloidosis significantly predicted both memory (hazard-ratio=7, p=0.005) and nonmemory decline (hazard-ratio=4, p=0.03), whereas hypometabolism did not (p=0.7, p=0.9). A higher cortical thickness in the posterior cingulate gyrus predicted lower risk of memory decline (hazard-ratio=0.1, p=0.05), but not nonmemory decline (p=0.8). Having a posterior cingulate thickness measuring less than 1 standard-deviation below average demonstrated a hazard-ratio of nine in predicting memory decline (p=0.05). In subjects who had both PET and MRI, the posterior cingulate thickness remained a significant predictor of decline, whereas amyloidosis did not, after including both in the model. Hippocampal and entorhinal cortex volumes were not predictive of decline.

Conclusions
Among normal elderly individuals, amyloidosis and cortical thickness of the posterior cingulate gyrus were significant predictors of cognitive decline. However, posterior cingulate thickness was a better predictor of decline when both measures were included in the model and was more specific for memory decline.

O-364

Hippocampal Cell Volume Fraction (“Cell Density”) is Stable Despite the Known Loss of Hippocampal Volume with Normal Human Aging

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Purpose
To determine the age-dependence of hippocampal cell volume fraction (CVF), given the loss of volume associated with normal aging.

Materials and Methods
Normal volunteers (n=48, age 22-80 years, 49±19 years (range, mean±SD); 23 male) consented for this IRB approved protocol. Quantitative sodium MR imaging used a customized 9.4T human scanner (1) and the flexible twisted projection imaging sequence under conditions of full T1 relaxation and minimal T2 relaxation (TR=160ms,TE=0.26ms,FA=90 degrees, isotropic voxel dimension=3.5mm) (2) with corrections for B0 and B1 inhomogeneities (2). Signal intensities were converted to tissue sodium concentration (TSC) using a 3-point calibration phantom (30, 70 and 110mM NaCl in 3% agarose gel) that matched the coil loading of a human head. Cell volume fraction was derived from TSC using the two-compartment model equation: CVF=(TSC–Ce)/(Ci-Ce) where Ci and Ce are intracellular and extracellular sodium
concentration, respectively (2). Coronal TSC maps were examined by region of interest analysis of the hippocampus using easily identifiable cerebrospinal fluid landmarks of choroid fissure superiorly, temporal horn laterally, atrium posteriorly and ambient cistern medially. Laterality differences in hippocampal CVF, TSC and volumes were examined by 2-tailed paired t-test (p<0.05). The relationships of hippocampal CVF, TSC and volumes as a function of age were analyzed by linear correlation.

Results
Although no laterality differences were found for hippocampal volumes (p=0.4), CVF and TSC did show small but significant laterality differences (p=0.013, CVF: right 0.804, left 0.799; TSC: right 38.0, left 38.7). However, no significant age dependent relationships were found for CVF or TSC for either side [Pearson coefficient >0.2, p>0.09, (Figure 1)].

Conclusions
This in vivo MR imaging observation of hippocampal CVF remaining stable with age in cognitively normal humans confirms the in vitro stereology literature reporting neuronal numbers and cell density remain constant with age (3). Cell volume fraction is a potential early surrogate marker of cell loss in early stages of Alzheimer disease.

![Figure 1: (a) CVF and (b) TSC for left (□) and right (O) hippocampus as a function of age. The data are fitted with linear correlations given as equations with fitting](TCT_O-364_Figure1forASNRhippo.jpg)

O-365

M Mild cognitive impairment (MCI) is an intermediate stage between normal aging and Alzheimer disease. We hypothesize an association between diffusion tensor (DTI) and kurtosis (DKI) metrics and the degree of impairment on neurocognitive testing in patients with MCI.

Materials and Methods
A total of 23 patients with MCI were included in this study. Standardized neurocognitive testing battery was performed in the following domains: visuospatial/visuoconstructural, executive function, language and memory. Test results were converted to z scores and the average of the four category z scores was reported as the composite score. Brain MRI was performed on a 3T Siemens scanner with a 12-channel matrix head coil. In addition to standard clinical images, diffusion imaging was performed using 30 gradient encoding directions and three b-values: 0, 1000, 2000. Image processing was performed with Diffusion Kurtosis Estimator (DKE) software. Anatomical regions of interest (ROIs) were placed bilaterally on the hippocampus, anterior centrum semiovale, posterior centrum semiovale, thalamus, internal capsule posterior limb, corpus callosum genu and corpus callosum splenium. Axial, radial, and mean kurtosis (MK); axial, radial, and mean diffusivity (MD) and fractional anisotropy (FA) were calculated for each ROI. Kendall tau coefficient was used to measure the association between diffusion metrics and neurocognitive z-score results. P values were declared statistically significant when <0.05 and a trend when <0.10.

Results
Significant correlation between clinical cognitive measures and diffusion parameters were observed. Corpus callosum splenium MD negatively correlated and MK and FA positively correlated with visuospatial/visuoconstructural z score. Corpus callosum genu MK and FA positively correlated with executive z score with a trend toward negative correlation with MD. Left hippocampal MD negatively correlated with memory z score with a trend toward positive correlation with FA memory z score. Right hippocampus MD trended toward a negative correlation with memory z score. Composite z score positively correlated for bilateral anterior centrum MK and corpus callosum genu FA

Conclusions
We observed statistically significant and potentially meaningful correlations in diffusion and kurtosis parameters with neurocognitive testing measures in patients with MCI. Similar findings have been described in patients with Alzheimer disease (AD), and longitudinal studies may indicate which of these metrics may be predictive of progression of MCI to AD. In addition, such correlations may lead to imaging markers of the severity of cognitive impairment in patients with MCI.

O-366
3:39PM - 3:47PM

Diabetes, Thalamic Degeneration and Postural and Gait Dysfunction in Parkinson Disease

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Purpose
Previous studies have shown more severe motor symptoms and specifically greater postural instability in Parkinson disease (PD) patients with co-morbid diabetes (DM). The mechanism underlying this remains unclear. The thalami have an important role in posture control and thalamic structural and metabolic alterations have been described in both PD and DM. The purpose of our study was to address the effects of DM on thalamic volumes and their relationship to motor outcomes in a cohort of PD patients.

Materials and Methods
Thirty-six PD subjects (12 DM; 32M/4F; mean age 66 years) were included in the study. All subjects underwent high resolution T1 imaging on a 3T MR unit as well as [11C]-DTBZ brain PET imaging to assess nigrostriatal dopaminergic denervation (primary pathology in PD). All patients underwent MR. Data were segmented using a multi-atlas consensus labeling method, based on the DRAMMS deformable registration algorithm. The Movement Disorder Society rating scale was performed on all subjects and subscores for Bradykinesia, Tremor, Rigidity and Postural Instability and Gait Difficulty (PIGD) were calculated. Effect of DM on right and left thalamic volumes were defined with an ANCOVA model accounting for effects of age, gender, intracranial volume (ICV), and striatal [11C]-DTBZ binding. Associations between thalamic volumes and motor scores also were assessed.

Results
Effects of DM on thalamic volumes were significant (p=0.01), with lower thalamic volumes in the diabetic group. There also was significant association between thalamic volumes and PIGD scores (p=0.006). Associations between thalamic volumes and tremor, rigidity and bradykinesia scores were not significant.

Conclusions
Co-morbid diabetes in the setting of PD is associated with decreased thalamic volumes and related greater postural instability and gait difficulty.

O-367 3:47PM - 3:55PM

Diagnosis of parkinsonism by 3T MRI of the nigrosonme: The strong correlation between susceptibility-weighted imaging and 123I-FP-CIT-SPECT findings

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Purpose
Nigrostriatal dopaminergic degeneration in parkinsonism results in the loss of the nigrosonme,
which can be visualized by 7T susceptibility-weighted imaging (SWI). Recently, Schwarz et al. demonstrated that the nigrosome also could be observed by 3T SWI. However, they could not evaluate the integrity of the nigrostriatal pathway, because they did not conduct 123I-FP-CIT-SPECT. To our knowledge, no study has been performed to ascertain if absence of the nigrosome on SWI is correlated with striatal degeneration indicated by 123I-FP-CIT-SPECT. In addition, the nigrosome has not been evaluated by SWI in multiple system atrophy and progressive supranuclear palsy, which also exhibit striatal dopaminergic degeneration on 123I-FP-CIT-SPECT. In this study, we evaluated striatal degeneration by 3T SWI of the nigrosome in patients with parkinsonism and compared diagnostic performance of this method with 123I-FP-CIT-SPECT.

Materials and Methods
Between January 2012 and August 2014, both 123I-FP-CIT-SPECT and 3T fast field echo SWI were performed on 191 consecutive patients with movement symptoms in our institution. Parkinsonism (i.e., idiopathic parkinsonism, multiple system atrophy, and progressive supranuclear palsy) was first diagnosed with clinical criteria, and confirmed with 123I-FP-CIT-SPECT. Two blinded observers interpreted the presence of the nigrosome on SWI, followed by a consensus reading. Parkinsonism was indicated if the nigrosome was absent on SWI on at least one side. Diagnostic accuracy was calculated and compared with 123I-FP-CIT-SPECT.

Results
A total of 156 patients (34 control and 122 patients with parkinsonism) were included in the study. Specifically, 115 patients demonstrated bilateral striatal degeneration on 123I-FP-CIT-SPECT. Among these, 97 patients showed bilateral loss of the nigrosome on SWI, and nine patients exhibited unilateral loss. Unilateral striatal degeneration on 123I-FP-CIT-SPECT was observed in six patients with unilateral idiopathic parkinsonism and one patient with multisystem atrophy cerebellar type. Notably, one patient with idiopathic parkinsonism exhibited unilateral loss of the nigrosome on SWI and unilateral striatal degeneration at the same side on 123I-FP-CIT-SPECT, suggesting that applying both methods may solidify the diagnosis of unilateral idiopathic parkinsonism. For SWI, diagnostic sensitivity and specificity for parkinsonism were 88.5% and 61.8%, respectively. When we calculated diagnostic accuracy of SWI on the basis of SPECT diagnosis, the values were same.

Conclusions
The loss of a typical appearing nigrosome on 3T SWI provides good diagnostic performance for parkinsonism, and is correlated with striatal degeneration observed on 123I-FP-CIT-SPECT. In many clinical settings 123I-FP-CIT-SPECT is not a viable option and patients often refuse to undergo an 123I-FP-CIT-SPECT examination due to its high cost or to avoid substantial radiation exposure. Therefore, SWI can complement 123I-FP-CIT-SPECT to diagnose parkinsonism, but one must consider that degeneration observed on 123I-FP-CIT-SPECT may precede detection by SWI.
Subcortical Gray Matter Volumes Do Not Differentiate Between Parkinson's Disease Motor Subtypes

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Purpose
Parkinson disease (PD) patients can be divided into tremor dominant (TD) and postural instability gait dominant (PIGD) motor subtypes. Tremor dominant and PIGD patients differ in their rates of disease progression and severity. Using voxel-based morphometry, Rosenberg-Katz et al. recently reported greater cortical gray matter atrophy in PIGD compared with TD patients (1). Only one volumetric MR study to date has investigated subcortical volumes in TD and PIGD patients which found no significant differences. This study, however, used a 1.5 T MRI and visual analysis, which may not be sufficiently sensitive to detect subtle differences (2). We utilized an automated volumetric MRI method to determine whether subcortical gray matter volumes differ between subtypes. We hypothesized that there would be smaller subcortical gray matter volumes in PIGD compared to TD patients.

Materials and Methods
Twenty-one PD patients and 20 age and gender matched healthy controls were recruited. All patients were taking and responsive to dopaminergic medication. Twelve patients were classified as TD and nine as PIGD. 3.0T high-resolution T1-weighted images were obtained using an 8-channel coil on a GE Signa scanner. MR imaging parameters were as follows: FOV=22, matrix 256 x 256, 140 slices, and slice thickness=1.2 mm, coronal plane, resulting in voxel resolution of 1x1x1.2 mm³. Automated segmentation of subcortical gray matter structures and calculation of total intracranial volume was conducted using FreeSurfer. We examined the putamen, caudate nucleus, globus pallidus, hippocampus, amygdala, and nucleus accumbens. Groups were compared on continuous and dichotomous demographic variables using independent t-tests and chi-square, respectively. For each structure, left, right and total bilateral gray matter volumes were analyzed for the main effect of group using analysis of covariance (ANCOVA), after adjusting for age and TICV. Statistical analyses were performed using SPSS. A significant group difference was defined as p<0.05.

Results
While mean subcortical volumes were smaller in the PIGD subtype for all structures except the hippocampus, no statistically significant differences were observed. Post hoc analysis comparing the subcortical volumes of the PD and control groups did reveal a significant difference in total hippocampal volumes with PD patients showing larger volumes compared to controls (p=0.03). No other statistically significant differences in volumes between PD patients and controls were found.

Conclusions
Our data strengthen the PD subtype volumetric literature verifying earlier findings with data acquired at 3T and processed with advanced automated segmentation methods. An unexpected and novel secondary finding was the presence of larger hippocampal volumes in PD patients.
compared with controls. This may be related to the use of improved automated methods or due to biologic changes, possibly related to dopaminergic therapy resulting in chronic supra-physiologic stimulation of hippocampal pathways (3-5). Further studies are needed to test this possibility and to determine the clinical significance of such volumetric change.

(Filename: TCT_O-368_Hippocampalvol95CI.gif)

O-369

Quantitative MR imaging biomarkers in premanifest Huntington’s disease

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Purpose

Huntington's disease (HD) is a progressive, fatal, autosomal dominant, neurodegenerative disease. Imaging biomarkers sensitive to disease progression during the premanifest phase will allow efficacy of new therapies to be evaluated. T1 relaxation in the rotating frame (T1ρ) is a quantitative MR imaging technique that generates its contrast from proton exchange. The goal of this project was to use advanced neuroimaging techniques to investigate changes in T1ρ as compared to other relaxation measures (T2 and T2*) among premanifest HD (preHD) individuals of different progression levels and normal controls.

Materials and Methods

Quantitative T1ρ, T2 and T2* MR parametric mapping were used to assess differences in 50 subject with preHD matched to 26 controls. Subjects with preHD were classified into two progression groups based on their CAG-age product (CAP ) score; a (HiCAP) group included 24 subjects with high CAP score (≥367), and a (LoMoCAP) group included 26 subjects with low
and moderate CAP score (<367). A voxel-wise approach and a region of interest analysis were used in this analysis.

Results
The HiCAP group demonstrated a prolonged T1ρ relaxation in the basal ganglia structures, particularly the putamen, as compared to both the control and LoMoCAP groups. No corresponding changes in T2 relaxation were seen between the groups. Both HiCAP and LoMoCAP had a shorter T2* relaxation compared to controls in the globus pallidus with no statistical difference between the HiCAP and LoMoCAP groups. The CAP score positively correlated with the T1ρ relaxation in the left putamen. The trails making test b cognitive assessment and the motor score positively correlated with the T1ρ relaxation in subserving motor regions.

Conclusions
The findings of this study suggests that T1ρ relaxation may be a good marker for monitoring disease progression in preHD while T2* changes do not appear to progress with disease. T1ρ relaxation is influenced by metabolism (pH, glucose, glutamate) and macromolecule concentrations. Further work is needed to understand the cause of the T1ρ changes found here. The strong correlation with deterioration in motor skills suggest that metabolic alterations in the striatum may be contributing significantly to the development of symptoms.

O-370

White and gray matter changes in adults with Niemann-Pick disease type C and correlation with clinical features

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Purpose
Niemann-Pick disease type C (NPC) is a progressive neurometabolic disorder causing neuronal and axonal alterations. We aimed to 1) assess volumetric and microstructural changes of gray and white matter and 2) correlate volumetric and microstructural changes in selected anatomical brain regions with clinical findings in adults with NPC.

Materials and Methods
We performed voxel-based morphometry (VBM) of 3D-T1WI and tract-based spatial statistics (TBSS) of DTI metrics (FA, MD, AD, and RD) to examine gray matter volumetric and white matter microstructural differences between NPC patients and age-matched controls. In addition, we performed atlas-based analysis of DTI metrics and correlated volume, FA, MD, AD, and RD values of selected anatomical regions with clinical findings including mini-mental status examination (MMSE), Iturriaga disability scale, and an ataxia scale (SARA).

Results
We included seven NPC patients (mean age 32.25±8.71 years) and seven age-matched controls (mean age 32.51±8.65 years). Tract-based spatial statistics revealed reduced FA and increased MD, AD, and RD in major white matter tracts in NPC patients compared to controls. Voxel-based morphometry showed reduced volume of cerebellum, basal ganglia, temporal operculum,
and parietal cortex in NPC patients compared to controls. We found multiple correlations between DTI scalars and clinical findings including total score MMSE and MD and RD within the bilateral superior and middle frontal gyri and language repetition and MD, AD, and RD within the middle and inferior left temporal gyri.

Conclusions
Diffuse changes in FA, AD, and RD most likely reflect alterations of white matter microstructure secondary to disrupted/injured myelination and axonal structure. Changes in gray matter volume are focal and may represent a selective vulnerability of certain anatomical structures in NPC. Despite the small cohort of patients, correlations between DTI metrics and clinical findings suggest that DTI may be a useful quantitative biomarker for indexing the clinical impairment and monitoring treatment response.

O-371
4:19PM - 4:27PM

Application of Quantitative Brain DTI Metrics in Adrenomyeloneuropathy

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Purpose
The pathological basis of adrenomyeloneuropathy (AMN) is a distal axonopathy involving the long tracts of the spinal cord, with brain MRI usually normal. In this work we used diffusion tensor imaging (DTI) to assess brain microstructural changes in AMN.

Materials and Methods
Eleven AMN male patients and 12 age- and gender-matched healthy controls underwent 3D-T1W and DTI (b=1000 s/mm2, 32 directions). Fractional anisotropy (FA), mean, axial and radial diffusivity (MD, AD and RD) maps were computed and tract-based spatial statistics (TBSS) (1) analysis was performed. A tractography-based analysis also was performed on corticospinal tracts (CSTs), both on the entire tracts and on subsegments (medulla, pons, midbrain, internal capsule, corona radiata, subcortical WM) (2). Parcellation of cortical regions was performed on 3D-T1W volumes using Freesurfer. Cortical regions were transformed to the DTI space and average values for each DTI metric was calculated in regional volumes of interest. Average cortical thickness and volume were assessed for each cortical region.

Results
Tract-based spatial statistics analysis showed a widespread, strong reduction of FA in several WM tracts (Figure A): CSTs, optic radiations, splenium of corpus callosum, superior cerebellar peduncles (P<.001, Threshold-Free Cluster Enhancement (TFCE), corrected for multiple comparisons). Radial diffusivity was significantly higher in the same regions (P<.001), without any significant modification of AD (P>.05). These results were confirmed by the tractography-based analysis (Figure B). The reduction of FA was more pronounced at the lower CST segments (medulla and pons, Figure B). No significant cortical volume reduction or cortical DTI values alterations were observed in AMN patients (P>.05). There was a positive correlation between RD along the CSTs and disease duration (r =.806, P=.009, covarying for age).

Conclusions
These results suggest that brain DTI is useful in AMN patients for measuring alterations
undetectable by morphological examination. The increase of RD likely reflects a primary myelin damage that precedes axonal degeneration in patients with longstanding symptoms of AMN.

Susceptibility weight imaging (SWI) changes in patients with acute hepatic encephalopathy

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Purpose
Characteristic abnormalities have been described in acute hepatic encephalopathy (AHE) on
diffusion-weighted imaging (DWI) and FLAIR MRI, but the findings on susceptibility-weighted imaging (SWI) have yet to be described. We set out to assess the frequency and location of SWI abnormalities in AHE patients on brain MRI, and to correlate the presence of such abnormalities with markers of clinical severity.

Materials and Methods
Over a 4.5-year period, the MR imaging and clinical results of 35 AHE patients were included who underwent SWI. The maximum plasma ammonia level (PAL) and MELD (Model for End-stage Liver Disease) score within 5 days of the MRI were recorded, and the clinical outcome was recorded. The SWI MRI images were reviewed jointly by two staff neuroradiologists, and, if present, the location and number of SWI abnormalities outside of the basal ganglia, hemorrhage type [intraparenchymal (IPH), microhemorrhage (MH), subdural, subarachnoid (SAH)], and site of DWI or FLAIR-T2WI abnormalities were noted and graded (DWI and FLAIR on a 4-point scale). Abnormalities on SWI, CT, and T1WI also were graded on a 4-point scale. Correlations were calculated between the following: number of punctate foci on SWI (presumed MHs), clinical severity, clinical outcome, and MRI severity (on both DWI and FLAIR).

Results
Punctate foci of SWI (presumed MHs) were found outside of the basal ganglia in 17/35 patients (average 1.3/patient); one subacute IPH and one SAH also were noted. SWI-positive foci were noted in the basal ganglia in 33/35 patients, 20/35 on T1WI (hyperintense), and 1/35 on CT (calcification). No significant correlation was identified between the initial clinical severity or outcome with the number of SWI-positive foci (p= 0.341 and 0.409, respectively); additionally, no significant correlation was found between the initial clinical severity or outcome with basal ganglial grade on SWI (p=0.366 and 0.537, respectively). However, the severity of FLAIR and DWI abnormalities did moderately correlate with the clinical outcome (ρ=0.384, p=0.033 and ρ=0.374, p=0.036, respectively). Notably, on SWI, the MHs disappeared in two patients following liver transplantation. Figure: A 41-year-old female with altered mental status due to acetaminophen toxicity. No calcifications were present on CT. Susceptibility-weighted imaging demonstrated abnormalities within the basal ganglia and the left occipital lobe (arrow).

Conclusions
This study suggests that punctate foci on SWI are present in nearly half of AHE patients on SWI MRI outside of the basal ganglia, and may reverse following transplantation, but do not correlate with clinical outcome. Punctate foci outside of the basal ganglia are presumably MHs, while SWI findings within the basal ganglia may relate to manganese or iron, not calcium.
Assessment of T1 Hyperintensity in Basal Ganglia on MR Brain Imaging in Patients with Hereditary Hemorrhagic Telangiectasia

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Purpose
To determine the frequency of increased T1 signal within basal ganglia in patients with hereditary hemorrhagic telangiectasia (HHT). Manganese deposition has long been associated with increase in T1 signal in basal ganglia, most commonly seen in patients with liver failure. These findings also have been reported occasionally in patients with HHT who may not have overt evidence of liver dysfunction. Purpose of our study was to determine the frequency of this abnormality in patients with HHT.

Materials and Methods
Between March 2009 and April 2013, a total of 75 definite HHT patients according to the Curacao criteria were identified retrospectively from the database at our hospital, which is a tertiary referral center for HHT. Fifty-four patients had brain MRI study performed as a screening test to rule out brain arteriovenous malformations. Presence of increase in T1 signal in the basal ganglia was assessed on spin echo sagittal T1WI (TR/TE 600/15 ms) performed on 1.5T MRI. A total of 50 MRI brain studies in age- and gender-matched controls referred for headache also were assessed for presence of abnormal T1 signal in the basal ganglia. Pallidal index (defined as the ratio of the signal intensity of the globus pallidus to that of the sub-cortical frontal white matter on sagittal T1-weighted spin echo MR imaging, multiplied by 100) was used as a semiquantitative measure of T1 signal in the basal ganglia. Liver function tests, hemoglobin
and ferritin levels of all HHT patients also were recorded. Note was made of any known porto-systemic shunts.

Results
Out of 50 HHT patients, 18 had symmetric increased T1 signal in the basal ganglia involving globus pallidi, extending into substantia nigra. There was no corresponding abnormality on GRE images. None of the 50 controls demonstrated abnormal T1 signal in basal ganglia. Of note, only one of the 18 HHT patients with abnormal T1 signal had evidence of abnormal liver function test at the time of imaging. There was a statistically significant difference between mean pallidal index of controls (104.03; 95% CI, 103.15 to 104.91) compared to cases (111.06; 95% CI, 108.67 to 113.45) (P<0.001).

Conclusions
Increase in T1 signal in basal ganglia is seen in a significant percentage of HHT patients and may reflect the increased deposition of manganese. The mechanism of manganese deposition is not clearly known but may relate to asymptomatic porto-systemic shunting which may not be evident on imaging. Co-existing iron deficiency may contribute to increased absorption of manganese in these patients, as both of these metals share common receptor for uptake. Adequate management of iron deficiency may help reduce the risk of manganese deposition in these patients. MR imaging of the brain may be valuable to detect manganese deposition in HHT patients, even in the subclinical stage.
Wednesday
3:15PM - 4:50PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)

18D - PARALLEL SCIENTIFIC PAPER SESSION-SPINE DIAGNOSTIC IMAGING TECHNIQUES

O-374

Longitudinally extensive transverse myelitis associated with aquaporin-4 antibodies. Clinical and MR imaging clues for diagnosis in older patients

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Purpose
Neuromyelitis optica spectrum disorders (NMOSD) associated with aquaporin-4 antibodies typically presented in young/middle-aged population. It is increasingly recognized that NMOSD also affects older populations, with longitudinally extensive transverse myelitis (LETM) the most frequent and disabling manifestation. We aimed to review clinical and MRI findings of the first LETM in a cohort of older NMOSD patients.

Materials and Methods
Twenty-six patients [mean age 65 years (range 51-84), 81% female, 82% Caucasian] with LETM due to NMOSD were identified. Spinal MR imaging was available in 22 cases; this was reviewed in conjunction with the clinical presentation.

Results
Longitudinally extensive transverse myelitis was the first manifestation of NMOSD in 60% of patients. The most common first symptom was a sensory disturbance (40%). Median time to maximal symptom severity was 7 days (range 2-30). In all patients the motor deficits were worse in the lower limbs; 50% had asymmetric cord syndrome. Imaging was performed a median of 10 days post-presentation (IQ range 6-21). The upper level of the LETM varied from the brainstem to the T4 level. The extent of the abnormality was from three spinal levels to the whole cord. In most cases the lesion was expansile (86%) and centrally located, with a more asymmetrical appearance in five patients. The asymmetric cord appearances did not correlate with the asymmetric clinical symptoms (p>0.05). The clinical sensory level was 1 to 12 (median 6) spinal levels below the upper level of cord signal abnormality.

Conclusions
Diagnosis of LETM due to NMOSD in elderly patients may be difficult, but should be considered, particularly in those with severe, asymmetric acute myelopathy, where the upper level of the imaged cord abnormality is much higher than the clinical sensory level. These findings are particularly relevant at the patient's admission, when MRI is performed, but antibody tests are still unavailable.

O-375

3:23PM - 3:31PM
No Agreement Between a Quantitative Measure and a Subjective Read for Identifying Muscle Fatty Infiltrate in Cervical Musculature

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Purpose
To identify whether a subjective read of muscle fatty infiltrate (MFI) by a neuroradiologist could substitute for an established quantitative measure of MFI for clinical use in patients with chronic whiplash associated disorder.

Materials and Methods
Cervical spine T1-weighted MRI was obtained from 20 female participants that were part of a larger scaled cross-sectional study of chronic whiplash. The quantitative measure (QM) was performed using a previously validated algorithm for identifying MFI. The axial images from the C5 segmental level were presented randomly to a board-certified neuroradiologist, with 22 years of experience. He was blinded to the clinical signs/symptoms of each subject and was asked to subjectively grade the percent MFI in both the right and left multifidus muscle. A total MFI, which combined the right and left extensor muscles (multifidus, semispinalis cervicis, semispinalis capitis, splenius capitis) also were prepared and compared with the previously validated QM. Additionally, 10 images were repeated randomly (a total of 30 reads were performed by the neuroradiologist) in order to assess intrarater reliability for NSR. Lin's concordance correlation coefficient (CCC) and Bland-Altman comparisons of agreement were used to assess agreement between methods of measurement (QM and NSR) and the intraclass coefficient (ICC) was used to measure intrarater reliability. A value of 0.4 for Lin's CCC was considered to meet the threshold of clinical agreement.

Results
There was poor agreement between methods, with no Lin's CCC value found to be greater than 0.14. Lin's CCC for total multifidus MFI was −0.08 (95% CI: −0.33 to 0.17), showing no correlation. Bland-Altman comparison of agreement showed a mean difference of 2.53 (95% CI -3.60 to 8.65), with a reference range for mean difference from -23.65 to 28.70. When average total MFI was low, the NSR under-reported MFI and when average total MFI was high, NSR over-reported MFI. The 10 repeated images were analyzed using the ICC and MFI and a significant effect was found between the first and second read of the same images.

Conclusions
Total multifidus MFI showed only a small mean difference on average but the reference range was very large including approximately ±24%. Lin's CCC showed no correlation between subjective and objective measures. It should be noted that neuroradiologists seldom read muscle images and the level of agreement might be expected to improve with further training. At present it appears that a subjective read is not recommended to replace a quantitative measure. The presence of neck muscle fatty infiltrates on conventional MRI scans appears to be a promising biological factor to discriminate between individuals post whiplash who progress to chronicity and those who do not. This data appears to be most accurately obtained using a quantitative measure.

O-376
Quantitative MRI of the Spinal Cord in Adrenomyeloneuropathy

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Purpose
Adrenomyeloneuropathy (AMN) is the late-onset form of adrenoleukodystrophy (ALD), a X-linked disease with a progressive axonal damage, consisting in dying-back axonal degeneration of the long tracts of the spinal cord (SC). In this work we present the application of quantitative magnetic resonance imaging (qMRI) methods to assess SC structural and microscopic changes in AMN.

Materials and Methods
Spine qMRI data of 13 AMN male patients and 12 age- and gender-matched controls were acquired at 3T (Achieva, Philips). The protocol included sagittal 3D-T1 FFE and axial diffusion tensor imaging (DTI) acquisitions (b=600 s/mm², 6 directions). Total cross-sectional area (TCA) was measured from C1-2 to T2-3 disc levels with a method analogous to (1), after reslicing the 3D-T1 images orthogonally to the SC (see the three example levels in Figure). Interoperator reliability was assessed. Fractional anisotropy (FA), mean, axial and radial diffusivity (MD, AD and RD) were assessed at C2-3 and C4-5 levels both in gray (GM) and white matter (WM) using regions of interest (ROIs) extracted by the MNI-poly-AMU template (2).

Results
Total cross-sectional area was reduced significantly in patients at all explored levels (independent samples T-test after testing for normality, P<.001; see the graph of the three example levels in Figure); the relative reduction was more pronounced at the thoracic levels. There was an excellent interobserver reproducibility of TCA measurements (mean ICC: .995, P<.001). A significant reduction of WM FA (P<.001) with a concomitant reduction of AD (P≤.003) and increase of RD (P ≤.003) was observed, without any significant difference in GM DTI values. These in vivo results support the histopathologic evidence of a coexistence of axonal degeneration (AD reduction) and demyelination/dysmyelination (RD increase) in the SC white matter of AMN patients.

Conclusions
Spinal cord qMRI is feasible in a clinical setting to obtain reliable measures of degeneration in AMN. The validation of these qMRI markers in longitudinal studies will be of great importance for the assessment of therapeutic efficacy in forthcoming clinical trials.
Full Coverage Axial T2w Spinal Cord Imaging in Multiple Sclerosis: Increased Sensitivity for Lesion Detection

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Purpose
According to multiple sclerosis (MS) imaging diagnosis criteria, lesions in specific locations are particularly relevant. For a typical spinal MRI, axial scans are utilized only with cervical coverage or to confirm suspected lesions in sagittal scans. For comparison, we sought to evaluate the sensitivity for T2 lesion detection on axial T2W scans with full spinal cord coverage (FSCC) in comparison to sagittal scans.

Materials and Methods
One hundred fifteen MS patients were scanned on a 3T Skyra including 3mm axial T2W images with FSCC and 3mm sagittal T2W images. T2 lesions were identified on axial and sagittal scans independently by two raters. Axial diameter (AD1 <0.3 cm; AD2 0.3-0.5 cm; AD3 >0.5 cm), cranio-caudal extension (CCE) and lesion location were documented. False positive lesions (FPL) were defined if identified by both raters on sagittal but not on axial scans.

Results
Both raters marked significantly more lesions (p<0.001) on axial than on sagittal scans: 463/458 axial and 324/301 sagittal lesions were marked by rater 1/2. Both raters agreed in 259 cervical, 285 thoracal and eight lesions located in the cervicothoracic junction (C7/Th1). Thirty-one
patients had no lesions. Inter-rater agreement was high and slightly better for axial (k=0.83) than for sagittal scans (k=0.80). Most lesions with AD1 were identified only on axial scans, while there was no significant difference in CCE of lesions. False positive lesions were identified in 65 cases.

Conclusions
Axial scans with FSCC display a higher sensitivity for T2 lesion detection in MS patients in comparison to sagittal scans - especially for smaller lesions. But even large lesions can be missed when only assessed in sagittal plane. Axial scans with FSCC should therefore be implemented in clinical routine protocols to increase sensitivity for lesion detection. Furthermore axial scans with FSCC allow quantification and volumetric analysis of spinal lesion load in MS patients and might provide a new impulse for future MS studies.
Comparison of STIR versus T1 Phase-Sensitive Inversion Recovery 3T sequences in the detection of spinal cord lesions in MS

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Figures showing a thoracal lesion (Th10) > detected on axial scan (b). Both raters reveal sagittal scan (a).
Purpose
The purpose of the study was to retrospectively compare STIR and T1 PSIR for imaging cervical and thoracic spinal cord lesions in patients with MS.

Materials and Methods
A retrospective analysis of 27 cervical and 19 thoracic MR studies of 30 MS patients who underwent spinal cord imaging at 3T was performed. Lesion segmentation was performed independently by two readers on T1 PSIR and STIR. Gold standard lesion segmentation was performed by consensus taking into account all sequences available. Sensitivity, specificity and interobserver agreement were calculated on a pixel-by-pixel basis.

Results
Sensitivity was higher for STIR in the cervical cord (STIR: 78.83%; T1 PSIR: 71.25%) and in the thoracic cord (STIR: 70.89%; T1 PSIR: 31.92%). Specificity was slightly higher for PSIR in the cervical cord (STIR: 98.63%; T1 PSIR: 99.35%) and in the thoracic cord (STIR: 98.89%; T1 PSIR: 99.47%). Differences in sensitivity and specificity between the two sequences were statistically significant (p< 0.05).

Conclusions
When compared to T1 PSIR, STIR offers higher sensitivity but slightly lower specificity in the detection of spinal cord lesions in MS. These results suggest that at 3T, STIR would be the preferred additional sequence to T2 FSE in both cervical and thoracic segments. T1 PSIR also remains a good option in the cervical cord, but it performs markedly worse than STIR in the thoracic cord.

O-380
Differentiating neuromyelitis optica from other causes of longitudinally extensive transverse myelitis on MRI

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Purpose
Longitudinally extensive transverse myelitis (LETM) is defined as a hyperintense spinal cord lesion extending over three or more vertebral levels. Although spinal cord MRI findings of neuromyelitis optica (NMO) have been described, there is limited data available about findings that help differentiate NMO from other causes of LETM. We aim to investigate the spinal cord MRI findings of acute LETM that help differentiate NMO from other causes of LETM.
Materials and Methods
The spine MRI of 160 patients with a radiologic diagnosis of LETM between 2002 and 2012 were reviewed retrospectively. After exclusion, 94 patients with acute LETM were enrolled in the study (48 patients with serum NMO-IgG positive NMO and 46 patients with other etiologies). Bright spotty lesions (BSL), the lesion distribution and location were evaluated on axial T2-weighted images. The "BSL" defined as lesion similar or higher in signal intensity than CSF. Brainstem extension, cord expansion and T1 darkness and lesion enhancement were noted. The "T1 dark" defined as the signal intensity of the lesion approaching that of CSF on T1-weighted images. Brain MRI of the patients during acute LETM also was reviewed.

Results
Patients with NMO had a greater amount of BSL and T1 dark lesions (p < 0.001 and 0.003, respectively). The lesions in NMO patients were more likely to involve greater than half of the spinal cord cross-sectional area, to enhance and be located centrally or both centrally and peripherally in the cord. Of 62 available brain MRIs, 14 of the 27 NMO patients had findings that may be specific to NMO.

Conclusions
Certain spinal cord MRI features are seen more commonly in NMO patients and obtaining brain MRI during acute LETM may support diagnosis.

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Purpose
To investigate the effect of a critical, non contained, lytic defect on the structural response of the human functional spinal unit under increased compressive loading.

Materials and Methods
Mechanical testing: An L2-L3 spinal segment, aged 65 years, was instrumented with strain gauge rosettes. A specialized, computer-controlled, CT-compatible test system was used to test the instrumented spine under increased compressive loading (50 .. 750)N with CT volumes obtained (64 array helical CT, Toshiba Medical) at each load state. A 50\% noncontained defect was created in the body under fluoroscopic control, the spine was imaged and retested. FEA modeling: For both intact and lytic spine test conditions, CT volumes were converted to highly anatomically accurate (0.70mm per element) material-weighted vertebral models with fully functional intervertebral disc and ligament models. Test conditions (constraints, external loading) were imposed and the model was solved using a nonlinear solver (ABAQUS, Simulia, RI).

Results
Inclusion of the uncontained defect, (Figure 1B versus Figure 1A), yielded a highly significant increase in compressive (S33) and shear (S23 and S13) stresses at the anterior and posterior cortices as well as the bone adjacent to the defect location (Figure 1C). Although the defect seemed not to affect the structural response of the noninvolved vertebra, a higher tensile stress was seen at the lower boundaries of the defect. Conversely, marked reduction in tensile stress was observed at the endplate area below the defect indicating the "un-loading" of the endplate.

Conclusions
The change in the state of stress due to osteolytic defects is three-dimensional and complex and affects not only the immediate region around the defect but appears to radiate to the whole area beneath the defect vertebra. Though we did not model the process of failure, this marked increase is likely to precipitate the occurrence of failure.
Evaluation of Chronic Inflammatory Demyelinating Polyneuropathy: 3D Nerve-Sheath Signal Increased with Inked Rest-Tissue Rapid Acquisition of Relaxation Enhancement Imaging (3D SHINKEI)

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Purpose
Magnetic resonance neurography is useful to evaluate nerves in patients with inflammations, tumors, and trauma. The purpose of this study was to evaluate feasibility of 3D nerve-sheath signal increased with inked rest-tissue rapid acquisition of relaxation enhancement Imaging (3D SHINKEI) in cervical nerve sheaths and ganglions in patients with chronic inflammatory demyelinating polyneuropathy (CIDP).

Materials and Methods
This study included 13 patients with CIDP (11 males and 2 females; age range 19-72 years; median 29 years) and nine normal subjects (4 males and 5 females; age range 27-66 years; median 33 years). 3D SHINKEI is a turbo spine echo with a diffusion-weighted prepulse called improved motion-sensitized driven equilibrium. The imaging parameters were as follows; TR/TE = 2400/74 ms, FOV = 220 x 310 mm, voxel size = 0.98 x 0.97 x 2.0 mm3, b = 10 s/mm2, acquisition time = 5 min 45 s. Regions of interests (ROIs) were placed at the nerve sheaths and ganglions from C5 to T1 and the scalene muscles on coronal reformatted images bilaterally.

Signal intensity ratio compared to the muscles were calculated. The size of the nerve sheaths
and ganglions also were measured. Statistical analyses were performed with Mann-Whitney U test. P values less than 0.05 were considered significant.

Results
The size of the nerve sheaths and ganglions was larger in patients with CIDP (4.76 ± 1.85 mm and 6.32 ± 1.73 mm) than in normal subjects (3.36 ± 0.85 mm and 5.29 ± 1.07 mm, P < 0.0001, respectively). The signal intensity ratio of the nerve sheaths and ganglions was larger in patients with CIDP (6.80 ± 3.71 and 9.62 ± 6.95) than in normal subjects (4.08 ± 1.53 and 7.14 ± 2.78, P < 0.0005, respectively).

Conclusions
With 3D SHINKEI we could obtain high-resolution MR neurography. Chronic inflammatory demyelinating polyneuropathy could be discriminated from normal subjects on 3D SHINKEI.

High Accuracy of Fat Suppressed Sequences in Differentiation of Aggressive vs Typical Asymptomatic Hemangioma of the Spine

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Purpose
While hemangiomas are common benign vascular lesions involving the spine, some behave in an aggressive fashion. We investigated the utility of fat suppressed sequences to differentiate between benign and aggressive vertebral hemangiomas.

Materials and Methods
Patients with the diagnosis of aggressive vertebral hemangioma during the past 14 years were
identified and their MR imaging retrospectively reviewed. Only patients with aggressive vertebral hemangioma and readily available STIR or T2 fat saturation sequence were included in the study. Eleven patients with typical asymptomatic vertebral body hemangiomas were selected as the control group. Region of interest signal intensity (SI) analysis of the entire hemangioma as well as the portion of each hemangioma with highest signal on fat saturation sequences was performed and normalized to a reference normal vertebral body.

Results
A total of eight patients with aggressive vertebral hemangioma and 11 patients with asymptomatic typical vertebral hemangioma were included. There was a significant difference between total normalized mean SI ratio (3.14 versus 1.48, p=0.0002), total normalized maximum SI ratio (5.72 versus 2.55, p=0.0003), brightest normalized mean SI ratio (4.28 versus 1.72, p<0.0001) and brightest normalized maximum SI ratio (5.25 versus 2.45, P=0.0003). Multiple measures were able to discriminate between groups with high sensitivity (>88%) and specificity (>82%), with brightest normalized mean SI ratio providing the best performance.

Conclusions
Quantitative evaluation of the signal intensity on fat suppressed sequences is highly accurate in differentiation of typical asymptomatic hemangioma from aggressive hemangioma.

O-384

CONTRAST ENHANCED FAT-WATER SEPARATION – DIXON IMAGING: ADDED VALUE OF FAT, OPPOSED PHASE AND IN PHASE IMAGING IN SPINE DISEASE.

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Purpose
Fat suppression is utilized commonly in gadolinium-based contrast-enhanced spine imaging to shift image dynamic range and boost lesion visualization despite a tendency to exaggerate the impression of pathological enhancement. As a result of common failure of traditional RF-based techniques, many adopt fat-water separation or Dixon (FWD) methods of suppressing fat signal. FWD imaging exploits the varied resonance frequencies of protons to iteratively decompose fat and water signals into separate in-phase (IP), opposed-phase (OP) "fat-suppressed" water-only (WO) and "water-suppressed" fat-only (FO) images in a single efficient acquisition. While WO images offer greater resistance to saturation failures the additional contrasts provided by FWD imaging add significant value in day to day practice. The IP series allow verification of the degree of enhancement at the same dynamic contrast range as the precontrast series. Opposed-phase imaging, with well documented marrow imaging benefits, boosts visualization of gadolinium contrast by further suppressing background signal. As the primary source spine tissue signal and inherent contrast resolution emanates from fat, FO imaging provides unique information that in some circumstances can outperform all others in lesion detection and characterization. The goal of this retrospective cohort study was to assess the performance and incremental value of each of the four FWD image series in patients undergoing postcontrast FWD imaging for evaluation of suspected spine disease.

Materials and Methods
We performed a retrospective analysis of 50 clinical spine MRI examinations implementing FWD imaging after GBC administration for evaluation of a variety of disease states. Studies were reviewed by two neuroradiologists rating the intrinsic and relative value of each of the four FWD series on a qualitative five-point scale. In addition, the consistency and uniformity of fat suppression for the WO series was assessed independently. When applicable, lesion to background ratios were quantitatively assessed for each technique.

Results
The additional image contrasts provided by FWD add value in everyday practice, frequently outperforming traditional techniques in terms of sensitivity, background suppression and lesion characterization.

Conclusions
Along with highly consistent fat suppression, FWD imaging offers three additional image contrasts that add value in everyday practice, frequently outperforming traditional techniques in terms of sensitivity, background suppression and lesion characterization. If available, FWD should replace traditional RF-based fat suppression techniques.
Purpose
Spontaneous intracranial hypotension (SIH) is diagnosed increasingly. T2 fat saturated images and myelographic sequences are known to highlight signs of SIH in the spinal canal (extradural fluid, cysts and diverticula). Conventional sagittal SE T1, and FSE T2 sequences are obtained for spine imaging, and axial and coronal T2 fat saturated images are performed in the cervical thoracic regions, usually without IV gadolinium. When SIH is the primary suspicion a short protocol was obtained imaging the whole spinal canal in under 40 minutes.

Materials and Methods
Retrospective review of patients with the diagnosis of hypotension on their MRI report from the last 3 years. Twenty-nine patients had a diagnosis of hypotension, and all had brain MRI. MR imaging reports yielded 18 spinal MRI, and 15 included the thoracic spine. In this last group 10/15 cases had laminar peripleural fluid. A control group of 15 selected age- and sex-matched thoracic MRI with axial or coronal T2 fat sat planes were reviewed searching for extradural fluid. Five patients were imaged with a total spine short protocol with T2 sagittal fat sat, and cervico-thoracic axial T2 fat sat images (30-40 min). All cases except one were without IV gadolinium.

Results
Extradural fluid was detected in all spinal MRI on T2 fat saturated sequences in several locations with the conventional protocol. We found 10 cases with laminar peripleural fluid on thoracic MRI in SIH. No peripleural was noted in the control group. Extradural fluid was detected by our short protocol in all five patients at multiple sites (foramina, epidural, dural diverticula).

Conclusions
Spontaneous intracranial hypotension in patients where spine imaging is requested should be studied with T2 fat saturation techniques to highlight extradural fluid, dural diverticula, perineural cysts, foraminal fluid and now also peripleural fluid. If any of these are detected and we also see other signs of SIH in the spine such as venous epidural plexus engorgement and dural sac festooning, IV gadolinium can be withheld. T2 fat saturation should be included in all spine MRI protocols to increase the radiologic detection of SIH in patients studied for cervicalgia or dorsalgia. Peripleural fluid may be related to CSF leaks and SIH, puncture and analysis of this fluid is encouraged.
A Multi-Disciplinary Approach Can Substantially Decrease Radiation in the Workup of Patients with Suspected Ventricular Shunt Malfunction

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Purpose
Ventricular shunt complications can be severe and life-threatening if not identified and treated in a timely manner. Evaluation for shunt obstruction or infection is not without risk, including lifetime cumulative radiation as patients routinely receive CT scans of the brain and shunt series (seven total radiographs of the skull, neck, chest and abdomen). Our purpose was to reduce radiation exposure and standardize care for children and young adults being evaluated for ventricular shunt complications.

Materials and Methods
A multidisciplinary team developed a clinical pathway with standardized guidelines to evaluate and manage children and young adults with signs/symptoms concerning for ventricular shunt
complication. The team implemented use of a lowered-dose CT scan (reference mAs 150, versus 250 for our standard ALARA dose brain CT), specifically tailored for evaluation of ventricular size and surgical navigation should shunt revision be required. The pathway recommends against the routine use of a radiographic shunt series, and instead provides specific recommendations for single view radiographs of the chest and/or abdomen, based on our experience with their clinical utility. As part of a quality improvement initiative, we reviewed the first 6 months of pathway implementation in our Emergency Department (ED), to assess for overall patient radiation dose reduction. Student's T-test was used to calculate p values.

Results
During the review period, 82 patients (ages 0.3-29 years) made 96 visits to our ED with signs/symptoms of shunt complication sufficient to warrant imaging. eighty-one of 96 (84.4%) of brain CTs were performed with the lowered dose protocol and a shunt series was performed in 17/96 (17.7%) visits, indicating good compliance with the new pathway albeit with room for improvement. Brain CTs averaged a 65% reduction in CTDI and 59% reduction in DLP (due to the slightly increased coverage necessary for surgical navigation). Average CT effective dose during this period was 1.25mSv, compared with 2.41mSv prior to pathway implementation, resulting in a 49.0% (CI 44.0-54.1, p=<0.0001) mean reduction in effective radiation from CT. On average, patients received 2.1 (range: 0-8) radiographs per visit, a significant reduction from the routine shunt series, resulting in a 64.6% (CI 55.6-73.6, p=<0.0001) mean reduction in effective radiation from radiographs per visit. No radiographs were obtained in 45/96 (46.9%) visits. Mean total effective radiation dose reduction was 50.6% (CI 45.7-55.6, p=<0.0001). There have been no reports of inadequate patient evaluations or serious medical events.

Conclusions
Initial experience with our new clinical pathway has significantly reduced radiation exposure without compromising patient care, both by reducing the dose of brain CTs and significantly reducing the number of radiographs obtained in the workup of children and young adults with complications related to ventricular shunts. Future gains are expected with increased pathway compliance and further CT dose reduction strategies, particularly for more radiosensitive younger patients.

O-386

Radiation Dose and Image Quality in Pediatric Head CT

M Vittoria-Spampinato, k byington, s tipnis, r brothers, B Zoghbi

1Medical University Of South Carolina, Charleston, SC, 2Medical University of South Carolina, charleston, SC, 3Medical University of South Carolina, Charleston, SC

Purpose
The purpose of this study is to retrospectively evaluate radiation doses and image quality of pediatric head CT studies. Our objective is to make recommendations for age-appropriate doses for pediatric head CT examinations.

Materials and Methods
We retrospectively reviewed all pediatric head CT examinations acquired at our institution over a 3-month period in children aged 5 to 9 years. Information regarding age, x-ray tube voltages, tube current, CT dose index (CTDIvol) and total DLP, which are two related measures of CT
radiation dose, were obtained from the Picture Archiving and Communication System (PACS). Median CTDIvol was calculated. Then, subjects were divided in a low-dose group (CTDInvol below or equal to the median CTDIvol) and high-dose group (CTDInvol above the median CTDIvol). A neuroradiologist assessed the scans on diagnostic image quality using a 5-point scoring system, where 1 = nondiagnostic and 5 = excellent diagnostic quality. From each exam, two slices, one at the level of basal ganglia and one at the level of fourth ventricle, were selected for evaluation. Exams with scores equal to or greater than three were considered of sufficient quality for clinical diagnostic purposes. Ratings for low-dose versus high-dose head CT studies were compared using the Person Chi-Square test. Differences in ratings were considered statistically significant when p < 0.05.

Results
A total of 57 pediatric head CT examinations (median age = 7 years) were considered for inclusion. One case was excluded because the dose report was not available on PACS. All head CT examinations were helical acquisitions from the vertex to the skull base and were acquired without the use of tube current modulation on 16 and 64-slice multidetector CT scanners. The x-ray tube voltages used to perform these examinations ranged from 80 to 120 kV. Tube current ranged from 68 to 240 mAs. Median CTDIvol was 24 (range = 14-60 mGy cm, SD = 15). Median DLP was 478 (range = 213-1179 mGy cm, SD = 279). In the low-dose CT subgroup (30 cases), image quality was deemed barely satisfactory (rating = 2) in the evaluation of the basal ganglia and of the posterior fossa respectively in 12/30 cases and 10/30 cases; unacceptable (rating = 1) in the evaluation of the posterior fossa in 1/30 cases. In the high-dose subgroup (26 cases), image quality was deemed barely satisfactory (rating = 2) in the evaluation of the basal ganglia and of the posterior fossa respectively in 2/26 cases and 2/26 cases; unacceptable (rating = 1) in the evaluation of the basal ganglia in 1/26 cases. Differences in image quality ratings of basal ganglia and posterior fossa CT slices were significantly different between low- and high-dose CT studies (basal ganglia p = < 0.001; posterior fossa CT p = 0.005). All studies with CTDIvol greater than 35 mGy were considered of at least satisfactory image quality (rating ≥ 3).

Conclusions
We evaluated the diagnostic quality of pediatric head CT performed using a wide range of CTDIvol values. Based on our results, a CTDIvol of at least 35 mGy should be used in pediatric head CT in children aged 5 to 9 years.

O-387
3:31PM - 3:39PM

Brain Imaging with Synthetic MRI in Children: Image Quality Assessment

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¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Purpose
To evaluate diagnostic image quality in pediatric brain MR exams using a multidynamic and multi-echo sequence (Qmap) that measures inherent tissue properties (R1, R2, PD), and postacquisition software processing, [SyMRI (TM)] (1, 2) to create FLAIR, T1, and T2-weighted image sets from a single acquisition.

Materials and Methods
Qmap sequences (1) were acquired on 30 brain MR exams performed from 12/2013 -10/2014.
Exams were performed on a 32-channel 3T (750W) or 1.5T scanner (450W) (GE Healthcare, Waukesha, WI). Sufficient time during the exam to perform the sequence in addition to routine scanning determined inclusion (Qmap scan time was 6 minutes). Data from the QMap sequence were de-identified and SyMRI software (2) was used to generate T1, T2, and FLAIR sequences matching conventional sequence settings and image contrast. Anonymized Qmap and matching conventional sequences were stored on a research PACS server. Each conventional and SyMRI generated sequence was rated separately by two pediatric neuroradiologists, blinded to sequence origin, scoring the images on overall quality, anatomical structure visualization (poor, sufficient, good, excellent), and severity of artifacts at specific locations (severe, moderate, mild, none). A combined rating was made for each sequence.

Results
Thirty cases were reviewed (age: 13 months to 20 years). Analysis of matched combined ratings for each case was performed using the Wilcoxon signed-rank test. Frequency data were analyzed by Fishers exact test. Overall quality and GM/WM differentiation were dichotomized as good or excellent versus sufficient or poor. Artifact ratings were dichotomized as none or mild versus moderate or severe. Results are summarized in Figure 1. No significant difference in overall image quality or GM/WM differentiation was noted between the conventional and synthetic T1-weighted and T2-weighted sequences, although on T1-weighted sequences basilar artery and cerebrospinal fluid (CSF) pulsation artifact were rated as worse on synthetic MRI. Cerebrospinal fluid artifact was rated as less pronounced on SyMRI T2 sequences (rank-sum test). SyMRI FLAIR sequences were rated as significantly lower in overall quality than conventional FLAIR sequences, with more pronounced basilar artery and CSF pulsation artifact. Additional results regarding inter-rater agreement and other imaging features will be presented.

Conclusions
Diagnostic quality T1- and T2-weighted sequences in pediatric patients can be generated by means of a single MR acquisition processed with SyMRI software. Synthetic FLAIR sequences created in the same manner were rated as significantly lower in quality than conventional imaging. Optimization of synthetic FLAIR images may be necessary in children prior to clinical application. Implications and strategies for use of this technique in pediatric neuroimaging will be presented.
The Utility of a Rapid 13-Minute MRI Protocol for Evaluation of the Pediatric Brain Following Intracranial Trauma.

J Becker¹, W Kubal¹, S Hur², R Khan¹, R Inampudi¹, R Carmody³, D Gilbertson-Dahdal², R Buckner², K Nael²

¹University of Arizona Medical Center, Tucson, AZ, ²University of Arizona, Tucson, AZ, ³University of Arizona, TUCSON, AZ

### T1-weighted images (N=30, combined rating)

<table>
<thead>
<tr>
<th>Good or better*; or none/mild^</th>
<th>Overall Quality*</th>
<th>GM/WM differentiation*</th>
<th>Basilar pulsation artifact^</th>
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<td>Conventional</td>
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<td>29 (97%)</td>
<td>30 (100%)</td>
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<td>SyMRI</td>
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<td>26 (87%)</td>
<td>10 (33%)</td>
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### T2-weighted images (N=30, combined rating)

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<td>23 (77%)</td>
<td>23 (77%)</td>
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<tr>
<td>SyMRI</td>
<td>28 (93%)</td>
<td>23 (77%)</td>
<td>16 (53%)</td>
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### FLAIR images (N=22, combined rating)

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<td>11 (50%)</td>
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<td>p (Rank sum)</td>
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<td>p=0.048</td>
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Purpose
The use of pediatric head CT has increased significantly in recent years. The pediatric brain is more radiation sensitive than that of an adult with a risk of leukemia in those under 5 years old undergoing CT brain of 1.9 per 10,000 (1). Traditionally these patients have up to daily CT scans until they are neurologically fit for discharge. In this setting it is not uncommon for up to daily CT scans and for up to six scans to be performed during this time. This is not without risk to the patient (2, 3). We recently have introduced a new imaging algorithm for pediatric patients following cranial trauma. All patients undergo a "low dose " CT scan on admission, essential for the diagnosis of skull fracture. A 13-minute MRI protocol then is used instead of CT for follow up in those with neurological deterioration or with known intracranial hemorrhage.

Materials and Methods
We present the first 28 patients (age range 11 weeks to 17 years) who have undergone our new pediatric trauma imaging protocol without sedation or anesthesia. Low dose CT was followed by our MRI protocol at 1.5 (ACRA) or 3T SKYRA, (Siemens Erlangen, Germany). This protocol takes 12 minutes, 30 seconds and includes DWI and ADC maps, T2 HASTE in axial, sagittal and coronal planes, axial FLAIR and GE sequences. Many patients viewed a movie during their scan. (Cambridge Research Institute Movie Monitor, Cambridge, England).

Results
All patients successfully underwent MRI with images of excellent diagnostic quality obtained. Total number of scans: 41. Maximum number per patient: five. Only one patient underwent repeat CT following MRI for evaluation for cranioplasty. Twenty-one of 28 patients had intracranial hemorrhage. All hemorrhage identified on CT was confirmed on MRI. MR imaging identified 3/28 with subarachnoid hemorrhage and 1/28 with parenchymal contusion not identified on CT. I patient had parenchymal mineralization on MR that has been identified incorrectly as hemorrhage on CT.

Conclusions
We have shown that it is possible to perform excellent quality rapid MRI imaging in pediatric patients following cranial trauma. Resulting in a significant reduction in radiation exposure without the requirement of sedation or analgesia. This results in less harm to the patient from radiation and in our cohort of patients was superior for the identification of subarachnoid and intraparenchymal hemorrhage. In this small cohort, 14% of patients had hemorrhage identified on MRI not identified on CT.

O-389
3:47PM - 3:55PM

Evaluation of neonatal brain myelination using a T1- and T2-weighted MRI ratio

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Purpose
Abnormalities in myelin development can indicate the presence of a clinical disorder, but the low intrinsic contrast in the neonatal brain presents a challenge for diagnostic imaging. An emerging technique takes a ratio between T1-weighted (T1W) and T2-weighted (T2W) images to enhance myelin contrast (1-2). In this study, we compared this technique to standard T1W and T2W
images in detecting myelin in neonates. We hypothesized that the T1W/T2W ratio provides better visualization of myelin development in the neonate compared to standard imaging.

Materials and Methods
This retrospective, HIPAA compliant, IRB approved study was conducted at Columbia University Medical Center. Ten term neonates (mean gestational age = 38.7 weeks) were scanned on the same 1.5T MRI scanner at mean 4.7 days postnatally. These scans were reviewed independently by a board-certified neuroradiologist (K.C.) and a second year radiology resident (J.S.) and determined to be normal by standard imaging criteria. Bias corrected, coregistered T1W and T2W images were intensity normalized, and T1W/T2W ratio images were created for each subject (2). For T1W, T2W, and ratio images, regions of interest (ROIs) were drawn in the posterior limb of the internal capsule (PLIC), anterior limb of the internal capsule (ALIC), and optic radiations. These ROIs were chosen based on areas of known myelination (PLIC) and very little myelination (ALIC, optic radiations) at term birth. The ROIs were normalized to the optic radiations and compared between image types. The Michelson contrast also was compared between image types. All analyses were performed using Matlab, Advanced Normalization Tools, and FSL (3-4).

Results
Figure 1 shows the average T1W, T2W, and ratio images. For ratio images, the intrinsic contrast was 25% higher than T1W and 218% higher than T2W images in the PLIC (p < 1E-5 and p < 7E-7) and 18% higher than T1W and 73% higher than T2W images in the ALIC (p < 3E-5 and p < 2E-6). The Michelson contrast of the ratio images was 59% higher than T1W and 258% higher than T2W images (p < 2.4E-6 and p < 7.6E-9).

Conclusions
T1W/T2W myelin mapping significantly increases the myelin contrast compared to standard imaging, allowing for improved image contrast and improved detection of myelin. Studies are in progress to evaluate the use of this technique in the evaluation of normal and pathologic brain myelination.

Figure 1. Average T1w, T2w, and T1w/T2w ratio images
(Filename: TCT_O-389_MyelinMaps.jpg)

O-390

Psychostimulant Medication Duration Correlates with Increased Brain Iron Levels in Attention-Deficit/Hyperactivity Disorder
Purpose
To examine the effects of psychostimulant treatment duration on brain iron levels in psychostimulant-medicated attention-deficit/hyperactivity disorder (ADHD) patients and healthy controls using magnetic resonance imaging (MRI) methods: magnetic field correlation (MFC) imaging (1) and the relaxation rate, R2*. Given that brain iron is required for dopamine metabolism (2) and that psychostimulants modulate the dopaminergic system (3), MRI indices of brain iron may serve as possible noninvasive biomarkers of dopamine status.

Materials and Methods
We recruited 11 male, comorbidity-free ADHD patients (mean age 13.8 ± 2.4 years; all diagnosed before 12 years and psychostimulant-medicated) and 12 male controls (mean age 13.3 ± 3.6 years). T1-weighted magnetization prepared rapid acquisition gradient echo, MFC asymmetric spin echo and T2* gradient echo images were acquired at 3T; MFC and R2* parametric maps were calculated as previously described (4). The globus pallidus (GP), caudate nucleus (CN), putamen (PUT) and thalamus (THL) were chosen as regions of interest (ROI) because they are targets of psychostimulants and have high iron levels (3, 5); individual MFC and R2* ROI means were extracted. Putative postmortem iron concentrations (CPM) in healthy brain ROIs were derived for every age (5). Within group linear regressions were conducted for MFC and R2* with CPM, age and medication duration (ADHD only). Group differences were tested with Student's t-test.

Results
Controls and medicated ADHD patients did not significantly differ in age, IQ and MFC and R2* indices of brain iron. In controls, MFC in all ROIs significantly correlated with CPM and significantly increased with increasing age (r = 0.81 – 0.89, p ≤ 0.001); R2* significantly correlated with CPM (r = 0.79, p = 0.002) and increased with age only in the GP (r = 0.81, p = 0.002). In ADHD, MFC and R2* in all ROIs did not significantly correlate with CPM or increase with age. Conversely, MFC in the GP (r = 0.75, p = 0.008) and PUT (r = 0.73, p = 0.011) significantly increased with medication duration in ADHD patients; R2* detected this only in the GP (r = 0.077, p = 0.006).

Conclusions
Consistent with our previous findings, psychostimulant-medicated ADHD patients had similar brain iron levels to controls (4). However, unlike controls, the brain iron levels in the medicated ADHD patients did not increase with age but may instead be compensated by psychostimulant medication – longer treatment duration resulting in normalized brain iron levels. Additionally, MFC exhibits higher sensitivity to brain iron level variations compared to R2*. 
postmortem iron concentration ($C_{PM}$) 

ADHD linear regression fit

---

**GP**

- $r = 0.75, p = 0.008$

---

**PUT**

- $r = 0.73, p = 0.011$

---

**CN**

- $r = 0.48, p = 0.139$

---

**THL**

- $r = 0.36, p = 0.277$

---

**Controls**

- ▲ ○ △

---

**ADHD-medicated**

- ▼ ● ▲ □
Purpose
Sound pressure levels (SPL) for DW scans can run as high as 100-120 dB, producing physical discomfort and potentially at least temporary hearing loss. This mandates the use of hearing protection devices which can be less reliable when used in young children and the debilitated elderly. A novel quiet DWI (qDWI) sequence based on segmented k-space, echo spacing (ES) reduced EPI (RESOLVE, Siemens, Erlangen, Germany) modified with partial Fourier acquisition to reduce TE provides substantial noise reduction. The purpose of this study is to retrospectively evaluate the quality of qDWI acquisitions compared to routine single-shot EPI techniques in day to day brain imaging practice.

Materials and Methods
Thirty patients were scanned with preclinical "Quiet" DWI techniques in addition to routine diffusion imaging sequences on clinical 1.5T and 3T MR scanners (Siemens Aera and Skyra, Erlangen, Germany). Conventional and "Quiet" diffusion images were tandem reviewed retrospectively by two experienced neuroradiologists who qualitatively assessed image quality for artifact (distortion and motion), gray-white contrast resolution and lesion conspicuity when applicable.

Results
Quiet DWI reduces acoustic noise levels by more than 15 dB(A), corresponding to a reduction of sound pressure of more than 75%. Quiet DWI was comparable in quality to conventional DWI acquisitions with no significant tradeoffs aside from longer scan times.

Conclusions
"Quiet" DWI provides equivalent quality at comfortable sound pressure levels and can replace conventional sequences for routine evaluations of the brain.
Investigating the Age Modulation of Functional Connectivity in a Pediatric Population Using Multi-echo EPI

B Sun\(^1\), R Jones\(^1\), T Burns\(^1\), T Reece\(^1\), L Hayes\(^1\), K Hendrix\(^1\), S Palasis\(^1\)

\(^1\)Children's Healthcare of Atlanta, Atlanta, GA
Purpose
Functional connectivity MRI (fcMRI) has attracted a tremendous amount of interest among neuroscience researchers in recent years. In particular, the technique is potentially an effective tool for studying the maturation of the human brain. Indeed, fcMRI recently has been used to improve our understanding of the maturation of neuronal networks. Clinical applications based on fcMRI also are being investigated for several diseases including epilepsy and autism. In the current study, we used single shot, multi-echo fcMRI data to investigate the age dependence of local and remote functional connectivity in a normal pediatric population. This knowledge benefits both our understanding of cerebral development and could also have implications for clinical applications of fcMRI.

Materials and Methods
Twenty-five right handed normal volunteers with no prior history of neurological disease were recruited. Participants were scanned in a 3T scanner equipped with a 32-channel head coil. Single-shot, four-echo EPI was used to acquire the fcMRI data. The four fcMRIs were combined into a single 4D dataset using a weighted average scheme. The generated local and remote connectivity maps for each participant were entered into a group level GLM to study the effect of age on the functional connectivity. Both +age and –age contrasts (uncorrectly p<0.001, cluster size>20 voxels) were generated for both local and remote connectivity maps by the GLM analysis. The +age contrast captures positive correlations between age and connectivity, whereas the age contrast reveals any negative correlations. Neuropsychological testing was performed.

Results
No abnormalities were detected on the anatomical MRI scans for any of the subjects. None of the fcMRI datasets showed severe motion (mean displacement > 3mm). Local connectivity exhibited an age dependent decrease (Figure 1A) in the (bilateral) frontal and temporal lobes but did not display any age-dependent increases. In contrast, remote connectivity showed age-modulated increase in the frontal-parietal network (primarily on the right hemisphere) but showed no areas of decreased modulation with age (Figure 1B). This result echoes the findings of a study which used graph theory to analyze fcMRI and which concluded that the functional networks evolve from high degree local connections to distributed networks as the brain matures. Our observations also demonstrate the importance of including age in the analysis when developing fcMRI-based clinical applications such as identifying surgical targets in epilepsy. The current study obviously is limited by the relatively small sample size. We are continuing the enrollment for this research and exploring means to better utilize the multi-echo data by means of automated selection of nuisance components in an ICA analysis based on the pattern of signal decay across the multiple echoes.

Conclusions
The current study shows a decrease in local connectivity with age, and a corresponding increase in remote connectivity with age in a pediatric population.
Cortical Activation Through Passive-Motion Functional MRI

R Patel¹, A Siddiqui¹, M Whitehead², J Wheless², A Choudhri²

¹University of Tennessee Health Science Center, Memphis, TN, ²University of Tennessee Health Science Center/Le Bonheur Children's Hospital, Memphis, TN

Purpose
Functional brain mapping is an important technique for neurosurgical planning, particularly for patients with tumors or epilepsy, however this has traditionally involved invasive techniques. Existing noninvasive techniques require patient compliance and may not be suitable for young children. We performed a retrospective review of our experience with passive-motion functional MRI (fMRI) in sedated patients to determine the diagnostic yield of this technique.

Materials and Methods
A HIPAA compliant IRB approved retrospective review was performed of patients undergoing passive-motion fMRI under sedation at a single institution over a two-year period. Clinical records were evaluated to determine the indication for the fMRI, the ability to detect cortical activation, and if present the location of cortical activation.

Results
Fifty studies in 47 patients were identified in this time period. The most common indication for fMRI was epilepsy/seizures. Passive motion was able to identify upper extremity cortical activation in 81 of 95 limbs evaluated (85%), of which 71 (88%) were in an orthotopic location. Lower extremity cortical activation was identified in 55 of 81 limbs evaluated (68%), of which 52 (95%) were in an orthotopic location.
Conclusions
Passive motion fMRI was successful in identifying cortical activation in a majority of patients. This tool can be implemented easily, and can aid in surgical planning for children with tumors or epilepsy surgical candidates, particularly those who may be too young to comply with existing noninvasive functional measures.

(Filename: TCT_O-393_Figure1.jpg)

O-395
4:35PM - 4:43PM

Altered Neurocircuitry in the Preterm Infants with Periventricular/Intraventricular Hemorrhage

J Cui¹, H Kim², O Tymofiyeva², T Flynn³, Y Chen², A Barkovich⁴, D Xu²
¹University of California San Francisco, San Mateo, CA, ²University of California San Francisco, San Francisco, CA, ³University of California, San Francisco, San Francisco, CA, ⁴UCSF Medical Center, San Francisco, CA

Purpose
Periventricular Leukomalacia /intraventricular hemorrhage (PVL/IVH) is very common in premature infants, which may result in long-term brain injury (1). Clinical and diffusion MRI have been used to evaluate the structural alternation (2). To date, the neurocircuitry underlying PVL/IVH remains poorly understood. Here, we aim to explore the functional network as well as the interconnected white matter tracts in the preterm brains with PVL/IVH.

Materials and Methods
A cohort of 36 preterm newborns (Table 1), including 15 with PVH/IVH (7 males and 8 females, 32.71±1.41 weeks) and 21 gestational age (GA)-matched controls (12 males and 9 females, 31.96±1.63 weeks) underwent resting-state functional MRI (rsfMRI) and diffusion tensor imaging (DTI) at 3T. FSL MELODIC was used to implement an independent components analysis (ICA) with dual regression to investigate group difference in brain circuits (3). The infant images were normalized to an MR infant template in Montreal Neurological Institute (MNI) standard space. The localized regions were used as seeding for probabilistic fiber tractography to reconstruct the interconnected white matter tracts (4). ANCOVA was performed to compare the DTI metrics in the reconstructed tracts, including fractional anisotropy (FA), mean diffusivity, axial diffusivity and radial diffusivity (RD). Gestational age and sex were controlled as nuisance covariance.

Results
Eight resting state networks were found (Figure 1). The functional signals of default mode
network (DMN) showed significant difference (PVL/IVH<Control) in the medical prefrontal cortex (MPC) (cluster size k=95, p=0.012, MNI: x=-2; y=41, z=-7) and posterior cingulate cortex (PCC) (k=106, p=0.004, MNI: x=1; y=-33; z=21) (Figure 2). Bilateral cingulum, the reconstructed tracts connecting MPC and PCC, showed significant lower FA (F=7.90, p=0.01) and higher RD value (F=5.16, p=0.03) in the premature infants with PVL/IVH compared to controls (Figure 3).

Conclusions
These findings suggest the functional circuits of DMN and the microstructural integrity of the interconnected tracts were disrupted in the preterm newborns with PVL/IVH, which might shed light on the understanding of the neurocircuitry underlying PVL/IVH.

<table>
<thead>
<tr>
<th>Gender (M/F)</th>
<th>PVH/IVH (n=15)</th>
<th>Col</th>
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<tr>
<td>7/8</td>
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| GA (weeks)   | 32.71±1.41 | 3 |

<table>
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<tr>
<th>Grade statistics (n)</th>
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(Filename: TCT_O-395_Table1.jpg)
(Filename: TCT_O-395_Figure1.jpg)
Wednesday
3:15PM - 4:45PM
Sheraton Chicago Hotel & Towers, Michigan AB (Level 2)
Iatrogenic Intracranial Hypotension and Sinus Vein Thrombosis

R Eliahou¹, R Leker¹, M Gomori¹, A Honig¹

¹Hadassah Medical Center, Jerusalem, Israel

Purpose
Intracranial hypotension (IH) is an increasingly recognized entity characterized by venous distention and sluggish venous flow that has been linked to sinus vein thrombosis (SVT). Direct lumbar punctures (LP), spinal anesthesia (SA) and epidural anesthesia (EA) are among common iatrogenic causes of IH. We studied the occurrence of IH following LP, SA, and EA in patients with acute SVT.

Materials and Methods
Patients aged ≥18 years, diagnosed with acute SVT from 2005–2014 were identified; children and those with SVT related to infectious etiology such as meningitis and otolaryngological problems were excluded. Digital records regarding invasive spinal procedures, clinical symptoms and imaging data were reviewed retrospectively. The hospital's Institutional Review Board waived the requirement for informed consent. The Fisher's exact test and T test for equality of means were used in the two subgroups. P<0.05 was significant.

Results
Overall, 123 patients with acute SVT were identified; 41 met inclusion criteria. Ten of 41 had undergone LP, EA, or SA within ≤10 days before the diagnosis of SVT. All 10 presented with clinical and imaging findings characteristic of IH. Nine of 10 were women aged 25–45 years, including 5/10 who were postpartum after EA. Thirty-one of 41 presented with SVT without history of a recent procedure and without signs and symptoms of IH. Statistical analysis showed that those with IH presented to the ER sooner after symptom onset (6±2.2 days versus 15.6±14 days; p=0.002), had a higher mean National Institutes of Health Stroke Score (NIHSS) at presentation (4.5±2.0 versus 0.5 ±0.5; p<0.01), and higher rates of venous infarction (6/10, 60% versus 6/31, 19%; p= 0.014) and seizures (4/10, 40% versus 3/31, 10%; p= 0.026). Thrombus location and morphology varied between the two groups. In the non-procedure group, 11/31 patients presented with extensive elongated thrombi, usually involving the superior sagittal, transverse and sigmoid sinuses as well as the proximal jugular vein, compared to 0/10 of such thrombi in the IH group (p=0.0276). In contrast, the IH group had significantly more superior sagittal sinus thrombi and cortical vein thrombi (6/10, 60% versus 4/31, 13%; p=0.0025).

Conclusions
Patients with SVT resulting from IH typically had a more severe clinical course with frequent seizures and venous infarcts. Although thrombi in the nonhypotensive group were more elongated and extensive, they were less symptomatic than in the IH group. Sinus vein thrombosis following invasive spinal procedures should initiate an imaging and clinical search for underlying IH.
Predictability of Abnormal Dural Sinus Signal on Routine MR Sequences for Dural Sinus Thrombosis

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¹University of Toronto and Sunnybrook Health Sciences Centre, Toronto, Ontario

Purpose
Dural venous sinus thrombosis (DVST) happens even if not suspected. Contrast-enhanced MR (CEMRV) or CT venography (CTV) may not be requested. Several signs for DVST from standard brain MRI are known, reported with variable accuracy. Diagnostic accuracy was assessed for those DVST signs.

Materials and Methods
Standard MR sequences done with 350 CEMRVs plus 79 conventional MRI studies within 48 hours of CTV (total n=429) were studied from April 2008 to June 2014. Dural sinus evaluation included sagittal T1 high signal, axial T2 and/or FLAIR loss of flow void, high signal on diffusion, and filling defect on axial contrast-enhanced spin-echo T1 and/or on 3D contrast-enhanced gradient echo T1. For these sequences of interest (SOI), comparable anonymized CTV/CEMRVs were separated from respective studies. Three neuroradiologists, blinded to reports, independently reviewed six SOI for signs suspicious for DVST. Each case had readers indicate presence/absence of signs of DVST and suspicious sequences noted. Two neuroradiologists independently reviewed CTVs and CEMRVs for consensus. Sequences of interest analysis was compared against respective CTV or CEMRV for each. Calculated were sensitivity, specificity, and accuracy (Sen/Spe/Acc) for DVST on conventional sequences for each reader, plus majority vote. Interobserver variability was calculated using intraclass correlation coefficient (ICC).

Results
Conventional MR sequences showed Sen/Spe/Acc of 69.4/91.6/87.9 percent based on majority vote amongst readers. Readers had Sen/Spe/Acc of 79.2/86.6/85.3, 58.3/93.6/87.6, and 69.4/86/83.2 percent with ICC of 0.50 (95% CI: 0.44 to 0.56). Sequence of greatest accuracy was 3D-T1 postcontrast, with an overall Sen/Spe/Acc of 59.1/95.5/91.5 percent and ICC of 0.41 (95% CI: 0.35 to 0.47). Of 429 cases studied, 72 were diagnosed with DVST (16.8%; male/female: 27/45). Thrombosis was found in various situations: malignancy 23.6% (17/72), previous DVST 13.9% (10/72), traumatic brain injury 12.5% (9/72), intracerebral hemorrhage 12.5% (9/72), arterial stroke 8.3% (6/72), meningioma sinus invasion assessment 6.9% (5/72), and others 22% (16/72). Standard MR yielded the DVST diagnosis even without clinical suspicion.

Conclusions
Routine MRI signs can suggest DVST, particularly filling defects on 3D-T1 postcontrast with high specificity and accuracy even if asymptomatic or undiagnosed DVST. Confirmatory venography is suggested to prevent hemorrhagic or nonhemorrhagic venous infarction.
Detection Of Cortical Vein Drainage And Determination Of The Cognard Type Of Dural Arteriovenous Fistulae Using 3D Pseudocontinuous Arterial Spin Label Perfusion

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1Stanford University, Stanford, CA, 2Stanford Univ. Med. Ctr., Stanford, CA, 3Stanford University Hospital, Stanford, CA

Purpose
With dural arteriovenous fistulae (dAVF), the risk of an aggressive presentation (e.g.,
hemorrhage) is related to the venous drainage pattern (the basis of Cognard classification), in particular the presence of cortical vein drainage (CVD). Cortical vein drainage therefore necessitates treatment, while patients without CVD can be managed conservatively with imaging and clinical follow up. Catheter-based digital subtraction angiography (DSA) is used to delineate venous drainage for management planning. Dural arteriovenous fistulae are associated with high signal within venous structures on arterial spin label (ASL) perfusion, an entirely noninvasive MR technique. We aim to determine whether the location of this venous ASL signal can be used to accurately detect CVD and determine Cognard type, as an alternative to invasive and costly diagnostic DSA. If pcASL is of adequate sensitivity for detection of CVD, it could be used instead of a purely diagnostic DSA to triage patients to either treatment or conservative management. This would decrease the risk to the patient as well as costs, as DSA can be reserved for patients with a high risk DAVF, in whom it can be performed at the same sitting as therapy.

Materials and Methods
Twenty-eight patients who underwent both DSA and MRI with pseudo-continuous ASL (pcASL) at our institution between 1/6/2006 and 30/5/2014 were included in this retrospective study. Two neuroradiologists independently reviewed the MRIs, noting the presence of CVD (inferred from high signal in a cortical vein) and Cognard type (based on the distribution of high signal in venous structures) for each of pcASL and time-of-flight MR angiography (TOF-MRA). Sensitivity, specificity and accuracy for detection of CVD, and percentage accuracy for determination of Cognard type, were calculated, and inter-reader agreement determined using the kappa statistic. A weighted kappa statistic was used to determine inter-reader agreement for Cognard typing, to reflect the nonlinear increase in risk with increasing Cognard grade. The "ground truth" with regard to the presence of CVD and Cognard type was determined on review of DSAs by an interventional neuroradiologist.

Results
See Table 1. Each reader missed one case of CVD; on subsequent consensus review, both readers agreed that high signal was in fact present in a cortical vein in both cases.

Conclusions
Pseudo-continuous ASL can detect CVD with high sensitivity, and higher accuracy than TOF MRA. The presence of high ASL signal in a cortical vein in all cases where CVD was detected on DSA suggests that pcASL is of sufficiently high sensitivity for reliable detection of high risk DAVFs. It therefore can be used potentially to triage patients to either treatment or conservative management.
Impact of MR Venography for Evaluation of Dural Venous Sinus Thrombosis: An Eight Year Institutional Experience During the Transition from Non-contrast MR venography to a Contrast-Enhanced Technique

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Purpose
CT venography (CTV) and MR venography (MRV) are noninvasive alternatives to digital subtraction angiography (DSA) for diagnosis of dural venous sinus thrombosis (DVST). Contrast-enhanced (CE) MRV has improved diagnostic accuracy over noncontrast (NC) MRV yet NC MRV still is utilized frequently. This study evaluated the effects of changing from NC MRV to CE MRV for evaluation of DVST.

Materials and Methods
A query of our institution's clinical data warehouse from December 2006 to March 2014 for all inpatient NC MRV and CE MRV studies yielded 166 NC MRV and 291 CE MRV. Studies were performed at 1.5T or 3.0T using either 2D TOF (for NC MRV) or CE MRV with standard dose intravenous gadolinium contrast. MR venography reports were reviewed for conclusiveness of presence or absence of DVST, and if an additional imaging test was recommended. Frequency of repeat MRV, CTV, and DSA for evaluation of DVST performed within 1 week of MRV was determined. Patient admission, MRV examination, and patient discharge times were obtained.

<table>
<thead>
<tr>
<th>Table 1: Results</th>
<th>pcASL</th>
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</tr>
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<tbody>
<tr>
<td></td>
<td>Reader 1</td>
<td>Reader 2</td>
</tr>
<tr>
<td>Cortical Vein Drainage</td>
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<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>95%</td>
<td>95%</td>
</tr>
<tr>
<td>Specificity</td>
<td>100%</td>
<td>88%</td>
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<tr>
<td>Accuracy</td>
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<td>93%</td>
</tr>
<tr>
<td>Cognard type</td>
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<td></td>
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<tr>
<td>Percentage accuracy</td>
<td>86%</td>
<td>81%</td>
</tr>
<tr>
<td>Agreement with DSA (weighted kappa)</td>
<td>0.87</td>
<td>0.84</td>
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</tbody>
</table>

(Filename: TCT_O-398_TABLE1revised.jpg)
Fisher's exact test was used to compare proportions of measures, and t-test was used to compare continuous variables between NC MRV and CE MRV groups.

Results
Noncontrast MRV was significantly more likely to be interpreted as nondiagnostic than CE MRV (19.9% versus 2.7%; p<0.0001). Noncontrast MRV also was significantly more likely to result in a recommendation for further imaging than CE MRV (13.3% versus 0.7%; p<0.0001). Patients who underwent NC MRV more frequently underwent additional imaging for dural venous thrombosis within the subsequent week than patients who underwent CE MRV (6% versus 2.1% for CTV; p=0.0343. 8.4% versus 3.4% for any neurovascular imaging study; p=0.028). There were no significant differences between the CE MRV and NC MRV groups in patient length of stay, time from MRV to patient discharge, or 30 day readmission rate.

Conclusions
For the evaluation of DVST, CE MRV results in a significantly higher percentage of definitive interpretations, fewer recommendations for additional imaging tests, and significantly fewer subsequently performed additional imaging studies for evaluation of DVST than NC MRV.

(Filename: TCT_O-399_Figure.jpg)

O-400

7T Evaluation of Posterior Fossa Veins: A High-Resolution Study.
Purpose
The multiple veins of the posterior fossa are difficult to be evaluated on the standard MRI of the brain, even at 3 T, while digital subtraction angiography (DSA) is the gold standard for the visualization of these vascular structures. The aim of the present study was to evaluate the potential of ultra-high-field (7T) MRI to evaluate the veins of the posterior fossa.

Materials and Methods
We developed an ultrahigh field MRI protocol to visualize the posterior fossa veins. We evaluated six healthy volunteers on a 7T human-sized MR scanner (Siemens Healthcare, Erlangen, Germany) as part of a prospective IRB-approved HIPAA-compliant study. The sequences performed were the following: GRE 2D coronal (TR=700 ms, TE=25 ms, matrix 1024x768, 2 mm thickness), GRE 2D axial (TR=700 ms, TE=25 ms, matrix 1024x704, 1.5 mm thickness), postcontrast sagittal T1-MPRAGE (TI=1100 ms, TR=2170 ms, TE=3.3 ms, matrix 448x364, thickness 0.57 mm). Qualitative and quantitative evaluation of the different sequences was performed with a focus on the veins of the posterior scans.

Results
Among the sequences performed, the best evaluation in terms of signal to noise ratio (SNR) of the posterior fossa veins was obtained with the postcontrast 3D T1 MPRAGE with a resolution of 0.5 x 0.5 x 0.5 mm. Best inplane resolution was obtained with the GRE 2D sequence where an inplane resolution of 0.2 x 0.2 could be obtained, although with the limiting slice thickness of 1.5 mm. Qualitatively, the combination of the two allowed the best evaluation of the veins of the posterior fossa, especially the veins surrounding the brainstem.

Conclusions
Ultra-high-field 7T allowed high resolution visualization of the veins of the posterior fossa that opens the ground for future clinical applications.
Anastomotic Cortical Vein Thrombosis: An Under Recognized Diagnosis

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Purpose
Venous strokes are rare and most are recognized readily with associated dural venous sinus thrombosis (DVST). Isolated cortical vein thrombosis without accompanying DVST is both extremely rare and a diagnostic challenge. The purpose of this study is to define the imaging spectrum of cortical vein thrombosis and introduce a novel imaging sign to aid in diagnosis.

Materials and Methods
Radiology reports for the past 15 years were searched for "cortical vein thrombosis." All patients with imaging available for review were included. Clinical data collected included demographics and presenting symptoms. The presence of associated DVST, hemorrhage, edema and the previously described "cord sign" were evaluated. Additionally, we propose a new imaging sign on postcontrast imaging where a ring or parallel lines of enhancement surrounding the nonenhancing thrombus is identified within a thrombosed cortical vein, which we have coined the "tootsie roll" sign. Review was performed in accordance with guidelines of the IRB.

Results
Forty-one cases of cortical venous thrombosis were identified. Of these, 32 had concurrent DVST (Group 1) and nine were isolated (Group 2). The most common presenting symptom in both groups was headache. In Group 2, focal neurologic deficit (37%) and seizure (37%) also were seen. Initial imaging in Group 1 demonstrated edema (68%), parenchymal hemorrhage (42%), and subarachnoid hemorrhage (26%) and in Group 2, demonstrated subarachnoid hemorrhage (33%), parenchymal hemorrhage (28%) and edema (42%). In Group 1, 85% demonstrated a "cord sign" and 33% had a "tootsie roll" sign. In Group 2, 85% had a cord sign and 71% had a "tootsie roll" sign.

Conclusions
Isolated cortical venous thrombosis is a rare diagnostic imaging challenge in evaluation of headache and stroke-like symptoms. We propose the "tootsie roll" sign as a helpful diagnostic aid on postcontrast images, especially when CTA is the initial study performed in the evaluation of stroke. Figure legend: Axial CTA image (A) shows a "Tootsie roll" sign of an isolated cortical vein thrombosis within an occluded vein of Trolard (curved arrow) in this 26-year-old man with new onset seizure. Axial CTA image (B) shows the occluded vein of Trolard in (cross-sectional view) in the same patient for whom MRI was not obtained. Axial GRE (C) demonstrates a "cord" sign in this 28-year-old female who is recently postpartum with seizures. Axial noncontrast CT (D) demonstrates a "cord" sign within an occluded superior sagittal sinus and right vein of Trolard in this 62-year-old with right hand weakness.
The Correlation of MR Venograms, Catheter Venograms, and Catheter Based Venous Pressure Measurements

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¹Medical University of South Carolina, Charleston, SC, ²MUSC Department of Radiology, Charleston, SC, ³Medical University of South Carolina, Charleston, SC, ⁴Massachusetts General Hospital, Cambridge, MA

Purpose
The pathogenesis of idiopathic intracranial hypertension (IIH) is unknown; however, venous sinus stenting may be an effective treatment in select patients. Therefore, evaluation of venous sinuses for significant stenosis using MR venography (MRV) is critical in triaging patients for invasive evaluations/treatment. The transverse sinuses (TS) are frequently asymmetric and demonstrate filling defects due to arachnoid granulations. We assessed the clinical significance of these MRV findings using catheter-based venous pressure measurements (CVPM) as the gold standard.

Materials and Methods
The study included 73 IIH patients who had undergone MRV and CVPM. The percentage stenosis of the TS was calculated with reference to the superior sagittal sinus using three methods in blinded fashion. 1) Two attending and one fellow neuroradiologists visually analyzed the MRVs to calculate the degree of TS stenosis. 2) Catheter venography images were analyzed visually by a neurosurgery fellow to calculate the percentage stenosis of the TS. 3) MR venographies were analyzed using iNtuition (TeraRecon, CA) to automatically generate percentage stenosis. These results then were compared statistically with pressure drops across the TS from CVPM.

Results
Of the 73 IIH patients, 32 had significant pressure drops across one or both of their TS at CVPM and underwent stent placement. The ratings by the two attending neuroradiologists correlated significantly with pressure drops across both TS (Right: r=.449, p<.001; r=.493, p<.001) (Left: r=.372, p=.007; r=.417, p=.002). Computer automated stenosis grading significantly correlated with pressure drops across the right but not the left TS (Right r = .381, p = .001; Left r = .173, NS). Ratings by the radiology fellow and ratings based on catheter venography images were not correlated significantly with CVPM.

Conclusions
Findings at MRV correlate with clinically relevant pressure drops across the TS obtained from CVPM. While variant sinus anatomy is common, these findings have clinical significance, particularly in symptomatic IIH patients.
Comparison of Flow Characteristics of Intracranial Aneurysm and Adjacent Arteries Between 4D-phase-contrast MR Measurement and Computational Fluid Dynamics Simulations

Y Watanabe1, Y Kunitomi1, A Arisawa1, A Tsukabe1, H Takahashi1, H Tanaka1, T Fujinaka1, S Wada1, N Tomiyama1

1Osaka university, Suita, Osaka

Purpose
Computational fluid dynamics (CFD) has been proved valuable for simulating hemodynamics in intracranial vasculature, which might influence the initiation, growth, and rupture of aneurysm. The purpose was to compare the flow characteristics between 4D phase-contrast MR measurement (4D PC MRA) and CFD simulations at aneurysm and adjacent vessel sites.

Materials and Methods
Five unruptured cerebral aneurysms (ACOM 2, IC-PC 2, BA top) were included in this study. 3D computational meshes were created from 3D DSA images and CFD simulations were performed using the patient-specific inflow data for inlet boundary condition and adjustment outlet boundary condition of distal arteries measured by 3D PC MR flow data. 4D Flow was performed by a 3.0T MR unit to measure the aneurysm and adjacent vessel flow. Imaging parameters for 4D Flow were as follows: TR/TE=8.1/3.8msec, flip angle(FA)=15°, field of view (FOV)=180X180X30mm, Matrix=192X192, slice thickness 1.0mm/0.5mm, 60 slice, acquisition time=about 15 minutes at heart rate 60 beat/min, velocity encoding was 100cm/sec in all directions. The number of cardiac phase was 15 and the view-sharing factor for the retrospective sorting of acquired k-space was varied 1.0 to 1.3 due to patient's heart rate. The difference of flow vector was defined as Eu=100 (∑(i=1-N)|vm-vc|)/(∑(i=1-N)|Vm|) vm: flow vector by PC MR, vc: flow vector by CFD. Differences in flow vector between CFD and PC MRA at systolic and diastolic phase were calculated at parent artery, aneurysm and distal arteries.

Results
The flow features such as vector map and stream line were similar between CFD and 4D kPC MRA. The difference of velocity vector at systole phase was 31.1±9.6 at parent artery, 95.2±28.2 at aneurysm, 50.2±18.6 at distal arteries. The difference of velocity vector at diastole phase was 25.6±5.6 at parent artery, 65.8±11.2 at aneurysm, 35.7±10.1 at distal arteries. The value in the aneurysm showed statistically large flow difference compared to parent artery and distal arteries.

Conclusions
Flow patterns like vector map are similar between 4D PC MRA and CFD, but the quantitative flow values are not coincident with PC MR and CFD and the difference is large in the aneurysm compared to in the adjacent vessels.
O-404  
4:19PM - 4:27PM  
4D-Flow MRI for Visualize the Intracranial Brain Aneurysm Hemodynamics  
Y Watanabe¹, Y Kunitomi¹, A Tsukabe¹, A Arisawa¹, C Matsuo¹, H Tanaka¹, H Takahashi¹, T Fujinaka¹, N Tomiyama¹  
¹Osaka university, Suita, Osaka
Purpose
Hemodynamics in brain aneurysms is believed to play an important role to initiate, growth and rupture of aneurysm. 4D Flow is ECG-gated 4D phase-contrast MR measurement to evaluate the flow velocity changes during cardiac phase. The purpose of this study was to elucidate the in vivo analysis of hemodynamics of intracranial aneurysm and its relation to aneurysm location and size.

Materials and Methods
The 4D Flow MRI using 3T MR unit was performed in 19 unruptured saccular aneurysm with 18 patients (mean age 61.9 years, Male:Female=7:11). The flow analysis was performed with GT flow and the aneurysm flow was divided four types: Type R-round circulation in the aneurysm and smooth and unstagnated flow stream line from the inflow to outflow; Type V-vortex flow formation at the bottom of the aneurysm separated from the main round flow circulation; Type S-completely separated flow pattern with two independent flow stream lines; Type C-disordered flow pattern and show a cross outlet flow to the main round circulation flow. The aneurysm location was classified as terminal or side wall aneurysm.

Results
The flow pattern was summarized in Table. Aneurysm were located at ACOM (4), BA top (2), ICA top (1), ICA (5), IC-PC (5), MCA (2). Every ACOM and MC aneurysm showed round flow pattern. The ICA side type aneurysm (ICA + IC-PC) showed five round flow, four cross flow and one vortex flow. There was no significant aneurysm size difference between round flow pattern and cross flow pattern (Cross: 7.2 ± 2.0 mm, Round: 7.8 ± 3.3 mm, mean ± standard deviation).

Conclusions
The 4D Flow MRI demonstrated the flow patterns on aneurysm hemodynamics and classify the four flow patterns.
<table>
<thead>
<tr>
<th>Site</th>
<th>Size</th>
<th>Location</th>
<th>Flow pattern</th>
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<tbody>
<tr>
<td>ACOM</td>
<td>5.5</td>
<td>terminal</td>
<td>Round</td>
</tr>
<tr>
<td>ACOM</td>
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<td>ACOM</td>
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</table>

(Filename: TCT_O-404_Table2.gif)
Multilobulated paraclinoid aneurysms may be more prone to rupture

M Hadi¹, N Maza¹, A Maxwell¹, J Romero¹
¹Massachusetts General Hospital, Harvard Medical School, Boston, MA

Purpose
Paraclinoid aneurysms often are seen on CTA or MRA studies, either as incidental or during initial presentation with subarachnoid hemorrhage. Our purpose is to determine clinicoradiological characteristics using CTA that may predict rupture.

Materials and Methods
An IRB approved retrospective review was conducted of patients who had an initial head CTA between January 2008 and December 2010 at our institution, that demonstrated one or more paraclinoid aneurysms. Morphometric features of these aneurysms were recorded by three trained observers, along with demographic information and clinical risk factors, as well as
whether these ultimately ruptured at the time of last follow up. Differences between the ruptured and unruptured groups were evaluated.

Results
A total of 204 paraclinoid aneurysms were studied in 180 patients (149 F, 31 M, age range 59.0±15.5 years). Thirteen aneurysms had documented rupture. Multilobulated aneurysms formed a significantly larger percentage of ruptured aneurysms versus nonruptured aneurysms (25% versus 5%, p=0.01).

Conclusions
The multilobulated appearance of paraclinoid aneurysms seen on Head CTA could indicate a greater propensity for rupture.

O-406
4:35PM - 4:43PM

Characteristics of Asymptomatic Unruptured and Ruptured Growing Cerebral Aneurysms Identified by CTA

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Purpose
To evaluate characteristics of growing unruptured and ruptured cerebral aneurysms using longitudinal CTA.

Materials and Methods
Patients (n=46) with asymptomatic, unruptured cerebral aneurysms were followed longitudinally over time using CTA. The characteristics of patients with growing aneurysms and of growing aneurysms were recorded, including age and gender, and size, location, geometry, rupture incidence, and treatment option was evaluated. Growth was defined as change in aneurysm volume greater than 5% over baseline. All measurements were made prospectively by trained neuroradiologists using commercially available postprocessing software. The study was HIPPA compliant and had institutional review board approval.

Results
A total 36 patients (F=29, M=7) ranging in age from 40-85 years with 46 asymptomatic growing intracranial aneurysms were followed for up to 8.5 years, with average of four scans/patient. Most common locations were MCA (n=10), ACOM (n=7), PCOM (n=6). Forty aneurysms were saccular and six fusiform, with 41 intradural and five extradural. Time to growth ranged from 0.18-8.2 years, mean 2.1 years. Six of 36 (13%) aneurysms experienced only unidimensional growth. Sixty percent of growing aneurysms were < 7 mm maximal diameter. A total of 3/46 (6.5%) aneurysms experience rupture during study period, all intradural in location. Time to rupture ranged from 0.35-2.2 years. Average size of growing aneurysms was 6.3 mm and of ruptured aneurysm was 6.1 mm at study entry, and 6.2, 6.2 and 11 mm maximal diameter at time of rupture. Average 60% mean growth. Twenty-three were treated with conservative management and 23 with coil (n=8), clip (n=12) or other (n=3).

Conclusions
Most small growing asymptomatic unruptured cerebral aneurysms are under 7 mm maximal diameter. Growing aneurysms are located more often in the MCA and ACOM locations than
nongrowing aneurysms. Rupture rates are higher for growing aneurysms (6.5%) than stable aneurysms (0.2%), and aneurysms (<7 mm) are capable of growth and rupture.

Wednesday
3:15PM - 4:45PM
Sheraton Chicago Hotel & Towers, Superior AB (Level 2)

18G - PARALLEL SCIENTIFIC PAPER SESSION - INTRACRANIAL ARTERIAL VASCULAR IMAGING
O-407

Multi-Contrast High Resolution Vessel Wall MR Imaging and its Value in Differentiating Intracranial Vasculopathy

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¹University of Washington, Seattle, WA, ²University of Utah, Salt Lake City, UT

Purpose
To evaluate the imaging findings of different intracranial vasculopathies using T2 and T1 pre and postcontrast vessel wall MR (VWI) protocol to determine discriminating features and their ability to differentiate disease.

Materials and Methods
Two independent blinded raters reviewed consecutive patients with intracranial vasculopathy determined by arterial stenosis or irregularity on MR angiography (MRA), clearly defined clinical presentations and who had undergone VWI, including 3D T2 SPACE (.6 mm³ isotropic voxel resolution), T2 (.4x.4.1 mm) and T1 (.35x.4x2 mm) pre and postcontrast. Lesions seen on MRA were evaluated on VWI for T2 signal characteristics, and T1 pattern of disease, presence, pattern and degree of enhancement. Categorical variables were summarized as count (percentage) in each of the vasculopathy groups. Permutation tests were used to compare the groups. The group labels were permuted across patients instead of lesions to account for the potential dependence between lesions from the same patient. Sensitivity and specificity were used to evaluate how well combinations of imaging findings could discriminate between vasculopathies. Cohen's kappa was used to evaluate inter-reader agreement for the imaging findings. Throughout, two-tailed tests were used with statistical significance defined as p<0.05. Diagnosis was based on assessment of clinical markers by stroke neurologists independent of VWI results.

Results
Twenty-one atherosclerosis (81 lesions), four vasculitis (15 lesions) and four reversible cerebral vasoconstriction syndrome (RCVS) (22 lesions) cases were included in the study. There was very strong agreement between the two raters for lesion T2 hyperintensity (kappa=.80), pattern of wall involvement (.87), and presence of enhancement (.90), with substantial agreement for degree and pattern of enhancement (.77 and .73). There was a significant difference in: presence of lesion T2 hyperintensity and pattern of wall involvement between atherosclerosis and each of vasculitis and RCVS. There is a significant difference in the presence and degree of wall enhancement between RCVS and atherosclerosis and vasculitis each. There is a significant
difference in the pattern of wall enhancement between atherosclerosis and vasculitis. Please see Table 1 below for details. Inclusion of T2 VWI in addition to T1 increases the sensitivity of detecting atherosclerosis from 90.1% to 96.3%, without changing specificity of 86.5%. The presence of enhancement had a sensitivity of 100% in differentiating vasculitis from RCVS, and specificity of 81.8%.

Conclusions
Multicontrast VWI with both T2 and T1 pre and postcontrast sequences can improve diagnostic capability in vasculopathy differentiation.
Table 1. Distributions of imaging findings in each vasculopathy group (N=29 patients with 118 lesions).

<table>
<thead>
<tr>
<th>Variable</th>
<th>AS (N=81)</th>
<th>VS (N=15)</th>
<th>RCVS (N=22)</th>
<th>AS vs. VS</th>
<th>AS vs. RCVS</th>
<th>VS vs. RCVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2 Hyperintensity</td>
<td>Present</td>
<td>64 (75.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Absent</td>
<td>17 (21.0)</td>
<td>15 (100.0)</td>
<td>22 (100.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 Wall Thickening</td>
<td>Eccentric</td>
<td>73 (90.1)</td>
<td>1 (6.7)</td>
<td>4 (18.2)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Circumferential</td>
<td>8 (9.9)</td>
<td>14 (93.3)</td>
<td>11 (50.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Absent</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>7 (31.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CET1 Enhancement†</td>
<td>Present</td>
<td>74 (97.4)</td>
<td>15 (100.0)</td>
<td>4 (18.2)</td>
<td>&gt;0.99</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Absent</td>
<td>2 (2.6)</td>
<td>0 (0.0)</td>
<td>18 (81.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CET1 Enhancement</td>
<td>Grade 2</td>
<td>31 (40.6)</td>
<td>9 (60.0)</td>
<td>0 (0.0)</td>
<td>0.35</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Grade 1</td>
<td>43 (56.6)</td>
<td>6 (40.0)</td>
<td>4 (18.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grade 0</td>
<td>2 (2.3)</td>
<td>0 (0.0)</td>
<td>18 (81.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CET1 Enhancement Pattern†</td>
<td>Focal</td>
<td>11 (14.9)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0.042</td>
<td>0.39</td>
</tr>
<tr>
<td>(For those with enhancement)</td>
<td>Diffuse</td>
<td>44 (59.5)</td>
<td>15 (100.0)</td>
<td>4 (100.0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Values are no. (%);
†Enhancement could not be assessed in 5 lesions, all from atherosclerosis patients.
Association of Vessel Wall MR Imaging Features of Intracranial Atherosclerotic Plaques and Calcification on Non-Contrast CT

M Alexander¹, C Yuan², N Balu², T Hatsukami², M Mossa-Basha²
¹University of Washington, Seattle, WA, ²University of Washington, Seattle, WA

Purpose
This study examines intracranial atherosclerotic disease (ICAD) features on vessel wall imaging (VWI) studies and their association with plaque calcifications visible on CT.

Materials and Methods
We reviewed images in patients with two or more vascular risk factors undergoing VWI evaluation for suspected symptomatic ICAD. Lesions were assessed for lesion remodeling pattern, presence of intraplaque hemorrhage (IPH), and contrast enhancement. Concurrently obtained CT examinations were evaluated for calcifications in lesions investigated on VWI studies. Calcifications were classified as absent, mild, moderate, or severe based on subjective volume of high-density material on CT. Lesions were identified in vessels upstream of acute infarcts as determined by restricted diffusion and clinical history. If more than one lesion was located upstream an acute infarct, a single culprit lesion was selected based on most specific match with the perfusion territory. Additionally, parenchyma downstream to all other lesions was examined for T2/FLAIR findings of prior infarction. Chi-square tests were performed to evaluate for statistically significant associations.

Results
We identified 75 lesions in 25 patients. Eighteen lesions (24.0%) had positive remodeling; 31 (41.3%) had negative remodeling. Fourteen (18.7%) had IPH, while 48 (64.0%) demonstrated enhancement. Calcifications were mild in 17 (22.7%) lesions, moderate in 13 (17.3%), and severe in 2 (2.7%). Twenty-one (28.0%) were upstream acute infarcts. Eleven (14.7%) plaques were classified as culprit lesions. Twenty-four (32.0%) were upstream chronic infarcts.

Enhancing lesions were associated with moderate (p=0.014) or moderate/severe (p=0.005) calcifications. No other statistically significant associations were identified. No calcification characteristics were associated with lesions upstream chronic or acute strokes.

Conclusions
Enhancing intracranial atherosclerotic lesions are associated with moderate to severe calcifications on CT.
Purpose
This study examines vessel wall imaging (VWI) features of intracranial atherosclerotic disease (ICAD) plaques upstream to acute and chronic infarctions.

Materials and Methods
We reviewed images in patients with two or more vascular risk factors undergoing VWI evaluation for suspected symptomatic ICAD. Lesions were assessed for lesion remodeling pattern, presence of intraplaque hemorrhage (IPH), and contrast enhancement. Lesions were identified in vessels upstream of acute infarcts as determined by restricted diffusion and clinical history. If more than one lesion was located upstream an acute infarct, a single culprit lesion was selected based on most specific match with the perfusion territory. Additionally, parenchyma downstream to all other lesions was examined for T2/FLAIR findings of prior infarction. Chi-square tests were performed to evaluate for statistically significant associations.

Results
We identified 75 lesions in 25 patients. Eighteen lesions (24.0%) had positive remodeling; 31 (41.3%) had negative remodeling. Fourteen (18.7%) had IPH, while 48 (64.0%) demonstrated enhancement. Twenty-one (28.0%) were upstream acute infarcts. Eleven (14.7%) plaques were classified as culprit lesions. Twenty-four (32.0%) were upstream chronic infarcts. Lesions upstream acute infarcts were associated with positive remodeling (p=0.004) and IPH (p<0.001). Culprit lesions were associated with positive remodeling (p<0.001), IPH (p<0.001), and enhancement (p=0.01). No significant associations were found for lesions upstream chronic infarctions.

Conclusions
Positive remodeling, IPH, and enhancement are found in ICAD lesions suspected of causing infarcts. Negative remodeling held no predictive value. Vessel wall imaging should be considered in the assessment of ICAD and strokes of indeterminate cause.

O-410
3:39PM - 3:47PM

Intracranial vessel wall imaging in stenoocclusive lesions of the anterior circulation by a T1-weighted black-blood 3D-TSE sequence

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¹Tokyo Teishin Hospital, Tokyo, Japan

Purpose
Assessment of stenoocclusive lesions is required for identifying the cause of ischemia and prediction of future events. We evaluated the feasibility of a T1-weighted black-blood imaging by a volume isotropic T2-weighted acquisition (VISTA) sequence (T1-BB VISTA) in the diagnosis of such lesions of the anterior circulation.

Materials and Methods
Our study group comprised 44 patients including seven with an internal carotid artery lesion (3 with occlusion and 4 with stenosis) and 37 with a middle cerebral artery lesion (2 with occlusion and 35 with stenosis). Eleven patients were in the acute stage and the remaining 33 were in the chronic stage. Vessel wall imaging was performed at 1.5T employing the T1-BB VISTA
sequence in the coronal plane. We assessed the location of a plaque or thrombus as well as its signal intensity.

Results
In each patient, a plaque/thrombus and a patent lumen were well discriminated. In patients in the acute stage (n=11), eight showed a single localized plaque/thrombus and three showed a circumferential lesion. Their lesion was at least partially hyperintense in six. In patients in the chronic stage (n=33), their lesion location was variable including a single localized lesion (n=13), multiple localized lesions (n=13), a circumferential lesion (n=6), and normal findings (n=1). Among them, lesions in 30 patients had an isointense part, while those in eight patients had a hyperintense part.

Conclusions
Vessel wall imaging by T1-BB VISTA enables detailed assessment of a plaque or thrombus in the anterior circulation.
Serial change of Intracranial Vertebral Artery Dissection: Based on radiologic findings of High-Resolution MR

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¹Asan Medical Center, Seoul, Songpa-gu, ²Asan Medical Center, Seoul, Korea, Republic of, ³Asan Medical Center, Seoul, Seoul

Purpose
To present serial change in intracranial vertebral artery dissection (IVAD) using high resolution MR (HR MR) and to improve diagnostic performance of HR MR in diagnosis of IVAD.

Materials and Methods
From January 2011 to December 2013, 31 patients (M:F= 12:19; age range, 32-74 years; 38 vertebral arteries) were enrolled retrospectively. The patients were diagnosed IVAD based on clinical and radiologic findings (luminal angiography and HR MR) and presented clear onset from symptoms. Intracranial vertebral artery dissection was classified into acute, early subacute, late subacute, and chronic stage according to intervals from onset. The serial HR MR findings were rated in intimal flap, double lumen, intramural hematoma (IMH), degree of enhancement in arterial wall and periarterial area, outer diameter and signal intensity.

Results
Based on the imaging findings, IVAD was classified into acute (0-3 days, n=4), early subacute (3-10 days, n=8), late subacute (10-90, n=15) and chronic (>90 days, n=11) stage. In acute stage, the affected arterial wall had increased outer diameter, iso- to slightly high signal intensity of IMH on T1-weighted image, mild enhancement of IMH and fuzzy periarterial enhancement. Intramural hematoma had high signal intensity on T1-weighted imaging with prominent enhancement of IMH and periarterial area in early subacute stage, whereas mixed iso- and high signal intensity of IMH with mild enhancement of IMH and periarterial area in late subacute stage. In chronic stage, the outer diameter was normalized and intramural hematoma was resolved with minimal residual enhancement of arterial wall and periarterial area.

Conclusions
Intracranial vertebral artery dissection can show various HR MR findings according to stages, which may be helpful to reach more precise diagnosis. Outer diameter, intramural hematoma, and degree of enhancement was the most important findings to distinguishing subacute to chronic stage in IVAD.
<table>
<thead>
<tr>
<th></th>
<th>Intramural hematoma (Pre-T1)</th>
<th>Arterial wall enhancement (e-T1)</th>
<th>Periarterial area enhancement (e-T1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute</strong></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
</tr>
<tr>
<td>(0-3 days)</td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
</tr>
<tr>
<td><strong>Early subacute</strong></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
</tr>
<tr>
<td>(3-10 days)</td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
</tr>
<tr>
<td><strong>Late subacute</strong></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
</tr>
<tr>
<td>(10-90 days)</td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
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</tr>
<tr>
<td><strong>Chronic</strong></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
</tr>
<tr>
<td>(&gt;90 days)</td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
<td><img src="TCT_O-411_Figure1.jpg" alt="Image" /></td>
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</tbody>
</table>

(Filename: TCT_O-411_Figure1.jpg)

O-412

Ultra high resolution 7T cerebral angiography: Towards the resolution of DSA?

E Raz\(^1\), M Shapiro\(^2\), J Brisset\(^2\), M Potts\(^2\), T Becske\(^2\), G Fatterpekar\(^2\), Y Ge\(^3\), P Nelson\(^2\)

\(^1\)NYU Medical Center, New York, NY, \(^2\)NYU Langone Medical Center, New York, NY, \(^3\)NYU Langone Medical Center, New York City, NY

Purpose

Very good results have been obtained with the use of 3T magnets. In fact, MR angiography (MRA) is one of the most significantly improved MR techniques at higher field strength. Few
studies in the literature have evaluated the potential of 7T magnets to further improve the MRA quality.

Materials and Methods
On a ultrahigh field 7T human-sized MR scanner (Siemens Healthcare, Erlangen, Germany), we tested an MRA protocol on a series of six healthy volunteers as part of a prospective IRB-approved HIPAA-compliant study. We performed time-of-flight (TOF) in the axial and coronal planes. Magnetization transfer or presaturation slabs were not used because of the excessive specific absorption rate. 3D-spoiled gradient echo sequence with TR/TE/ 15 ms/4.8 ms. Data were acquired with matrix704x520, and acquired slice thickness 0.5 mm. Image data were acquired in approximately 10 minutes. Two neuroradiologists evaluated the delineation of arterial vessels in the circle of Willis, the lenticulostriate arteries, presence of artifacts, vessel-tissue contrast and overall image quality of TOF MRA scans in consensus on a five-point scale.

Results
Parameters yielding the best contrast and contrast-to-noise ratio were determined. Ratings ranged between good and excellent for most of the evaluated features. The results demonstrate that ultrahigh field at 7T allowed high resolution depiction of the intracranial vasculature. Time-of-flight MRA at 7T demonstrates considerably more first- and second-order branches than was seen on the standard 3T MRI. The lenticulostriate arteries were visualized and quantified in all the subjects. Venous saturation was sufficient for all cases.

Conclusions
Longer T1 times at 7T result in preserved signal intensity inside the vessels even in smaller vessels, making higher resolutions possible with reasonable times of acquisition. In the future, this may result in better diagnostic quality, especially in patients that cannot undergo catheter cerebral angiogram. Our protocol is suitable for clinical application with excellent image quality for delineation of various intracranial vascular pathologies.
Diagnosing CNS vasculitis: CTA versus Conventional Angiography

P Mehta¹, D Murph¹, S Kralik¹, D O'Neill²
¹Indiana University School of Medicine, Indianapolis, IN, ²Indiana University, Indianapolis, IN

Purpose
To determine the sensitivity, specificity, and interobserver agreement of using computed tomography angiography (CTA) to detect evidence of central nervous system (CNS) vasculitis compared to digital subtraction angiography (DSA).

Materials and Methods
A retrospective case-control study was conducted from Sept 2006 - July 2014 among patients with and without DSA evidence of CNS vasculitis. The experimental group consisted of patients with DSA evidence of CNS vasculitis, and the control group consisted of patients without DSA evidence of CNS vasculitis. Both groups had CTA exams performed near the time of DSA. CT angiography cases from both groups were randomized, and two fellowship trained, board certified neuroradiologists performed a blinded review of the CTA studies for evidence of CNS vasculitis. Sensitivity and specificity of CTA for the diagnosis of CNS vasculitis were calculated, using DSA diagnosis as the imaging gold standard. Interobserver agreement for CTA diagnosis of CNS vasculitis also was performed.

Results
A total of 21 patients were evaluated, with 11 patients in the control group (DSA without evidence of vasculitis) and 10 patients in the experimental group (DSA with evidence of vasculitis). The average patient age was 38 years of age (range 23-65), and the male:female ratio was 1:1.6. The median time from CTA to DSA was 1.0 days (mean 11.5 days, range 0-120 days). When compared to DSA, CT angiography had a sensitivity of 67% (radiologist A, 95% CI 31-91%) and 60% (radiologist B, 95% CI 27-86%). Specificity was 90% (radiologist A, 95% CI 54-99%) and 91% (radiologist B, 95% CI 57-99.5%). Interobserver agreement was 95%, k=0.886.

Conclusions
CT angiography is a relatively less sensitive but highly specific test for diagnosing CNS vasculitis when compared to DSA. CT angiography is a reasonable initial imaging test in evaluating suspected CNS vasculitis and may potentially obviate the need for more invasive DSA.

O-414

Interrogating the Functional Correlates of Collateralization in Patients with Intracranial Stenosis using Multi-modal Hemodynamic Imaging

B Roach¹, M Donahue², L Davis², C Faraco², D Arteaga², A Scott¹, M Strother³
¹Vanderbilt University Medical Center, Nashville, TN, ²Vanderbilt University, Nashville, TN, ³Vanderbilt University School of Medicine, Nashville, TN

Purpose
The importance of collateralization for maintaining adequate cerebral perfusion, particularly in
the setting of steno-occlusive diseases, is increasingly recognized. However, measuring collaterals noninvasively, and specifically understanding anatomy of collateral vessels and the contribution of collaterals to flow, has proved elusive. The aim of this study was to assess correlations between (1) baseline perfusion and arterial transit time, (2) cerebrovascular reactivity (CVR), and (3) the presence of collateral vessels on digital subtraction angiography (DSA).

Materials and Methods

The relationship between the presence of collateral vessels on arterial spin-labeling (ASL) MRI and DSA was compared to blood-oxygenation-level-dependent (BOLD) MRI measures of hypercapnic cerebrovascular reactivity (CVR) in patients with symptomatic intracranial stenosis (n=18), anterior, posterior, and middle cerebral artery flow territories. Digital subtraction angiography maps were reviewed by a board-certified neuroradiologist and given the following scores: 1) collaterals to the periphery of the ischemic site; 2) complete irrigation of the ischemic bed via collateral flow; 3) normal antegrade flow. Arterial spin-labeling maps were scored according to 0) low signal; 1) moderate signal with arterial transit artifact (ATA); 3) high signal with ATA; 4) normal signal.

Results

Arterial transit artifact on ASL MRI and collateral perfusion on DSA strongly correlated with declines in CVR as measured on BOLD MRI (P=<0.001 and 0.0012, respectively), suggesting that collateral vessels may have reduced CVR. Regions with severe ASL ATA positively correlated with presence of collaterals on DSA (P=0.0420). There was a significant correlation between increasing degrees of collateralization on DSA with declines in both CVR (P<0.001) and CBF (P=0.0151) on BOLD MRI.

Conclusions

Arterial transit artifact on noninvasive ASL MRI, which has been shown previously to correlate with collateral perfusion on DSA, correlated significantly with reduced CVR. Noninvasive measures of perfusion, ATA, and CVR may be useful for more thoroughly interrogating the functional architecture of collateralization.
Vertebrobasilar arterial variations resulting from partial persistence of the primitive lateral basivertebral anastomosis (PLBA) of Padget

L Gregg¹, P Gailloud¹
¹The Johns Hopkins Hospital, Baltimore, MD
Purpose
The primitive lateral basovertebral anastomosis (PLBA) of Padget is a longitudinal embryonic channel of the hindbrain that transiently connects the developing branches of the vertebrobasilar system (1, 2). This work describes several vertebrobasilar variants resulting from partial persistence of the PLBA.

Materials and Methods
Seven types of vertebrobasilar anomalies are illustrated by 12 angiographic observations.

Results
The angiographic appearances of typical and atypical persistent trigeminal artery variants, common trunks of origin for one, two or three cerebellar arteries, abnormal origins of the cerebellar arteries, and several types of vertebrobasilar duplications are described. The PLBA likely is the cranial continuation of the ascending ramus of the dorsal radicular branch of the proatlantal artery (i.e., the radicular artery of C1), and represents the cranial equivalent of the posterior-lateral spinal artery.

Conclusions
Several previously ill-defined or poorly understood variations of the vertebrobasilar arterial system are explained by a partial persistence of the PLBA of Padget.
Is Digital Subtraction Angiography (DSA) necessary for Computed Tomography Angiography (CTA) negative subarachnoid hemorrhage patients’ management?

J Shankar¹, L Hodgson²
¹QE II Health Science Center, Dalhousie University, Halifax, Nova Scotia, ²Dalhousie University, Halifax, Nova Scotia

Purpose
Imaging of head and neck vessels with CTA has evolved rapidly since the introduction of helical CT with the ability to scan quickly and capture the arterial phase of enhancement. Multisection CT scanners such as the 64-section scanner enable isotropic imaging, which provides high-resolution 3D reconstructions and further shortened acquisition time. CT angiography is becoming the frontline modality to reveal aneurysms in patients with subarachnoid hemorrhage (SAH). However, in about 20% of SAH patients no aneurysm is found. In these cases, intra-arterial DSA is still performed. Our aim was to evaluate whether negative findings on CTA can reliably exclude aneurysms in patients with acute SAH.

Materials and Methods
We conducted a retrospective analysis of all DSA performed from August 2010 to July 2014 in patients with various indications. We selected patient who presented with SAH and had a negative CTA. Findings of the CTA were compared with DSA. CT angiograms were performed with a 64-section multidetector row CT scanner.

Results
Eight hundred fifty-seven DSA were performed during the study period. Fifty-one (5.95%) patients with SAH and negative findings on CTA who underwent subsequent DSA were identified. Of these, only three (5.9%) of patients had positive findings on the DSA. One patient had a posterior inferior cerebellar artery aneurysm on the DSA. This was not seen on the initial CTA due to the incomplete coverage of the head on the CTA which excluded the area of the brain where the aneurysm was located. Another CTA done immediately after the DSA as the patient was disoriented, showed the aneurysm very well. Second patient had SAH in the pre-pontine and cerebello-pontine cistern. His CTA did not show any evidence of aneurysm. However DSA showed the suspicious dissection of the extracranial segment of the right vertebral artery. Even in retrospect, we could not see any evidence of dissection on the CTA. The intracranial segment of the vertebral artery did not show any evidence of dissection or irregularity. There was a suspicion of this iatrogenic dissection from the catheter angiogram. The third patient had SAH in the pre-pontine cistern with intraventricular extension. His CTA did not show any evidence of aneurysm. On DSA, the only suspicious finding was a tiny protuberance from the left paraclinoid ICA. The appearance is suggestive of an infundibular origin of a hypoplastic PCOM artery. However, tiny, sessile aneurysm here cannot be excluded. This did not show any change even on the third follow-up DSA. The patient did not receive any treatment for this and did not have rebleed. He made an excellent recovery.

Conclusions
In patients with SAH, negative CTA findings are reliable in ruling out aneurysms in any pattern
of SAH or no blood on CT. The only patient with negative CTA who had positive findings on DSA had possibly an iatrogenic dissection of the extracranial vertebral artery. Although our study had small number of patients, we believe that we may not have to do a catheter angiogram in patients with SAH and negative CTA.

O-417

4:35PM - 4:43PM

Dose comparison of classical 2-plane technique and 3D rotational angiography

N Guberina¹, M Schlamann¹, C Mönninghoff², M Forsting¹, A Ringelstein³

¹Institute for Diagnostic and Interventional Radiology and Neuroradiology, University Hospital Essen, Essen, Germany, ²Institute for Diagnostic and Interventional Radiology and Neuroradiology, Essen, Germany, ³University Hospital Essen, Essen, NRW

Purpose
Classical 2-plane technique in comparison to 3D rotational angiography requires a series of images and involves high radiation doses in interventional neuroradiology. Hence, the purpose of our study was to contrast the effective radiation dose imparted to patients during these two competing imaging methods for neurovascular studies.

Materials and Methods
We performed TLD-measurements (lithium fluoride TLD-100) on a female anthropomorphic phantom (ATOM dosimetry phantom 702-D), during 2-plane and 3D rotational angiography in a flat-panel detector and vascular interventional system (Allura Xper FD20, Phillips Healthcare), as daily accomplished in the clinical routine. In the first technique the head is assessed from digital subtraction angiography of posterior/anterior and lateral projections (frame rate: 1p/sec for a scan time of approximately 8 sec.). The second technique involves 122 images acquired from one single image run with the imaging system rotating 240 degrees around the phantom's head.

Results
The mean effective radiation dose from 2-plane technique DSA and from 3D rotational angiography is summarized as follows: (a) total effective radiation dose 0.4mSv/ 0.1mSv; (b) brain 11.4mSv/ 2.4mSv; (c) eye-lens 4.5mSv/ 1mSv; (d) salivary glands 7mSv/ 1.7mSv; (e) oral mucosa 2.7mSv/ 0.9mSv (f) thyroid 0.5mSv/ 0.2mSv; (g) thymus 0.2mSv/ 0.05mSv; (h) bone marrow 1mSv/ 0.2mSv; (i) oesophagus 0.07mSv/ 0.03mSv (j) endotracheal system 2.6mSv/ 0.7mSv; (k) skeleton 0.7mSv/0.2mSv. Intermodality comparison proves that effective radiation dose imparted to patients from 3D rotational angiography is approximately four times less than in classical 2-plane technique.

Conclusions
Our results show that the mean effective radiation dose of 3D angiography is significantly lower than in classical 2-plane technique DSA. The current results further enhance the goal to reduce effective radiation dose in the diagnostic assessment of cerebral vessel diseases.

Wednesday
3:15PM - 4:50PM
Sheraton Chicago Hotel & Towers, Erie (Level 2)
LASER ABLATION THERAPY OF HYPOTHALAMIC HAMARTOMA

V Trinh¹, S Karnezis¹, N Salamon²
¹UCLA, Los Angeles, CA, ²David Geffen School of Medicine at UCLA, Los Angeles, CA

Purpose
Hypothalamic hamartoma presents with not only gelastic seizures but also may develop intractable dysesthetic seizures. Conventional surgical techniques are associated with complications and morbidities. We present the acute, midterm efficacy and safety of MRI-guided laser-induced thermal ablation technology, for treatment of hypothalamic hamartoma.

Materials and Methods
A 22-year-old woman with severe dyscognitive epilepsy with 40-50 times a day, due to hypothalamic hamartoma. A single laser ablation was performed. Postprocedure MRI confirmed enhancement within the hamartoma, confirming the ablation and the patient became seizure-free since immediately after the procedure and maintain seizure freedom for more than 5 months. A 22-year-old man with intractable dyscognitive epilepsy frontal spikes, underwent MRI that revealed 1cm hamartoma. MRI-guided laser ablation of the dysplastic cortex was carried out with postprocedure MRI confirming complete ablation. The patient became seizure-free after the procedure.

Results
A and B: Preoperative image: 1cm hypothalamic hamartoma involving the fornix and displacing the mammillary body. C: During laser ablation and the temperature map (white arrow) compatible with the location of the hamartoma. D: Immediately after ablation image with contrast shows enhancement in the hamartoma.

Conclusions
We observed favorable outcome with successful seizure freedom of two hypothalamic hamartoma patients. The result provides evidence for safety and efficacy of MRI-guided thermal laser ablation as a promising novel technology that may be used as an additional epilepsy surgery, avoiding perioperative risks reported with conventional surgical techniques.
Rare Variant Persistent Carotid-Basilar Anastomosis Through the Jugular Foramen

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Purpose
To describe a rare variant carotid-basilar anastomosis; an artery arising from the left internal carotid artery and passing through the jugular foramen to continue as a vertebrobasilar artery.

Materials and Methods
A 60-year-old female was admitted after being struck by a car. The patient presented with a GCS of 11 and localized to painful stimulation with the left extremity only. Imaging work-up demonstrated numerous injuries including subdural, subarachnoid, and intraparenchymal intracranial hemorrhage, and a nondisplaced bilateral parietal and left occipital calvarial fracture. Given the severity of injury, computed tomographic angiography (CTA) of the neck was obtained.

Results
Vascular imaging revealed markedly hypoplastic vertebral arteries. Arising from the left internal carotid artery was an anomalous artery which coursed superiorly with extension intracranially through the jugular foramen; this vessel predominantly supplied the basilar artery and is compatible with a persistent carotid-basilar anastomosis (Figure). The left posterior inferior cerebellar artery (PICA) arises from this anomalous vessel, just cephalad to the jugular foramen. The right PICA origin was not well delineated but appeared to arise from the hypoplastic right vertebral artery.

Conclusions
Our case represents a rare variant carotid-basilar anastomosis extending through the jugular foramen which, to our knowledge, there has been only one previously described case report in the literature (1). This variant is likely closely related to the persistent hypoglossal artery. While the persistent hypoglossal artery is felt to arise from the hypoglossal branch of the neuromeningeal trunk of the ascending pharyngeal artery (APhA), this vessel may be derived from the jugular branch of the neuromeningeal trunk of the APhA (2). Given the course of this vessel through the jugular foramen, it is possible that this could cause symptoms resulting in cranial nerve IX, X, or XI palsy, similar to the reports of hypoglossal nerve symptoms associated with the persistent hypoglossal artery.
It's SMART to be ALERT: Acute Neurological Syndromes following Radiation Therapy

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Purpose
We will discuss the imaging and pathophysiology of ALERT syndrome (acute late-onset encephalopathy after radiotherapy), which encompasses the entities of SMART (stroke-like migraine attacks after radiation therapy) and PIPG (peri-ictal pseudoprogression).

Materials and Methods
A 53-year-old female with medulloblastoma resected 33 years ago, narrow-angle glaucoma, and polysubstance abuse presented with 10/10 thunderclap headache and transient left visual scotomas, nausea, and photophobia. Ophthalmologic examination showed normal tonometry and fundoscopy. Neurologic examination was significant for cerebellar signs. Lumbar puncture demonstrated opening pressure of 12 mm H2O and normal CSF analysis. Subsequently, the patient developed right homonymous hemianopsia and aphasia (expressive > receptive). Electroencephalogram (EEG) showed continuous focal slowing over the left hemisphere.

Results
Initial head CT was negative for hemorrhage and showed sequelae of posterior fossa resection/radiation with atrophy and mineralization. There was an indwelling right parietal Ommaya reservoir with mild ventriculomegaly at the patient's baseline. CT angiography/CTP 5 days later showed new hypodensity in the left occipital lobe with elevated mean transit time. Intracranial vasculature was within normal limits. Subsequent MR showed an acute left occipital lobe infarct with restricted diffusion. In addition, there was patchy gyriform edema/enhancement involving the left posterior temporal and occipital cortex. Numerous radiation-induced foci of susceptibility were noted throughout the brain. Follow-up MR 2 weeks later showed evolution of the left occipital infarct and near complete resolution of enhancement.

Conclusions
Our patient had a complex clinical picture with wide differential diagnosis including migraine, infarct, seizure, posterior reversible leukoencephalopathy (PRES), reversible cerebral vasoconstriction syndrome (RCVS), subarachnoid hemorrhage, meningitis, and hydrocephalus. CT was useful in excluding many of the above etiologies and identified sequelae of prior cranial irradiation. MR demonstrated the characteristic transient cortical edema/enhancement and superimposed infarction. Physiologically, ALERT syndrome is thought to represent a delayed radiation vasculopathy with impaired autoregulation and/or endothelial damage. Risk factors include male gender, young age at time of radiation, and genetic susceptibility. SMART tends to produce migraine/stroke symptoms with cortical enhancement, while PIPG more often presents with seizures and leptomeningeal enhancement. Other self-limiting vascular-mediated processes include PRES and RCVS. Treatment for SMART syndrome is supportive, including antiepileptics and steroids. The majority of cases resolve completely in 2-5 weeks, but can recur. Brain biopsy should be avoided, as it may impair the degree of recovery.
Dissection of a limb of a vertebral artery fenestration: case report

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Purpose
Vertebral artery fenestrations and vertebral artery dissections are rare. Both have been documented independently as pathologies of the vertebral artery. Dissection of a limb of the vertebral artery fenestration has not been reported. We present a rare case of dissection within one limb of a vertebral artery fenestration mimicking an intracranial aneurysm, which was explored and confirmed with CTA, MRI and catheter angiography.

Materials and Methods
The patient presented with a sudden onset, severe headache associated with ataxia, dysphagia and vomiting. The patient went to a local emergency room, was evaluated for a possible cardiac cause and was discharged without further investigations. After conducting his own research, the patient's concern for subarachnoid hemorrhage prompted a visit to the emergency department at our institution. A lumbar puncture and CT angiogram of the head and neck were done. The latter revealed a sausage-shaped elongated aneurysm at the dome at the vertebral basilar junction. The aneurysm's location was atypical and an MRI was ordered. MR imaging including time-of-flight (TOF), high-resolution wall-imaging pre and postcontrast images was performed. Time-of-flight images demonstrated the suspected aneurysm; however, distally, there was evidence of high-T1 signal suspicious for hematoma within a dissection flap. High resolution axial T2 wall-imaging showed an abnormal flow-void converging towards the basilar artery, consistent with a dissection within one limb of a vertebrobasilar fenestration.

Conclusions
The angiographic findings supported the MRI diagnosis of a dissection within one limb of a fenestration. Given the patient's clinical presentation of headache associated with a posterior circulation transient ischemic attack, a dissection of a portion of the left limb of a vertebral basilar fenestration was felt to be the underlying cause.
Enlargement of the Inferior Intercavernous Sinus Mimicking an Intrasellar Mass in a Patient with CSF Hypotension.

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Purpose
To describe the appearance of an enlarged inferior intercavernous vein in a patient with cerebrospinal fluid (CSF) hypotension that mimicked an intrasellar mass.

Materials and Methods
A 44-year-old female who underwent resection of a posterior fossa low grade astrocytoma 23 years prior presented with an 8-month history of a progressive occipital headache. She had associated intermittent blurry vision, dizziness, and nausea. An MRI was obtained (imaging findings discussed below) and neurosurgical consultation requested. She underwent a CT myelogram and cisternogram due to the findings on the MRI. Initially it was thought that she had the classic imaging findings of CSF hypotension and a coexisting sella mass with a differential diagnosis of Rathke cleft cyst, cystic macroadenoma, or craniopharyngioma on an outside interpretation. After further review it was noted that she had marked venous engorgement throughout the skull base venous system and that the intrasellar structure was an enlarged inferior intercavernous sinus. No CSF leak was found on myelography and her symptoms were managed nonoperatively.

Results
Figure 1. A. B. Sagittal T1WI, and Sagittal T1WI with gadolinium demonstrates a T1
hypointense avidly enhancing structure elevating the adenohypophysis. The bright spot of the posterior pituitary remains intrasellar. Also demonstrated are the classic signs of CSF hypotension including downward transtentorial herniation of the brain, enlargement of the pituitary, thickening of the pituitary stalk, flattening of the anterior aspect of the pons, effacement of the third ventricle, and venous engorgement along the inferior petrosal sinuses and prepontine venous plexus. C. D. Coronal T2WI and T1WI postgadolinium images demonstrate an intact sella floor with an engorged cavernous sinus connected through a markedly engorged inferior intracavernous sinus. Diffuse pachymeningeal enhancement.

Conclusions
MR imaging findings of patients with CSF hypotension have been well documented including the venous distension sign involving the transverse sinus. Venous engorgement of the intrasellar sinuses have not been described previously in this condition and in this case mimicked a pathologic intrasellar lesion. This may have led to neurosurgical intervention if not for re-review of the imaging studies at our institution which may have led to increased morbidity as bleeding in this location is sometimes difficult to control. The intercavernous sinuses, including the anterior, posterior, and inferior intercavernous sinus, extend across the midline and occupy a space between the meningeal dural layer covering the pituitary gland and the endosteal layer covering the osseous sellar floor. The neuroradiologist should be aware of these sinuses as they may mimic pathologic sella lesions especially in conditions which have associated venous engorgement such as CSF hypotension or dural AVF.
Tumefactive Demyelination associated with a Developmental Venous Anomaly

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Purpose
Demyelinating diseases such as MS and ADEM have a perivenular distribution, and active aggressive demyelinating processes have been shown to be associated with enlarged medullary draining veins. Some authors speculate that demyelination progresses along veins by a process of perivenular inflammatory infiltration which contributes to axonal damage and demyelination, suggesting an association between demyelinating lesions and venous structural abnormalities (1). A review of the literature reveals only one previously reported case of demyelination associated with a developmental venous anomaly (DVA) (2). We present a rare case of tumefactive demyelination occurring in close association with a DVA.

Materials and Methods
A 29-year-old female presents with several days of vertigo, headache, and vomiting. Her history is significant for AML for which she underwent total body radiation and bone marrow transplant at age 13. Physical exam revealed dysarthria, diplopia, right-sided dysmetria and dysdiadochokinesia. Cerebrospinal fluid did not clearly indicate an immunologic process. The patient was treated with steroids with mild improvement of her symptoms. Despite a leading diagnosis of demyelination, given the patient's history and a desire on her part to be definitive, a stereotactic biopsy was performed. The biopsy showed active demyelination with no evidence of neoplasia.

Results
MR imaging revealed a large centrally T2/FLAIR hyperintense lesion in the right cerebellum with peripheral T2 hypointensity exerting mild mass effect on the fourth ventricle. A network of veins with a "caput medusa" appearance consistent with a DVA traversed the lesion. The lesion showed a peripheral rim of restricted diffusion and ring enhancement. Arterial spin labeling (ASL) perfusion imaging demonstrated increased cerebral blood flow along the periphery of the lesion. As expected, the DVA enhanced after contrast administration. The constellation of findings is most consistent with tumefactive demyelination occurring in the vicinity of a DVA.

Conclusions
Developmental venous anomalies usually are incidental and asymptomatic. Symptomatic DVAs are thought to relate to thrombosis, hemorrhage, or associated parenchymal abnormality within their drainage territory, presumably on the basis of chronic venous ischemia (4). Parenchymal changes have been described in the drainage territory of 13-28% of DVAs and are thought to represent edema, gliosis, leukoaraiosis, or demyelination, but these changes have not been fully elucidated yet pathologically (4). It also has been shown that some DVAs have associated perfusion changes on ASL and dynamic susceptibility contrast imaging, the former suggesting the presence of abnormal AV shunting in a subset of lesions (5). In our case, the imaging findings are most compatible with acute tumefactive demyelination. The presence of veins
traversing the lesion also supports a demyelinating process rather than a malignant lesion. Recognition of these features is important as an invasive biopsy may be avoided if imaging findings are consistent with tumefactive demyelination even in cases where the clinical circumstances are equivocal.

**Figure 1.** Axial T2 image shows a large lesion with central T2 hyperintensity and peripheral T2 hypointensity in the right cerebellum and middle cerebellar peduncle. There is mild mass effect on the fourth ventricle and a traversing flow void with a “caput medusa” appearance consistent with a developmental venous anomaly.
**Figure 2.** The lesion demonstrates a rim of restricted diffusion (bright on DWI and dark on ADC). There is centrally increased diffusion, as well as increased diffusion in a halo of vasogenic edema surrounding the lesion.

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**Figure 3.** ASL perfusion imaging shows markedly increased cerebral blood flow along the periphery of the lesion.
**Figure 4.** Axial T1 BRAVO postcontrast image shows rim enhancement of the lesion. As expected, the developmental venous anomaly along the medial aspect of the lesion also enhances following gadolinium administration.
Purpose
There are few cases in the literature describing intracranial findings of disseminated intravascular coagulation (DIC), and only one case that presented with diffuse cerebral microhemorrhages. We will describe a case of a patient who had extensive microhemorrhages on magnetic resonance imaging (MRI) and in which DIC was not initially clinically suspected. In addition, we will discuss the imaging differential diagnosis of diffuse cerebral microhemorrhages and highlight imaging findings that will help distinguish between the various etiologies.

Materials and Methods
A 55-year-old female with idiopathic pulmonary fibrosis presented with respiratory failure and septic shock. Her admission coagulation values were normal. Several weeks later, the patient received a double lung transplant. At that time, her laboratory values were: platelet count 58 (nl 150-400), activated partial thromboplastin time 62.4 sec (nl 22-35), prothrombin time 19.8 sec (nl 11-14), and fibrinogen 46 (g/ml) (nl 150-400). An MRI was obtained because the patient had persistently poor mental status. The MRI demonstrated diffuse cerebral microhemorrhages, predominantly located at the gray-white junction, raising the possibility of an embolic phenomenon, such as fat or air emboli, or DIC. Clinically, fat emboli from sternotomy were suspected. Cerebral amyloid angiopathy and diffuse axonal injury were not diagnostic considerations given the patient's age and lack of trauma. A follow-up MRI 5 days later demonstrated a slight increase in the number of microhemorrhages. A D-Dimer was obtained, which was 8805 ng/ml (nl <500). Overall, the laboratory values met DIC diagnostic criteria, and eventually normalized.

Results
Initial MRI demonstrated extensive supratentorial and infratentorial hypointense foci on susceptibility-weighted images, consistent with microhemorrhages, which were predominantly located at the gray-white junction (A and B). There was no associated restricted diffusion (C) or other signal abnormality. A follow-up MRI 5 days after the initial MRI study demonstrated a slight increase in the microhemorrhages (D). This pattern of microhemorrhages and lack of associated restricted diffusion are distinct from other embolic phenomenon. Microhemorrhages associated with fat emboli typically are located more centrally and have associated restricted diffusion ("starfield pattern"). Microhemorrhages resulting from air emboli typically are based cortically with associated gyriform restricted diffusion.

Conclusions
With more widespread utilization of susceptibility-weighted imaging, a newer imaging method that maximizes sensitivity to magnetic susceptibility effects, diffuse cerebral microhemorrhages will be encountered more often. Therefore, it is important for the radiologist to consider DIC in the differential diagnosis in the appropriate clinical scenario. Our case suggests that certain imaging findings, such as the distribution and lack of associated restricted diffusion, may help differentiate DIC from other embolic phenomena.
Susceptibility-Weighted Imaging: Improving the Reliability of Interpretation of Phase Information to Differentiate Hemorrhage and Calcium

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Purpose
To illustrate an internal control method to improve reliability of interpreting susceptibility-weighted imaging (SWI) filtered-phase images for differentiating hemorrhage from calcium. Differentiation of hemorrhage and calcium can be performed using phase information from SWI. On right-handed systems differentiation assumes positive phase for paramagnetic substances (deoxyhemoglobin and thrombus), and negative phase for diamagnetic substances (organic calcium). We illustrate a case in which internal controls allow determination of the correctness of the assumed substance-dependent phase shifts, subsequently allowing interpretive compensation for MRI machine-specific inversions.

Materials and Methods
A 91-year-old male with multiple medical problems presented with confusion and hypoxia. Head CT and brain MRI with SWI were performed. Unexpectedly, the apparent phase of incidental areas of microhemorrhage and known calcification on SWI images were inverted, making hemorrhage appear calcific and calcifications appear hemorrhagic. Deoxyhemoglobin-containing veins and pineal calcifications were used as internal controls to discover phase inversion on that MRI unit to allow interpretative compensation of the phase images.

Results
Initial head CT showed physiologic pineal and choroid plexus calcifications and disproportionately dilated lateral and third ventricles (Figure 1a). Subsequent brain MRI revealed the expected SWI signal-loss of the pineal calcifications, but unexpected decreased signal on phase images (Figure 1b), whereas chronic microhemorrhages showed the expected SWI signal loss (Figure 1c), but unexpected increased signal on phase images (Figure 1d). Susceptibility-weighted imaging phase images of control areas of the deoxyhemoglobin-containing deep cerebral veins and superficial venous sinuses showed bright signal as well as dark signal in pineal and choroid plexus calcifications (Figure 1b).

Conclusions
Susceptibility-weighted imaging filtered-phase images of this case revealed inversion of the expected phase of the diamagnetic calcium and paramagnetic deoxyhemoglobin and hemorrhage. Using the phase appearance of internal controls (veins and pineal calcifications) allows more reliable machine-specific SWI phase differentiation of calcium versus hemorrhage.
Subarachnoid hemorrhage secondary to ophthalmic artery avulsion

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Purpose
Subarachnoid hemorrhage in basal cisterns is common in the setting of trauma or rupture of an intracranial aneurysm, however very rarely encountered following ophthalmic artery avulsion.

Materials and Methods
A 51-year-old female with mental retardation presented with self-inflicted dislocation of the right globe. Because of the known poor vision in the right eye prior to this admission, the globe was repositioned in the ER into the socket without exploration.

Results
Computed tomography (CT) of the orbits showed proptosis of right globe along with diffuse subarachnoid hemorrhage in the basal cisterns (A). Given the presence of subarachnoid hemorrhage, a cerebral angiogram was performed to rule out a ruptured intracranial aneurysm. On cerebral angiogram no aneurysm was evident, however, filling of the proximal stump of ophthalmic artery with delayed retrograde filling of distal ophthalmic artery were noted (B and C, arrows). These findings were consistent with a traumatic ophthalmic artery avulsion. Patient was managed conservatively and follow-up imaging demonstrated resolution of subarachnoid hemorrhage with no vasospasm.

Conclusions
Imagers should be aware that traumatic avulsion of ophthalmic artery is a rare but potential cause of subarachnoid hemorrhage.
Pneumatization of the Optic Nerve Sheaths Induced by Temporal Bone Fracture

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Purpose
Pneumatization of the optic nerve sheath, also called pneumo-opticus, has been reported in cases of severe head trauma in association with optic neuropathy. We present a case of extensive but asymptomatic post-traumatic bilateral optic nerve sheath pneumatization. Clinical correlation, short term follow-up imaging and the available literature will be reviewed.

Materials and Methods
A 32-year-old man with no past medical history presented to the ED with GCS 15, nausea, emesis, right-sided tinnitus and ear pain after a bicycle accident the night prior to admission. The initial CT scan showed a fracture of the right temporal bone with a 1.8-cm epidural hematoma and multifocal extra-axial pneumocephalus, including air throughout both optic nerve sheaths. No visual symptoms were present at presentation or during the hospital stay. Clinical examination of the orbits and cranial nerves II, III, IV, and VI, including visual acuity and visual fields, were normal. The patient underwent surgical evacuation of the epidural hematoma. He was discharged in stable and asymptomatic condition.

Results
Initial CT shows extensive diffuse pneumatization of both optic nerve sheaths. Pneumocephalus also is present in the suprasellar cistern and bifrontal extra-axial spaces. Postoperative CT was
obtained 7 hours after the initial scan and shows interval decrease in the amount of air in the optic nerve sheaths and in the suprasellar cistern.

Conclusions
This case shows diffuse pneumatization of the optic nerve sheaths following a temporal bone fracture and associated pneumocephalus in the suprasellar cistern. In contrast to prior reports, although the degree of optic nerve sheath pneumatization in this case is significantly more severe, the patient in this case remained asymptomatic (with respect to vision) both at presentation and throughout his entire hospital course. This case suggests that although pneumatization is associated with optic neuropathy in some cases, it may not be the proximate cause of the neuropathy.
Internal Maxillary Artery and Retromandibular Vein Arteriovenous Fistula: Case Review And Management

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Purpose
Congenital arteriovenous fistulas in the neck are rare entities presenting as pulsatile neck masses. Though benign, untreated they can result in cardiac decompensation due to overload. We present the imaging findings in two children who presented with a single hole fistula between the pterygoid branch of the internal maxillary and the retromandibular vein. The MR appearances and catheter angiogram features are described. These lesions have been managed previously with surgical exploration and excision, balloon and glue embolization. We treated the fistulas by platinum coil embolization using interlocking double catheter technique.

Materials and Methods
Two boys, aged 3 and 4 years, presented to the ENT department with pulsatile neck lumps. MR scan of the neck and MR angiography showed dilated vessels deep to the parotid gland. This was interrogated with catheter angiography. Embolization of the fistula was performed using dual catheter technique using interlocking coils.

Results
The MR scan demonstrated dilated internal maxillary artery and proximal external artery. There was marked dilatation of the retromandibular vein. The fistulous site was deep to the parotid gland. Catheter angiography confirmed a single hole fistula between the pterygoid branch of the internal maxillary artery and the retromandibular vein. There was marked dilatation of the proximal external carotid circulation. The site of fistulation was seen as a small area of narrowing in both patients. In both patients, it was treated by coil embolization using a double microcatheter technique using interlocking coils to prevent distal embolization across the fistula.

Conclusions
Internal maxillary artery with retromandibular vein fistulation is rare. We describe the MR and angiographic findings in two pediatric patients. The dual catheter technique is safe and offers permanent cure in treating these challenging lesions.
Recurrent sino-nasal Schneiderian papillomas with extent into both middle ears, in a 14 year female patient.

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Purpose
To describe imaging findings in a rare case of recurrent Schneiderian papilloma involving the ethmoid sinus, nasal cavity and bilateral middle ears, in a 14-year-old female patient.

Materials and Methods
A 14-year-old female with no chronic medical conditions presented to our ER with epistaxis. Right nasal endoscopy with biopsy was performed and control of epistaxis achieved. The pathology was consistent with Schneiderian papilloma. Endoscopic resection was performed later with a wide field resection for local control. The patient returned within 3 months with recurrent ear infections, hearing loss and nasal discharge. Revision endoscopic sinusotomy with debridement and bilateral aural polyp resection with myringotomy tube placement were done.
Since then patient has needed multiple surgical resections for sino-nasal recurrence and bilateral radical tympano-mastoidectomies.

Results
CT sinuses: A soft tissue mass with minimal enhancement centered within the anterior right ethmoid air cells, extends into right nasal cavity and right maxillary sinus, with widening of the ostium. MR imaging of the face: Expansile mass with heterogeneous signal and enhancement with 'cerebriform' appearance. Extension to right frontal sinus, inferior turbinate, and partial obliteration of right middle turbinate. Middle ear and mastoid clear. Follow up MRI: Expansile mass with heterogeneous signal and enhancement with 'cerebriform' appearance in right ethmoid air cells and frontoethmoidal recess. Similar lesions are seen in both the middle ears.

Conclusions
Schneiderian papilloma of the sino-nasal region is rare in pediatric age group. The combination of papillomas in the sino-nasal region and otogenic involvement is extremely rare. To our knowledge this combination has not been described in the English imaging literature.

E-80

Complete Aplasia of the Optic Nerves with Bilateral Partial Aniridia: Case Report and Review of the Literature.

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Purpose
Optic nerve aplasia (ONA) is a rare developmental anomaly resulting in blindness of the affected eye. This condition occurs when there is congenital absence of the optic nerve, retinal ganglion cells, and retinal blood vessels. Optic nerve aplasia can be unilateral or bilateral. Most cases of bilateral ONA are associated with major central nervous system (CNS) anomalies. We present a case of bilateral ONA without additional CNS abnormalities, reviewing the phenotypic, fundoscopic, and imaging findings in patients with ONA. Additionally, we review what is currently known about genetic associations and potential etiologies for this condition.

Materials and Methods
A young infant born at 40 and 5/7 weeks gestational age following an uneventful pregnancy and delivery was found to have abnormal irises. The ophthalmology service was contacted. On evaluation, the patient had partial absence of the superior margins of both irises (bilateral partial aniridia). Both pupils were nonreactive to light stimulation. Fundoscopic examination revealed absence of the optic discs and retinal vessels in both eyes. An unenhanced MRI examination of the brain and orbits was obtained to assess for additional pathology within the central nervous system. This revealed absent optic nerves with mildly atypical contour of the posterior aspect of both globes. No additional intracranial abnormality was present.

Results
Image 1 (Photograph of the right eye): There is a flattened contour of the superior margin of the iris due to congenital absence. The left iris (not shown) had a similar appearance. Image 2 (Right retina on dilated fundoscopic exam): There is absence of a normal optic disc and retinal vessels. A focal lacunae ("punched out" chorioretinal defect) is noted in the right retina in the expected region of the optic disc. Image 3 (Left retina on dilated fundoscopic exam): There is
absence of a normal optic disc and retinal vessels. An additional area of whitish to yellow chorioretinal depigmentation (a chorioretinal atrophic patch) was visible at the periphery of the left retina. Image 4 (MRI axial T2 image through the expected region of the optic nerves): 1. Nonvisualization of both optic nerves along their entire course with absence of the optic chiasm. 2. Mild atypical contour of the globes with posteromedial flattening of the left globe, and posterolateral flattening of the right globe. 3. No additional intracranial abnormality was present. Specifically, the septum pellucidum and pituitary were normal.

Conclusions
While exceedingly rare, ONA is a known entity that causes blindness. Bilateral ONA is less frequent than the unilateral form but more frequently associated with severe and widespread congenital CNS anomalies. To our best knowledge, we present the fourth reported case of bilateral ONA without associated CNS anomalies, reviewing the findings and associations in the context of prior cases.
Organizing Hematoma of the Maxillary Sinus, CT and MRI Findings

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Purpose
Organizing hematoma of the maxillary sinus is a rare benign disease that can mimic neoplastic lesions due to aggressive imaging appearance. We report CT and MRI imaging feature of two patients with organizing hematoma of the maxillary sinus.

Materials and Methods
Patient 1: A 30-year-old female with one episode of nasal bleeding and chronic nasal congestion was evaluated by CT and MRI that demonstrated an expansile mass in left maxillary sinus. She underwent left endoscopic resection of the mass. Patient 2: An 84-year-old male with a history of recurrent left-sided nose bleeds and nasal congestion and facial pain for years was evaluated by CT which demonstrated an expansile mass in left maxillary sinus. He underwent left endoscopic resection of the mass. Histopathology in both patients was consistent with organizing hematoma.

Results
Patient 1: CT scan and MRI demonstrated an expansile mass in the left maxillary sinus protruding into and obstructing the ostiomeatal unit and nasal cavity. The mass was hyperdense on CT, and had heterogeneous signal on T2-weighted imaging with a peripheral hypointense rim, and solid central frond-like enhancement. There was mild irregularity and thinning of the orbital floor. Patient 2: CT scan demonstrated a hyperdense left maxillary sinus expansile mass protruding into the left nasal cavity and obstructing ostiomeatal unit and nasal cavity. There was marked thinning and displacement of the medial inferior floor of the right orbit.

Conclusions
Organizing hematoma of the sinus is a rare benign lesion that can mimic a neoplasm. Radiologists should be familiar with imaging findings of this entity to avoid inappropriate extensive surgery.
Middle Ear Osteoma with Sensorineural Hearing Loss

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Purpose
Temporal bone osteomas are rare benign tumors most commonly found in the external auditory canal, and only rarely within the middle ear cavity. This case demonstrates a rare middle ear osteoma which presented with sensorineural hearing loss.

Materials and Methods
A 75-year-old male presented with progressive bilateral right much greater than left hearing loss over the course of 10 years. The patient reported a rare whistling tinnitus, right greater than left, and rare episodes of dizziness when he "gets up from lying down." There was no history of ear infection, significant noise exposure, surgery, or trauma. There was no family history of hearing loss. On exam, the right external auditory canal was clear. Otomicroscopy revealed an intact tympanic membrane with a pale tan rounded mass, nonpulsatile and nonerythematous, abutting the tympanic membrane inferiorly (red arrow). The tympanic membrane was otherwise mobile above it. Weber test lateralized to the right, and Rinne test demonstrated right sided bony greater than air conduction (patient reported he could not hear air conduction). Audiometry demonstrates moderate to severe mixed right hearing loss.

Results
Computed tomography (CT) of the temporal bone demonstrated a small right hypotympanum, likely secondary to congenital hypoplasia and slightly high-riding jugular bulb, as well as an area of increased bone growth and bone thickening approximately 3-4 mm thick, projecting upward from the floor of the hypotympanum (orange arrow). On axial images, the growth appeared to fill the sinus tympani (yellow arrow) and round window niche (green arrow). Axial CT of the left temporal bone demonstrates patent sinus tympani and round window niche (blue arrow). The bony overgrowth does not directly contact the middle ear ossicles.

Conclusions
Middle ear osteomas are benign tumors of lamellar bone which rarely are found in the middle ear cavity. They have been described most commonly in the literature to originate at the cochlear promontory, followed by the incus, pyramidal process, and the epitympanum (Yoon et al). The most common reported presentation is conductive hearing loss. Other presenting symptoms include sensorineural hearing loss, tinnitus, otitis media, and facial nerve weakness; 16.7% of patients were asymptomatic (Yoon et al). Management is conservative, with surgical resection indicated in cases of progressive hearing loss (Park et al). Surgery also may be considered in cases of vertigo or Eustachian tube obstruction. In the case of facial nerve impingement, resection may be indicated to attempt to recover facial nerve function (Curtis et al). In our patient, audiometry demonstrated a left high frequency sensorineural hearing loss without left conductive hearing loss. It was felt that the right conductive hearing loss likely was related to the osteoma, whereas the right sensorineural hearing loss component likely was not related. Given
the presence of bilateral sensorineural hearing loss which would likely persist even with resection of the osteoma, conservative management was recommended, with close clinical follow up of the right middle ear.
Pre-operative Embolization for Neonatal Intractable Epilepsy due to Hemimegalencephaly

M Pearl¹, I Kaminsky², P Gailloud²

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Purpose
Hemimegalencephaly is a rare dysplastic brain malformation resulting from overgrowth of a cerebral hemisphere. The resulting seizures usually are refractory to medical therapy and hemispherectomy has been advocated as an effective method of seizure control. We present two neonatal cases of hemimegalencephaly and intractable seizures in which staged pre-operative embolization was performed prior to hemispherectomy at 3 months of age.

Materials and Methods
A 3-week-old baby boy and an ex-premature 51-day-old baby girl, both with left hemimegalencephaly, suffered from intractable seizures refractory to multiple anti-epileptic medications including a continuous versed drip. Hemispherectomy was proposed for both patients at 3 months of age due to the intractable seizures and concern over the potential adverse effects of multiple high-dose anti-epileptic medications on the contralateral hemisphere. Pre-operative embolization was requested both to aid in seizure control and for reducing blood loss during surgery. Staged transarterial n-NBCA glue embolization was performed on the left MCA, left PCA, and left ACA in both patients. Both patients tolerated the staged embolizations without significant edema or mass effect. Continuous intraprocedural EEG was performed during the embolizations and showed reduction in seizure activity immediately after embolization of the specific vascular territory. Successful hemispherectomy was performed in both patients at 3 months of age with significantly decreased blood loss and operative time.

Results
MR imaging of the brain in both patients showed diffuse enlargement of the left hemisphere consistent with left hemimegalencephaly. Coronal (A) and axial (B) T2-weighted images (patient 1) are shown. Staged embolization was performed in both patients, beginning with the left MCA. Postero-anterior views (patient 2) before (C) and after (D) n-BCA glue embolization of the left MCA with attention paid to preserve the lenticulostriate arteries.

Conclusions
Staged transarterial n-BCA glue embolization for intractable seizures in neonates with hemimegalencephaly can be performed safely and is a useful adjunct for reducing blood loss and operative time during hemispherectomy.
Intracranial Venous Hypertension Due to Severe Focal Web-Like Stenosis of the Sigmoid Sinus Associated with Contralateral Sinus Hypoplasia: A New Diagnostic Entity?

A Honarmand\(^1\), S Schoeneman\(^2\), F Syed\(^1\), S Ansari\(^1\), M Hurley\(^1\), Y Curran\(^1\), A Shaibani\(^1\)

\(^1\)Northwestern University Feinberg School of Medicine, Chicago, IL, \(^2\)Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, IL

Purpose
Regardless of the underlying pathology, elevated intracranial pressure is the end-point of any impairment in either cerebrospinal fluid (CSF) absorption (arachnoid vili) or intracranial venous drainage. In all age groups, the predominant final common pathway for CSF drainage is the dural venous sinus system. Intracranial venous hypertension (ICVH) is an important vascular cause of intracranial hypertension (and its subsequent sequelae) which often has been ignored due to excessive attention to the arterial system and specifically arteriovenous (AV) shunts. Various anatomical and pathological entities have been described to cause ICVH. For the second time, we present a unique case of severe focal web-like stenosis in the distal sigmoid sinus associated with concurrent hypoplasia of the contralateral transverse sinus causing a significant pressure gradient and intracranial hypertension, which was treated with endovascular stent placement and angioplasty.

Materials and Methods
A 31-month-old boy presented with the chief complaint of progressive vision loss and frequent falls. Physical examination was positive for prominent periorbital veins and decreased bilateral visual acuity. Fundoscopy revealed extensive fluid around the optic nerve and inappreciable cup-to-disc ratio with blurring of the disc margins bilaterally consistent with papilledema.

Results
MR imaging examination revealed mild to moderate lateral and third ventriculomegaly associated with an empty sella, consistent with increased intracranial pressure. There was significant asymmetry of the transverse and sigmoid sinuses with marked left dominance and a diminutive right system. No intracranial/parenchymal, extra-axial mass effect or optic nerve lesion was identified (Figure A). Digital subtraction angiography demonstrated congenitally hypoplastic right transverse and sigmoid sinuses extending into a small right internal jugular vein. A severe focal web-like stenosis of the distal dominant left sigmoid sinus was observed (Figure B). Direct pressure measurement in the dural venous sinuses revealed abnormally elevated pressures proximal to the web-like stenosis and a significant gradient (20 mm Hg) across the stenosis: proximal left internal jugular vein: 12 mmHg, left transverse sinus: 40 mmHg, and distal sigmoid sinus: 32 mmHg. Using over-the-wire technique, a self-expanding nitinol stent was placed successfully across the web-like stenosis and sequential overlapping balloon angioplasty was performed successfully. There was immediate improvement in the appearance of the stenosis with a mild residual stenosis and the pressure gradient was immediately and dramatically reduced to normal (Figures C and D).

Conclusions
Isolated venous outflow obstruction leading to intracranial hypertension has been reported before
(1); however, the presented case is the second case of a unique morphological venous anomaly, namely a severe focal web-like stenosis occurring in the dominant sigmoid sinus associated with concurrent hypoplasia of the contralateral transverse sinus leading to significant pressure gradient and ICVH.

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E-90

Chagas Meningoencephalitis in the Setting of AIDS: A Case Report

J Cramer¹, D Renner¹, K Salzman²

¹University of Utah, Salt Lake City, UT, ²University Of Utah, Salt Lake City, UT

Purpose

Chagas disease is an endemic infection in several countries, and up to 5% of U.S. immigrants from certain countries are infected (1). It is caused by infection with the Trypanasoma cruzi parasite. Primary infection is a major cause of heart failure (2). The central nervous system (CNS) is the most common site when reactivation occurs in immunocompromised states (3). Chagas meningoencephalitis is highly fatal, with a reported 10-day median survival (3). We present a rare case of reactivated CNS Chagas disease.
Materials and Methods
A 37-year-old male Mexican immigrant with known AIDS and syphilis presented with CMV colitis and dilated cardiomyopathy. During his hospital stay, he became encephalopathic. MR imaging demonstrated multiple brain lesions, and the patient died shortly after. Trypanasoma cruzi was detected by antibody assay.

Results
Brain MRI demonstrated numerous lesions in a primarily subcortical distribution. Smaller lesions demonstrated homogeneous enhancement (Figure a) and T2/FLAIR hyperintensity with minimal surrounding edema (Figure b). The largest lesion demonstrated peripheral enhancement (Figure a) with central hemorrhage (Figure c). Abnormal FLAIR signal also was present in adjacent sulci (Figure d) without leptomeningeal enhancement. No diffusion restriction was present. There is little literature detailing the imaging appearance of CNS Chagas. The appearance of our case is similar to a 1997 literature review describing a more subcortical distribution of tumefactive lesions with or without ring enhancement (3).

Conclusions
Chagas meningoencephalitis should be considered in immunocompromised patients from endemic regions with multifocal brain lesions, particularly tumefactive lesions in a subcortical distribution. Suggesting the diagnosis will aid in early recognition and treatment for this rare but highly fatal disease.
Wednesday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

19A - ASSR: THE SPINE: MORE THAN A STACK OF BONES

19A-1
Degenerative Spine: Does Imaging Really Make a Difference?

Kazmi, K.
Drexel University College of Medicine
Philadelphia, PA

19A-3
Diffusion Imaging of Bone Marrow

Tanenbaum, L.
Mount Sinai Medical Center
New York, NY

19A-3
Value Added for Imaging: A Surgeon’s Perspective

Gjolaj, J.
University of Miami Health System
-, FL

19A-4
Whiplash Injuries: Does Imaging Have a Role

Van Goethem, J.
University Hospital Antwerp
Antwerp

Wednesday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)
19B - Emergent Large Vessel Occlusion Stroke Treatment: Update with New Trial Results

19B-1

Introduction

Hetts, S. · Cooke, D.
University of California, San Francisco · University of California San Francisco
San Francisco, CA

19B-2

Stroke Neurology Perspective

Prabhakaran, S.
Northwestern University
Chicago, IL

19B-3

Diagnostic Neuroradiology Perspective

Rowley, H.
Univ. Of Wisconsin
Madison, WI

19B-4

Interventional Neuroradiology Perspective

Rai, A.
West Virginia University
Morgantown, WV

19B-5

Panel Discussion with Speakers & Summary

5:00PM - 5:05PM

5:05PM - 5:25PM

5:25PM - 5:45PM

5:45PM - 6:05PM

6:05PM - 6:30PM
Feasibility Study To Assess Diffusion Tensor Imaging For Evaluation Of Acute Traumatic Cervical Cord Injury

J Becker¹, N Martirosyan², G Choudhary², E Krupinski³, W Erly², W Kubal¹
¹University of Arizona Medical Center, Tucson, AZ, ²University of Arizona, Tucson, AZ, ³University of Arizona, Tucson, AZ

Purpose
Diffusion tensor imaging (DTI) is an emerging tool for the assessment of spinal cord microstructure. Contusive spinal cord injury leads to varying disability and may result in paralysis. Recently trial therapies have become available that have shown promise in the repair of spinal cord injury (1). It therefore is important that we develop reliable, reproducible methods for obtaining quantitative data to assess neuronal integrity in the acutely injured spinal cord. This study assesses the feasibility of using DTI to assess neuronal integrity in the acutely injured cervical spinal cord at a level one trauma center.

Materials and Methods
Diffusion tensor imaging was performed on 10 normal volunteers and 45 patients admitted to a level one trauma center with cervical spine fracture (40) or acute neurology (3) or both (2) within 24 hours of injury. All imaging was performed at 3T on a Siemens Skyra scanner, (Siemens, Erlangen, Germany). The imaging protocol utilizes monopolar DTI using a 3D radial vibe technique with fat saturation. Bandwidth 2004, echo spacing 0.58, ET 61, TR 3500, Slice thickness 1.5mm, no gap, 32 sagittal slices, phase direction A-P, b value 600, b1: 4 averages, b2: 7 averages. Postprocessing was performed using Neuro 3D (Siemens, Erlangen, Germany). Diffusion tensor imaging parameters were correlated with standard of care, neurological assessment and ASIA score (2).

Results
We were able to obtain good quality DTI data in all subjects. Our DTI data in our 10 volunteers correlate precisely with our 35 patients without focal neurologic deficit and with the existing DTI data for normal humans (3). We observed statistically significant reductions in tensor values (fraction anisotropy) for patients with a neurologic deficit.

Conclusions
We have shown that it is feasible to use diffusion tensor imaging to assess for acute traumatic spinal cord injury within 24 hours of acute injury. We have shown that the technique is precise, reproducible and robust. Our values for neurologically normal injury group differ significantly from the injury group with neurologic deficit but coincide with our normal cohort and with published values for normal human subjects.
Validation of an Easy to Implement and Clinically Practical DTI Acquisition Protocol for Assessment of Acute Cervical Spinal Cord Injury.

M Poplawski, R Marino, R Gorniak, C Oleson, J Harrop, A Flanders

Thomas Jefferson University Hospital, Philadelphia, PA

Purpose
Magnetic resonance imaging (MRI) provides the only means to directly inspect the damaged cord after spinal cord injury (SCI). Diffusion tensor imaging (DTI) can provide supplemental quantitative information, that may serve as a biomarker for white matter integrity that is not evaluated directly by anatomical imaging. This study aimed to demonstrate changes in fractional anisotropy (FA), apparent diffusion coefficient (ADC), axial diffusivity (AD), and radial diffusivity (RD) in acute cervical SCI patients using an easy to implement and clinically practical DTI protocol.

Materials and Methods
Twenty-three acute cervical SCI patients participated in the study. Diffusion tensor MRI was performed on admission utilizing a 5-minute full-field of view ssEPI DTI sequence or a ZOOM-EPI DTI sequence that purported to provide substantial improvement in image quality. Control DTI data were obtained in forty 40 normal cervical cords for both techniques. Axial DTI images were obtained throughout the cervical cord, and regions-of-interest were drawn at seven levels from C1/2 to C7/T1. To control for differences in DTI technique, and variance with cervical level, FA, ADC, RD (radial diffusivity), and AD (axial diffusivity) were converted to z-scores based on corresponding spinal level data in control cords.

Results
Z-scores co-registered to injury level show that the DTI metrics of FA, ADC, and RD all sharply deviate from baseline at the lesion center with reduction in FA and concomitant elevation in ADC and RD. The average scores significantly differed by spinal level relative to epicenter (ANOVA, p<0.0001). For AD, there was no significant difference (p=0.36). Adjusted pairwise comparisons showed FA, and AD values at lesion epicenter were significantly different than all positions. There was a broader profile of ADC across the length of the spinal cord such that a significant difference in ADC was demonstrated beyond +/- 2 indexed locations from epicenter.

Conclusions
In the setting of acute SCI, time limitations preclude use of prolonged imaging protocols that require specialty expertise to acquire. Useful spinal cord DTI data can be acquired relatively efficiently with minimal additional operator expertise. We developed an easy to implement DTI protocol using an FDA approved vendor sequence that is practical both from a time investment and can be acquired successfully by a competent technologist. In acute SCI patients, these rapidly acquired DTI data show consistent changes that are proportional to the proximity to the anatomical center of the injury, with increase in ADC and RD, and decrease in FA. This DTI method may be of practical use in discriminating severity of SCI.
Diffusion Tensor Imaging Parameters Measured at Epicenter Boundary Correlate Strongest with Neurologic Deficit in Acute Human Cervical Spinal Cord Injury (SCI)

M Poplawski¹, R Marino¹, R Gorniak¹, C Oleson¹, J Harrop¹, A Flanders¹
Thomas Jefferson University Hospital, Philadelphia, PA

Purpose
Magnetic resonance imaging (MRI) provides the only means to directly inspect the damaged cord after spinal cord injury (SCI) and as such may provide an objective surrogate for neurological injury. Diffusion tensor imaging (DTI) provides supplemental quantitative information, that may serve as a marker for severity of injury. Proof of detailed clinical relationships is limited. The purpose of this investigation is to evaluate the relationship of DTI changes in proximity to injury epicenter after acute SCI to the neurological deficit at time of injury to determine if DTI can serve as an objective surrogate for the neurological examination.

Materials and Methods
Diffusion tensor MRI was performed on admission in 23 acute cervical SCI patients utilizing a rapid 5-minute EPI DTI sequence. Contiguous axial DTI images were obtained throughout the cervical cord, and regions-of-interest were drawn at seven levels from C1/2 to C7/T1. Diffusion tensor imaging parameters of FA, ADC, RD, and AD were normalized to data from 40 healthy cervical spinal cords. Neurological assessments were conducted: within 24 hours of injury, at 1 week, 2 weeks, 3 months, and 6 months. This included: (1) American Spinal Injury Association (ASIA) impairment scale, (2) lower extremity motor index score (MIS), (3) number of useful muscles in the lower extremities (MIS>3), and (4) a modified composite motor and sensory score [Yale Scale Score (YSS)]. Spearman rank-order correlation and receiver operating characteristic (ROC) analysis was used to identify relationships between the initial DTI parameters at the lesion epicenter and in adjacent regions, with the clinical data.

Results
Diffusion tensor imaging metrics of FA, ADC, and RD (radial diffusivity) all significantly deviated from baseline at the lesion center with reduction in FA and concomitant elevation in ADC and RD. There was no significant difference in AD (axial diffusivity) by level. Spearman correlations for the four cardinal DTI parameters at the anatomical level of injury showed that FA exhibited a significant correlation with lower extremity motor scores obtained at 1 week after injury, the 1-week ASIA impairment grade, and number of useful lower extremity muscles at 1 week and at 2 weeks, while the other DTI parameters showed little correlation. Diffusion tensor imaging values measured at one level cranial to the injury epicenter showed substantially more significant correlations with multiple clinical features at several time points (see Table). The correlations were strong for FA, ADC, and RD, but weak for AD. Furthermore, ROC analysis revealed that FA (AUC=0.77) at lesion epicenter, as well as FA (0.83), ADC (0.75), and RD (0.82) just cranial to epicenter, significantly discriminate severe from mild/moderate injury (initial MIS LE < or > 30).

Conclusions
Fractional anisotropy (FA), ADC, and RD DTI values obtained at the time of injury appear to be
useful in discriminating severity of spinal cord injury. Diffusion tensor imaging indices measured immediately cranial to the actual lesion epicenter exhibit consistently stronger correlations and accuracy in predicting neurological injury. Obtaining reliable DTI measures at lesion epicenter is often problematic; this study shows that values obtained at the boundary of the lesion center may be consistently more useful.

<table>
<thead>
<tr>
<th>Neurologic Feature</th>
<th>Time</th>
<th>FA above lesion p value</th>
<th>FA above lesion r value</th>
<th>ADC above lesion p value</th>
<th>ADC above lesion r value</th>
<th>RD above lesion p value</th>
<th>RD above lesion r value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIS LE</td>
<td>Initial</td>
<td>0.042*</td>
<td>0.603</td>
<td>0.054</td>
<td>-0.564</td>
<td>0.028*</td>
<td>-0.6</td>
</tr>
<tr>
<td></td>
<td>7 day</td>
<td>0.029*</td>
<td>0.489</td>
<td>0.164</td>
<td>-0.324</td>
<td>0.039*</td>
<td>-0.4</td>
</tr>
<tr>
<td></td>
<td>14 day</td>
<td>0.015*</td>
<td>0.563</td>
<td>0.023*</td>
<td>-0.531</td>
<td>0.004*</td>
<td>-0.6</td>
</tr>
<tr>
<td></td>
<td>90 day</td>
<td>0.049*</td>
<td>0.540</td>
<td>0.007*</td>
<td>-0.680</td>
<td>0.007*</td>
<td>-0.6</td>
</tr>
<tr>
<td></td>
<td>180 day</td>
<td>0.092</td>
<td>0.514</td>
<td>0.070</td>
<td>-0.275</td>
<td>0.109</td>
<td>-0.4</td>
</tr>
<tr>
<td>Modified YSS</td>
<td>Initial</td>
<td>0.155</td>
<td>0.418</td>
<td>0.496</td>
<td>-0.204</td>
<td>0.180</td>
<td>-0.3</td>
</tr>
<tr>
<td></td>
<td>7 day</td>
<td>0.035*</td>
<td>0.474</td>
<td>0.155</td>
<td>-0.330</td>
<td>0.043*</td>
<td>-0.4</td>
</tr>
<tr>
<td></td>
<td>14 day</td>
<td>0.021*</td>
<td>0.540</td>
<td>0.084</td>
<td>-0.418</td>
<td>0.013*</td>
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<td></td>
<td>90 day</td>
<td>0.181</td>
<td>0.380</td>
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<td>-0.578</td>
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<tr>
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<td>180 day</td>
<td>0.243</td>
<td>0.364</td>
<td>0.703</td>
<td>-0.119</td>
<td>0.301</td>
<td>-0.3</td>
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<tr>
<td># Useful Muscles LE</td>
<td>Initial</td>
<td>0.148</td>
<td>0.445</td>
<td>0.097</td>
<td>-0.438</td>
<td>0.089</td>
<td>-0.5</td>
</tr>
<tr>
<td></td>
<td>7 day</td>
<td>0.029*</td>
<td>0.488</td>
<td>0.111</td>
<td>-0.368</td>
<td>0.026*</td>
<td>-0.4</td>
</tr>
<tr>
<td></td>
<td>14 day</td>
<td>0.003*</td>
<td>0.693</td>
<td>0.018*</td>
<td>-0.517</td>
<td>0.002*</td>
<td>-0.6</td>
</tr>
<tr>
<td></td>
<td>90 day</td>
<td>0.179</td>
<td>0.383</td>
<td>0.015*</td>
<td>-0.518</td>
<td>0.082</td>
<td>-0.4</td>
</tr>
<tr>
<td></td>
<td>180 day</td>
<td>0.097</td>
<td>0.506</td>
<td>0.091</td>
<td>-0.235</td>
<td>0.132</td>
<td>-0.4</td>
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<tr>
<td>ASIA Impairment Score</td>
<td>Initial</td>
<td>0.017*</td>
<td>0.689</td>
<td>0.022*</td>
<td>-0.600</td>
<td>0.010*</td>
<td>-0.7</td>
</tr>
<tr>
<td></td>
<td>7 day</td>
<td>0.005*</td>
<td>0.597</td>
<td>0.053</td>
<td>-0.438</td>
<td>0.009*</td>
<td>-0.5</td>
</tr>
<tr>
<td></td>
<td>14 day</td>
<td>0.018*</td>
<td>0.591</td>
<td>0.019*</td>
<td>-0.483</td>
<td>0.008*</td>
<td>-0.6</td>
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<tr>
<td></td>
<td>90 day</td>
<td>0.178</td>
<td>0.398</td>
<td>0.002*</td>
<td>-0.692</td>
<td>0.021*</td>
<td>-0.6</td>
</tr>
<tr>
<td></td>
<td>180 day</td>
<td>0.113</td>
<td>0.516</td>
<td>0.040*</td>
<td>-0.377</td>
<td>0.006*</td>
<td>-0.5</td>
</tr>
<tr>
<td>SCI Severity (boolean) Initial MIS LE &lt; or &gt;30)</td>
<td>Initial</td>
<td>0.015*</td>
<td>-0.512</td>
<td>0.027*</td>
<td>0.471</td>
<td>0.009*</td>
<td>0.5</td>
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</tbody>
</table>

Data represents p-values and r-values for Spearman rank-order correlations of DTI values at level cephal data in bold highlights p-value<0.05

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O-421

**Diffusion Tensor Imaging Parameters Obtained at the Time of Injury Correlate with Recovery in Human Acute Cervical Spinal Cord Injury.**

M Poplawski¹, R Marino¹, R Gorniak¹, C Oleson¹, J Harrop¹, A Flanders¹

¹Thomas Jefferson University Hospital, Philadelphia, PA
Purpose
There are unpredictable variations in the extent of spontaneous recovery within similar impairment groups of spinal cord injury (SCI). Development of novel objective criteria that can help to better forecast inherent capacity for spontaneous neurological recovery would be invaluable. Diffusion tensor imaging offers objective measures of white matter integrity that correlates with deficit. The purpose of this study was to determine if the initial spinal cord DTI changes in acute cervical SCI of fractional anisotropy (FA), apparent diffusion coefficient (ADC), axial diffusivity (AD), and radial diffusivity (RD) in acute cervical SCI patients, can stratify patients capacity for spontaneous neurological recovery.

Materials and Methods
Diffusion tensor MRI was performed on 23 acute cervical SCI patients utilizing a rapid 5-minute EPI DTI sequence. Axial DTI images were obtained throughout the cervical cord, and regions-of-interest were drawn at seven levels from C1/2 to C7/T1. Diffusion tensor imaging parameters of FA, ADC, RD (radial diffusivity), and AD (axial diffusivity) were normalized to healthy cervical cords. Neurological assessments were conducted from within 24 hours of injury up to 6 months postinjury, and included: (1) ASIA impairment scale, (2) lower extremity motor index score (LE MIS), (3) number of useful lower extremity muscles (MIS>3), and (4) a modified composite motor and sensory score [Yale Scale Score (YSS)]. Additional measures included the self-care subscale of the Spinal Cord Independence Measure (SCIM) and the Walking Index for Spinal Cord Injury (WISCI-II). Spearman rank-order correlation and receiver operating characteristic (ROC) analysis were used to identify relationships between the initial DTI parameters at the lesion epicenter and in adjacent regions, with the clinical recovery data.

Results
Fractional anisotropy, ADC, and RD all deviated significantly from baseline at the lesion center with reduction in FA, and elevation in ADC and RD. Axial diffusivity did not vary significantly at the injury level. Apparent diffusion coefficient and RD correlated significantly with recovery of LE MIS, and YSS score (see Table) at injury level. Apparent diffusion coefficient also correlated with recovery of LE useful muscles. Fractional anisotropy correlated with WISCI only. At a level immediately cephalad to the lesion epicenter, similar correlations were noted. Fractional anisotropy and RD cephalad to the lesion correlated with SCIM and WISCI scores. Overall, recovery rates most robustly correlated with ADC and RD. Receiver operating characteristic analysis revealed that ADC (AUC=0.79) and RD (0.73) at lesion epicenter, as well as ADC (0.78) immediately cranial to epicenter, all significantly discriminate good from poor recovery (MIS LE RR < or > 0.5).

Conclusions
Diffusion tensor imaging values obtained at the time of injury may be useful in stratifying patients who have potential for recovery. Diffusion tensor indices measured cephalad to the lesion epicenter exhibit consistently stronger correlations and demonstrated improved accuracy in predicting recovery. With the advent of novel therapeutic interventions for acute SCI there is a need to rapidly discriminate patients who may have an improved capacity to respond to these interventions. To our knowledge, this is the first report to demonstrate correlation between acute DTI indices and clinical recovery.
Diffusion Tensor Imaging of the Cervical and Thoracic Pediatric Spinal Cord in Normal Subjects

S Saksena¹, D Middleton¹, L Krisa², P Shah¹, S Faro¹, R Sinko², M Mulcahey², J Gaughan¹, J Finsterbusch³, F Mohamed¹
¹Temple University, Philadelphia, PA, ²Thomas Jefferson University, Philadelphia, PA, ³Medical Center Hamburg-Eppendorf, Philadelphia, PA

Purpose
The purpose of this study was to (a) investigate the feasibility of obtaining reliable DTI parameters namely FA, MD, AD and RD of the entire cervical and thoracic spinal cord (SC) in healthy children using an inner field-of-view (iFOV) with View Angle Tilting (VAT) DTI sequence and (b) examine reproducibility of the DTI parameters.
Materials and Methods
Ten controls (2 males and 8 females) with a mean age of 9.7 yrs were recruited. The subjects had no evidence of spinal cord injury or pathology. The study was approved by IRB and written informed assent and consent was provided by subjects and their parents. Subjects underwent 2 identical scans using a 3.0T Siemens Verio MR scanner with a 4-channel neck and 8-channel spine matrix coils. The protocol consisted of conventional T1- and T2-weighted structural scans and axial DTI scans based on the iFOV sequence.1 VAT has also been applied to reduce in-plane distortions. Manual shim volume adjustments were also performed prior to data acquisition. High resolution axial DTI images were acquired in 2 slabs to cover the cervical (C1-T1 levels) and thoracic (T1-mid L1 levels) SC. The imaging parameters included: 3 averages of 20 diffusion directions, 6 b0 acquisitions, b=800s/mm2, voxel size=0.8x0.8x6mm3, axial slices=40, TR=7900ms, TE=110ms, and acquisition time=8:49min. Anesthesia was not administered to the subjects nor was cardiac and respiratory gating used. The 6 b0 images were first co-registered to create a mean b0 image. The diffusion weighted images were corrected for motion using the rigid body correction algorithm.2 Tensor estimation was done on a voxel-by-voxel basis from the axial DTI images using in-house software developed in MATLAB. For robust diffusion tensor estimation RESTORE (robust estimation of tensors by outlier rejection) was used. This method used the least-squares regression to identify potential outliers and subsequently excluded them. Region of interest was manually drawn on grayscale FA maps at every axial slice location along the cervical and thoracic SC for both scans. The value of each DTI parameter was averaged for each level of cervical and thoracic cord across all controls. To test the reliability of datasets from 2 separate scans per subject, intraclass correlation coefficient (ICC) for each DTI parameter was calculated.

Results
Fig 1a, b shows the reconstructed sagittal FA color maps of cervical and thoracic SC of a representative control subject. Similar results with good delineation of the cord and minimal distortion were obtained in all the subjects studied. Fig 2 shows various DTI parameters across the entire length of the cord. To our knowledge this is the first demonstration of measurements of DTI parameters along the entire pediatric SC. Test-retest reproducibility showed an ICC of 0.87 for FA, 0.83 for MD, 0.81 for AD and 0.88 for RD in all 10 controls across all levels of cervical and thoracic SC.

Conclusions
This study demonstrates the feasibility of pediatric DTI SC imaging in both cervical and thoracic sections. These DTI values also show moderate-to-good test-retest reliability on repeated scans.
Acute Cervical Spinal Cord Injury on MRI: Comparison of a Prognostic Axial Grading System to Traditional MRI Predictors of Spinal Cord Injury

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Purpose
The architecture of the spinal cord and pre-clinical models support the extent of spinal cord injury in the axial plane as a strong predictor of clinical outcome. Studies evaluating the prognostic value of MRI have focused on the longitudinal extent of T2 signal abnormality or secondary markers such as canal compromise and cord compression. We have developed a method for evaluating spinal cord injury on axial MRI, which we here apply in a multi-variable model with other previously described MRI markers of spinal cord injury. We aim to demonstrate that this axial grading method adds prognostic information to traditionally used methods.

Materials and Methods
We performed a retrospective cohort study including 64 patients who presented with blunt cervical spinal cord injury (2005-2013) and had an MRI acutely before any surgical intervention. We applied a novel axial grading system and a traditional sagittal grading system, and measured the longitudinal extent of injury, the maximum canal compromise (MCC), and maximum spinal cord compression (MSCC). These five predictor variables were correlated individually with American Spinal Injury Association (ASIA) Impairment Scale (AIS) grade at discharge. Multiple linear regression then was performed to predict AIS grade at discharge in a combined model. Variables for AIS improvers (at least 1 grade) during hospitalization were compared to nonimprovers with a Welch's t-test.

Results
Axial grade (r=-0.873,p<0.001), sagittal grade (r=-0.743,p<0.001), and longitudinal extent (r=-0.675,p<0.001) all were correlated negatively with AIS grade at discharge. The maximum canal compromise (r=-0.258,p=0.04) demonstrated low-level correlation and MSCC (r=-0.135,p=0.288) was not statistically significantly correlated with AIS grade at discharge. Multiple linear regression (overall model adjusted R²=0.749,p<0.001) demonstrated axial grade (effect=-1.084,p<0.001) as the dominant predictive variable. No other variable demonstrated a statistically significant effect in the combined multivariable model. Patients whose AIS grade improved during hospitalization had lower axial (p=0.006) and sagittal (p=0.015) grades. Additional results are presented in the figure.

Conclusions
Axial grading of acute blunt cervical spinal cord injury has clinical predictive value and was the dominant predictor of AIS grade at discharge in our multivariable model. Axial grade should be taken into account when evaluating acute spinal cord injury.
Blunt Cerebrovascular Injury Risk Factors Assessed on Screening CT Angiography: Experience From a Large Level 1 Trauma Center.

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Purpose
Blunt cerebrovascular injury (BCVI) is a rare but potentially devastating post-traumatic outcome. Despite prior studies examining BCVI-associated risk factors, screening criteria remain largely institution/provider specific. The relatively recent replacement of conventional angiography with neck CT angiography (CTA) in the initial assessment for BCVI has lead to widespread availability of a fast and effective screening tool. However, data to guide optimal use of this tool are currently lacking. We performed a retrospective chart review to determine the correlation between commonly used risk factors and BCVI as detected on neck CTA, with particular attention to the controversial cervical seatbelt sign.

Materials and Methods
Electronic medical record (EMR) was queried for neck CTA performed between January 2012 and December 2013. Exclusion criteria included CTA performed for nontraumatic indications or for penetrating injury and subsequent CTA performed during the same encounter. Electronic medical record data obtained for each patient included: trauma history, GCS at presentation, presence of seatbelt sign, neck CTA results with BCVI graded on Denver scale and results of other imaging studies obtained at presentation including c-spine CT/MRI, head/maxillofacial CT, and chest/abdomen/pelvis CT. Descriptive statistics were used on the demographic variables and Fisher exact tests for the remaining data with significance set as p < 0.05; in addition, odds ratios (OR) were calculated for each variable.

Results
Four hundred forty-seven patients underwent screening neck CTA following blunt trauma. Fifty-three patients had findings of BCVI on neck CTA [11.1%) in 69 vessels (38 vertebral arteries and 31 internal carotid arteries (ICA)]. Patients with and without BCVI were not statistically different in age or GCS (mean of 11.2 with BCVI and 12.8 without BCVI). Vertebral artery BCVI was associated significantly with CT c-spine fracture of any type (OR 9.3) and MRI c-spine paraspinal ligamentous injury (OR 5.9). Internal carotid artery BCVI was significantly associated with CT basilar skull fracture (OR 2.8), CT maxillofacial fracture (OR 3.8) and intracranial hemorrhage (OR 2.4). History of pedestrian versus motor vehicle significantly increased risk of BCVI overall (OR 2.5). No significant associations were found for the remaining risk factors studied.

Conclusions
Distinct from several other studies of BCVI, our results were stratified by particular vessel injured. We confirm the statistically significant association of c-spine fractures and paraspinal ligamentous injury with vertebral artery BCVI as well as basilar skull and maxillofacial fractures and ICH with ICA BCVI as diagnosed on CTA. Cervical seatbelt sign, commonly used as a screening criteria, was not significantly associated with either vertebral or ICA BCVI. While our study is limited by its retrospective nature, it provides additional evidence to guide clinicians in efficient screening of BCVI.

O-426  6:04PM - 6:12PM
Reformatting Thoracic and Lumbar Spine CT from Blunt Trauma Scans: Improved Accuracy or Waste of Time?

B Carter¹, P Patton¹, P Vallee¹, T Williams¹, S Zintsmaster², B Griffith³, F Mossa-Basha¹, S Patel¹
Purpose
The purpose of this study was to compare the detection rate of thoracolumbar spine (TL spine) fractures on a routine trauma CT of the chest, abdomen, and pelvis (CT CAP) with the more specialized reformatted images of the TL spine, and determine whether, in a routine clinical setting, thin section reformatted images of the spine detect additional fractures and whether any of these additional fractures altered patient management.

Materials and Methods
This project was HIPAA-compliant and IRB approved. Imaging records of 1000 consecutive patients who underwent blunt trauma protocol CT CAP with TL spine reformatted images were reviewed retrospectively to determine identification of TL spine fracture in the radiology reports of both studies. The type and location of all acute fractures were recorded with fracture types grouped into those involving the vertebral body alone, spinous process, transverse process, and other. Patient clinical records also were reviewed to determine subsequent treatment and management.

Results
Of the 896 patients included in the study, 66 (7.4%) had fractures of the TL spine reported on either CT CAP or CT TL spine reformats. Of these 66 patients, 40 (60.6%) had fractures reported on both the CT CAP and reformatted TL spine imaging. Twenty-four patients (36.4%) had fractures reported on the reformatted images of the TL spine alone and two patients had fractures reported on the CT CAP alone. Of the 14 patients treated with surgery or bracing, 10 (71.4%) had fractures identified on both studies while four patients (28.6%) had fractures identified on reformatted TL spine imaging only. None of the patients requiring treatment had fractures identified only on the CT CAP study. The most commonly unreported fractures on the CT CAP study included: vertebral body fractures (56.5% of unreported fractures); transverse process fractures (39.1%); and spinous process fractures (4.3%).

Conclusions
A significant number of fractures are reported on the thin section reformats that are not reported on the thick section imaging, which in a few cases led to changes in patient management. Although a variety of factors may have influenced this increased fracture detection rate, the results of this study strongly suggest that thin sections reformats of the TL spine should be a standard part of the work-up of blunt trauma patients.

Wednesday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)

19D - SAFETY SYMPOSIUM: NEUROIMAGING GENTLY: CREATING A SAFE AND QUALITY ENVIRONMENT FOR NEURODIAGNOSTICS & NEUROINTERVENTIONS: SAFETY SESSION 3: TIPS AND TRICKS IN SPINAL AND ENDOVASCULAR INTERVENTIONS
19D-1

5:00PM - 5:20PM
Thromboembolism During Endovascular Treatment: What to Do and When
19D-2

**Minimizing Patient Dose in Neuro-Interventional Procedures**

Shownkeen, H.
Central DuPage Hospital
Winfield, IL

19D-3

**Safe Imaging of Spine Ballistic Injuries**

Liu, B.
Northwestern Memorial Hospital
Chicago, IL

19D-4

**Epidural Steroids - Particulate vs Non-particulate, Which is Safer?**

Fenton, D.
Mayo Clinic Florida
Jacksonville, FL

**Wednesday**

5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

19E - CSI: WELCOME TO THE ELECTRONIC CLASSROOM

19E-1

**Electronic Solutions for Audience Participation**

Rajamohan, A.
University of Southern California
Los Angeles, CA
19E-2

Maintaining a Database (for Interesting Cases)

Cramer, J. · Quigley, E.
University of Utah
Salt Lake City, UT

19E-3

Remote Access and Online Access, Creating your own Webpage

Wiggins, III, R.
University of Utah Health Sciences Center
Salt Lake City, UT

19E-4

RSNA/MIRC Teaching File

Flanders, A.
Thomas Jefferson Univ. Hosp.
Philadelphia, PA

Wednesday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Michigan AB (Level 2)

19F - PARALLEL SCIENTIFIC PAPER SESSION-GENOMICS
O-427

The expression of P2X7 receptors in EPCs and their potential role in the targeting of EPCs to brain gliomas

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Purpose
In order to use endothelial progenitor cells (EPCs) as a therapeutic and imaging probe to overcome antiangiogenic resistance for gliomas, how to enhance proliferation and targeting ability of transplanted EPCs is a high priority. Here, we aim to investigate the functional
expression of P2X7 receptors in EPCs, role of P2X7 receptors in proliferation and homing to glioma of EPCs.

Materials and Methods
The expression of P2X7 receptors in EPCs was detected by western blot and immunofluorescence staining. The effects of P2X7 receptors on EPCs proliferation, migration, and apoptosis were detected by series of in vitro experiments. In vivo, seventy-two 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 fluoresein. Rats in the EPC group were transplanted with double labeled EPCs via tail vein on 10 days after glioma established. Rats in the EPC+BBG group were injected intraperitoneally at a dose of 10mg/kg immediately after double labeled EPCs transplantation, and then once every other day. MR imaging was performed at a 7.0T MR system before EPCs transplantation and on 1-, 3-, 5-day post-transplantation of EPCs. T2-weighted was used to track the migration of these double labeled EPCs. Susceptibility-weighted imaging (SWI) was performed to detect these cells integrating into the vessels in gliomas. Additionally, T2-map was used to detect the T2 value and corresponding ΔR2 value. In parallel, the distribution of double labeled EPCs was detected by Prussian blue staining, and the incorporation of these cells into tumor vessels was performed by immunofluorescent staining. Further, DCE MRI was used to detect the effects of P2X7 receptors on C6 glioma neovascularization and the vascular function.

Results
We confirmed, for the first time, the expression of P2X7 receptors in rat spleen-derived EPCs. Activation of P2X7 receptors in EPCs by BzATP promoted cells proliferation and migration, rather than apoptosis. Compared to the group without BBG treatment, less transplanted EPCs homed to gliomas in the group with BBG treatment, especially integrated into the vessels containing tumor-derived endothelial cells in gliomas. Moreover, western blot showed that CXCL1 expression was downregulated in gliomas with BBG treatment, which meant P2X7 receptors suppression inhibited the homing of EPCs to gliomas through down-regulation of CXCL1 expression. Additionally, MTT assay and MRI revealed that P2X7 receptors exerted no significant promoting effect on C6 glioma cells proliferation, glioma growth and angiogenesis.

Conclusions
Taken together, our findings imply the possibility of promoting proliferation and targeting ability of transplanted EPCs to brain gliomas in vivo through P2X7 receptors, which may provide new perspectives on application of EPCs as a therapeutic and imaging probe to overcome antiangiogenic resistance for gliomas.

O-428
5:08PM - 5:16PM

Integrated Multi-parametric MRI Biomarkers Analysis Identifies Molecular Subtypes of Glioblastoma

H Akbari1, L Macyszyn1, J Pisapia1, X Da1, M Attiah1, Y Bi2, S Pat1, R Davuluri2, L Roccogrand1, N Dahmane1, R Wolf1, M Bilello1, D O'Rourke4, C Davatzikos1
1University of Pennsylvania, Philadelphia, PA, 2Northwestern University, Chicago, IL, 3Wistar Institute, Philadelphia, PA, 4Hospital of the University of Pennsylvania, Philadelphia, PA
Purpose
The goal of this study is to develop a robust radiogenomic-based molecular classification of glioblastoma into classical, neural, proneural, and mesenchymal subtypes. Advanced computational methods were employed for multiparametric imaging pattern analysis to extract distinctive imaging biomarkers. Defining glioblastoma subtypes based on radiologic signatures may allow for a molecularly targeted therapy. Ultimately, this technique may assist in evaluating the spatial heterogeneity of molecular tumor characteristics and monitoring response to treatment and progression.

Materials and Methods
A retrospective cohort study was performed on 99 de novo glioblastoma patients. Preoperative multiparametric MRI data (T1, T1-Gad, T2, T2-FLAIR, rCBV, DTI, and DSC-MRI) were analyzed to extract a rich set of multiparametric imaging features and to create an integrative predictor of molecular subtype using a machine learning method in a cross-validated study. Size of enhancing tumor, nonenhancing tumor, and edema; location of tumor, mass-effect parameters, distribution of intensities of all modalities in each region were some of the most important features that were utilized through a feature selection method to build the model. For each subtype, a separate prediction model was created and the final class was defined through voting in the models. The imaging-predicted subtypes were evaluated against the RNA isoform-based classes.

Results
The proposed method successfully classified proneural subjects with an accuracy of 86% and AUC of 0.87; neural subjects with an accuracy of 88% and AUC of 0.92; mesenchymal subjects with an accuracy of 84% and AUC of 0.89; and classical subjects with an accuracy of 85% and AUC of 0.75. The overall accuracy for all subtypes was 76%.

Conclusions
Multiparametric image analysis extracts informative biomarkers that correlated to the molecular subtype of glioblastoma patients. When integrated via machine learning methods, these biomarkers form patterns that are quite predictive of molecular tumor subtype. These patterns are not easily appreciated by examining individual features.
MRI phenotype characteristic predictions for somatic mutations in GBM

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Purpose
Magnetic resonance imaging (MRI) can noninvasively display tumor phenotype characteristics at the macroscopic level. Here, we investigated whether somatic mutations are associated, and hence can be predicted using MRI tumor subcompartments data of glioblastoma (GBM) tumors.

Materials and Methods
From the Cancer Imaging Archive (TCIA), we identified 76 GBM patients with pre-operative MRI sets including T1W, postcontrast T1W, T2W and FLAIR images, and defined tumor subcompartments, including necrotic core, relative contrast-enhancing volume (CE), abnormal tumor volume, and tumor-associated edema. Radiogenomic analysis assessed the performance of these compartments to predict mutational status using the area under the curve (AUC). Gene mutation data were obtained from The Cancer Genome Atlas (TCGA) database.

Results
MR imaging subcompartments data are strongly associated with mutation status. For example, TP53 mutated tumors had significantly smaller contrast enhancement and necrotic volumes (p= 0.012 and 0.017, respectively), compared to wild-type. RB1 mutated tumors showed a significantly lower edema (p= 0.015). MR imaging subvolumes could strongly predict mutational status. For example, TP53 mutations could be predicted significantly by contrast enhancement (AUC= 0.68) and necrosis (AUC= 0.67) volumes. EGFR mutations could be predicted best by the ratio of contrast enhancement/tumor bulk (AUC= 0.69). Furthermore, also RB1 (AUC= 0.66, edema), NF1 (AUC= 0.68, contrast enhancement), and PDGFRA (AUC= 0.72, edema/total tumor volume ratio) mutations could be predicted significantly.

Conclusions
Glioblastoma (GBM) mutations drive observable phenotypes that are quantifiable with MRI. Mutation status can be predicted with high performance. These results may impact personalized medicine, as mutation status can be predicted using noninvasive imaging, and may shed insights into unique behavioral and growth characteristics of individual tumors as a result of mutational status of the patient.
Identification of Gene Specific MRI Texture Features in First Radiogenomic Mouse Model

R Colen\textsuperscript{1}, M Luedi\textsuperscript{2}, S Singh\textsuperscript{3}, A Chaddad\textsuperscript{4}, A Bakhtiari\textsuperscript{1}, P Zinn\textsuperscript{5}

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Purpose
Radiogenomics is poised to shape the future of cancer treatment as it combines the powers of imaging with genomics to augment personalized therapeutics. By utilizing radiogenomic approach we previously reported Periostin (POSTN) is associated with edema in GBM patients, which has since been validated in preclinical settings. Here, we report generation of first MRI texture feature based orthotopic mouse model to study glioblastoma invasion. We aim for direct identification of texture features which reliably report to underlying genetic makeup of glioblastoma stem cell (GSC) derived orthotopic tumors.

Materials and Methods
We established and validated clones of two independent GSC lines for doxycycline (Dox) inducible knockdown of POSTN by qRT-PCR and western blots. Approximately 5X10^4 these GSC clones were implanted in frontal cortex of 3-week-old male mice. MR imaging (MRI) were performed 2 weeks postimplantation to confirm tumor engraftment and mice were randomized into -Dox and +Dox cohorts. MR imaging were performed every week to monitor tumor growth and volume (n=5 per group per GSC line) until mice were sacrificed due to neurological symptoms. Region of interest (ROI) methods were applied to the rigid registration images based on axial T1-weighted (T1-WI) and its corresponding fluid attenuated inversion recovery (FLAIR) sequences. Three types of textures, namely fine, medium and coarse were provided by using a Laplacian of Gaussian (LoG) filter. Each texture was quantified by six parameters namely, mean, standard deviation, entropy, and their normalizations to provide the characteristics of orthotopic GBM phenotypes.

Results
Orthotopic tumors originating from GSCs with depleted levels of POSTN (+Dox group), displayed significantly lower levels of invasion as judged by MRI and histopathology in comparison to the syngenic control (-Dox group). Texture features specifically associated with FLAIR sequences were aligned most robustly with control groups with high POSTN levels.

Conclusions
Here, we describe first orthotopic mouse model where radiogenomics-derived gene has been connected back to specific MRI texture features. These radiogenomic-MRI texture models will be specifically useful in monitoring the efficacy and specificity of gene specific therapeutics.

O-431

Influency Power of Imaging Parameters on Pseudoprogression Diagnosis and Progression-free Survival Prediction in Subgroup Stratified by MGMT Methylation Status

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Purpose
To determine the contribution of clinical and imaging parameters on progression-free survival (PFS) stratified by MGMT methylation status in patients with newly diagnosed glioblastoma.

Materials and Methods
The institutional review board approved this retrospective study and waived the informed consent requirement. Forty-eight patients with newly diagnosed glioblastoma underwent
methylation specific polymerase chain reaction for MGMT promoter methylation and three advance MR images including diffusion-weighted imaging (DWI), dynamic susceptibility contrast (DSC) perfusion MR imaging and dynamic contrast-enhanced (DCE) perfusion MR imaging. Area under the receiver operating characteristic curve (AUC) and leave-one-out cross-validation were used for determining the diagnostic accuracy of the imaging parameters for identifying pseudoprogression in subgroup stratified by MGMT methylation status. Cox's regression model was used to determine the effect of the clinical and imaging parameters to MGMT methylation stratified PFS.

Results
For diagnosing pseudoprogression, each MR imaging method showed a trend toward higher AUCs in MGMT methylation group (0.89-0.91 for reader 1; 0.85-0.89 for reader 2) than in unmethylation group (0.72-0.82 for reader 1; 0.74-0.84 for reader 2) but did not reach statistical significances. Cross validation revealed the same trend of AUCs for each MR imaging methods. The MGMT methylation group showed a significant longer PFS than unmethylation group even with multivariate Cox's regression (P = .0108), But the influence quantity of MGMT methylation status decreased on the PFS on analyses by the inclusion of age, surgical extent, DWI, and DCE imaging, beside DSC imaging.

Conclusions
Age, surgical extent, DWI, and DCE imaging results can affect progression-free survival (PFS) stratified by MGMT methylation status in patients with newly diagnosed glioblastoma.
Quantitative MR Texture Analysis Differentiates Tissue Characteristics of LGG, Peritumoral, and Normal Appearing White Matter (NAWM) Phenotypes

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Purpose
To assess the efficacy of texture analysis (TA) in differentiating low grade gliomas (LGGs) from peritumoral and normal appearing white matter (NAWM) in a cohort of LGG patients using T2-FLAIR MR images. Also the impact of the number of gray levels employed was investigated.

Materials and Methods
T2-FLAIR and post-gadolinium (GD) contrast T1-weighted MR images of 11 TCGA patients (mean age 40.8 years, range 27 to 59.5 years) were retrospectively analyzed. All patients were diagnosed with LGGs (grades II and III). Four different volumes of interest (VOIs) were segmented for each patient by an experienced neuroradiologist: i) tumor, ii) peritumoral WM (pWM), iii) far ipsi-lateral WM (iWM) and iv) contra-lateral WM (cWM) (Fig. 1a). Following VOI segmentation, TA was performed using FLAIR images on MatLab environment. A complete list of invariant texture features was calculated. Because the ideal number of gray levels is unknown, we used various gray levels (8, 16, 32, and 64 levels). To assess the efficacy of the calculated features we constructed a decision tree. The model was validated using a 10-fold cross validation of the training data. The accuracy, sensitivity and specificity were calculated. Finally, the impact of the number of gray levels on the performance indicators was investigated.

Results
For discrimination of LGG from NAWM, TA achieved 100% accuracy (Figure 1b). High accuracy (80-87.5% for different gray levels) was achieved for discrimination of all four VOIs. Of note, the peritumoral WM was identified with 86.7% to 93% accuracy from the two remaining NAWM regions combined. Also, from the performance indicators it is evident that the number of gray levels does not affect the calcification.

Conclusions
Texture analysis provided excellent accuracy for discrimination between LGG, peritumoral and NAWM. A major strength of the presented work is that it showed high performance in discriminating among normal WM regions depending on their proximity to the tumor. Thus, TA of brain tumors is a method that can complement current approach used by neuroradiologists; it has high accuracy, no contraindications and is noninvasive.
Classification of 1p/19q genotype in glioma using VASARI criteria and additional conventional MRI metrics

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Purpose
Loss of heterozygosity of 1p/19q (LOH 1p/19q) is associated with favorable prognosis in glioma. Indistinct tumor borders are associated with LOH 1p/19q, (1) and T2-signal heterogeneity is associated with improved survival in anaplastic oligodendroglioma (2). More recently, magnetic resonance descriptors, the Visually Accessible Rembrandt Images (VASARI) features, have shown correlation with molecular subgroups in GBM (3). This study aimed to evaluate correlation between VASARI and additional conventional MRI descriptors and LOH 1p/19q.

Materials and Methods
Patients were identified from a histopathology database of 1p/19q testing. Imaging was assessed for VASARI features and additional MRI descriptors (T1/T2 heterogeneity, relative T1 signal of infiltrated cortical gray matter to normal cortical gray matter and relative T1 signal of infiltrated...
white matter to normal appearing white matter (NAWM). Data was analyzed using Chi-square test and Spearman's rank correlation.

Results

Ine hundred thirty-four imaging sets were included. Positive correlations were found between LOH 1p/19q and indistinct tumor margins, T2 heterogeneity, and isointense T1 signal within the tumor compared to NAWM (a T1 "occult" appearance). An infiltrative pattern was seen more commonly in grade II oligodendroglioma (T1 signal abnormality << T2 signal abnormality), whilst mixed or expansive patterns were seen in anaplastic oligodendroglioma (T1<T2).

Conclusions

A novel MRI descriptor of a T1 "occult" appearance is described correlating with LOH 1p/19q. Significant differences in the ratio of T1:T2 signal were found between grade II and III oligodendroglioma, which may reflect an increase in tumor cellularity.

O-435

Radiomic Subclassification of Glioblastoma

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Purpose

To identify clinically relevant glioblastoma (GBM) subclassification/subtypes based on radiomic analysis. Integrated genomic analysis already has identified genomic subtypes of GBM as characterized by specific genomic aberrations and mutations. In our study, we seek to demonstrated a GBM subclassification based on radiomic texture analysis that is both predictive and prognostic.

Materials and Methods

We retrospectively identified 80 GBM treatment-naive patients from the Cancer Genome Atlas with corresponding MRI data in the Cancer Imaging Archive. We applied texture analysis (528 features) to each tumor. We extracted texture features and performed feature selection. Univariate and multivariate analysis also were performed. Clustering identified subclasses.

Results

Multiple texture features were associated with GBM and we were able to classify GBM into four subtypes. These were associated with differences in patient progression-free and overall survival.

Conclusions

Glioblastoma subtypes based on radiomic texture signatures were identified that were both predictive and prognostic. These findings are important as this can help stratify patients and serve as imaging endpoints for clinical trials.

O-436

Imaging Genomic ADC Mapping Elucidates Associated Gene Network Signature

M Hatami¹, S Singh¹, M Luedi², P Zinn³, R Colen³
Purpose
To determine pretreatment apparent diffusion coefficient (ADC) values, measured by diffusion magnetic resonance (dMR) imaging, and its association with gene and microRNA networks in glioblastoma (GBM) tumors.

Materials and Methods
We retrospectively identified 44 treatment-naïve glioblastoma patients from The Cancer Genome Atlas (TCGA) whom had gene expression profiles and corresponding dMR imaging available in The Cancer Imaging Archive (TCIA). Apparent diffusion coefficient mean, min and max were measured in contrast enhancement region of the tumor. Using K-mean clustering method, patients categorized based on overall mean ADC into high versus low group. Kaplan-Meyer survival analysis was used to determine the difference of overall survival between the two groups of patients. Imaging genomic analysis subsequently was performed using GenePattern Comparative Marker Selection module (Broad Institute). To identify the associated gene networks, the top 100 most positively and the top 100 most negatively correlated genes in the high group versus the low group then were analyzed with Ingenuity Pathway Analysis (IPA).

Results
Based on the KM analysis, patients with higher overall mean ADC had better overall survival. Median of overall survival time in low and high group was 355 and 946 days, respectively (P value=0.002). Specific gene and microRNA networks associated with high versus low groups were uncovered and canonical pathways elucidated; networks in the low ADC group were found to be involved in tumor invasion. The validation of these analyses was done in a separate nonoverlapping group of glioblastoma patients.

Conclusions
We demonstrate that DMR characteristics can identify highly significant survival differences and that these harbor a specific molecular and microRNA network signature.
Radiogenomic rCBV-imaging visualizes the distinct angiogenesis transcriptome signatures of IDH mutant and wild type gliomas

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Purpose
The recent identification of isocitrate dehydrogenase (IDH) mutations in gliomas and several other cancers suggests that this pathway is involved in oncogenesis; however effector functions on epigenetic and genetic cellular signaling are complex and yet incompletely understood. To resolve the so far conflicting regulatory effects of IDH on hypoxia inducible factor 1 alpha (HIF1A) (1-4), a driving force in hypoxia-initiated angiogenesis, we performed mRNA expression and genotype/imaging phenotype correlation analysis.
Materials and Methods
We studied differential mRNA expression profiles from 288 samples with low grade diffuse and anaplastic gliomas from The Cancer Genome Atlas (TCGA) on HIF1A and related downstream signaling on a single-gene and pathway level, as well as upstream biological causes and probable downstream effects between mutant and wild-type IDH tumors. Genotype/imaging phenotype correlation analysis was performed with relative cerebral blood volume (rCBV) MRI – an estimate of tumor angiogenesis – in 69 treatment-naive patients with low grade and anaplastic gliomas.

Results
We show decreased expression of HIF1A target genes on a single-gene and pathway level, strong inhibition of upstream regulators such as HIF1A and downstream biological functions such as angio- and vasculogenesis in IDH mutant tumors. Our radiogenomic imaging approach revealed that these differential mRNA expression signatures translate into distinct phenotypes, with increased levels of rCBV in IDH wild-type tumors, where a one-unit increase in rCBV corresponded to a two-third decrease in the odds for an IDH mutation.

Conclusions
Together, these findings show that both mutant and wild-type IDH tumors are associated with a unique transcriptome signature which is noninvasively detectable with rCBV imaging and highlight the future role of radiogenomics for noninvasive tissue imaging as a substitute for invasive profiling of cancer genomic key events.

Wednesday
5:00PM - 6:30PM
Sheraton Chicago Hotel & Towers, Superior AB (Level 2)

19G - PARALLEL SCIENTIFIC PAPER SESSION -EXCERPTA - ADULT BRAIN II
E-85

Nonketotic Hyperglycemic Hemichorea

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Purpose
Nonketotic hyperglycemia is a relatively rare cause of unilateral hemichorea in patients with poorly controlled diabetes. This educational excerpta will review the diagnostic criteria for nonketotic hyperglycemic hemichorea (NHH) focusing on its unique imaging appearance.

Materials and Methods
This excerpta will detail the diagnosis, clinical course and imaging appearance of four cases of confirmed nonketotic hyperglycemic hemichorea.

Results
The CT appearance of nonketotic hyperglycemic hemichorea classically consists of unilateral increased attenuation in the caudate head and lentiform nucleus with sparing of the internal capsule. The lesion is without corresponding mass effect or surrounding edema. Clinically, the
patient will exhibit hemichorea contralateral to the side of basal ganglia abnormality. Occasionally, basal ganglia involvement may be bilateral and asymmetric. MR imaging reveals corresponding T1 hyperintensity and T2 hypointensity with a variable appearance on DWI, SWI, and contrast-enhanced sequences. The attached graphic demonstrates the classic CT and MRI findings of NHH.

Conclusions
Knowledge of the unique imaging appearance of nonketotic hyperglycemic hemichorea can help expedite the diagnosis and treatment of this rare movement disorder.

(Filename: TCT_E-85_NHH.jpg)

E-86
5:05PM - 5:10PM
Voltage Gated Calcium Channel Autoimmune Encephalitis: A Rare Cause of Encephalitis.

M Kelly1, C Gradinaru2, S Patel2, B Griffith1
1Henry Ford Health System, Detroit, MI, 2Henry Ford Hospital, Detroit, MI

Purpose
Encephalitis often presents with nonspecific symptoms and imaging findings, which can lead to a delay in diagnosis. Having a broad differential guided by the clinical information and imaging
findings can aide in appropriate clinical work-up and management. The purpose of this exhibit is to present a rare cause of encephalitis, review the literature on Ca2+ voltage gated autoimmune encephalitis, and discuss other causes of encephalitis and how they differ on imaging. 

Materials and Methods
We will report the case of a 36-year-old female who presented with left arm weakness and left visual field defect. The working clinical diagnosis at this time was stroke. After MRI, vascular studies, and appropriate clinical management, the patient's symptoms improved. The patient returned 1 month later with new right sided symptoms. Imaging at this time revealed contralateral findings from the prior study and further investigation to find an underlying metabolic, neoplastic or autoimmune etiology was done. Whole body imaging did not reveal a primary neoplasm. A muscle biopsy was negative. A brain biopsy was performed and consistent with cortical laminar necrosis and blood work showed abnormally elevated voltage gated calcium channel antibodies, consistent with autoimmune encephalitis.

Results
Initial presenting MRI demonstrated T2 and FLAIR hyperintensity involving the cortical and subcortical white matter in the right occipital lobe without corresponding restricted diffusion. Vascular imaging was normal and the working clinical diagnosis was subacute stroke. The patient returned 1 month later with new MRI demonstrating partial resolution of the T2/FLAIR abnormality in the right occipital lobe and new T2/FLAIR hyperintense signal in the left occipital lobe without restricted diffusion. Similar to the prior exam, there was cortical enhancement.

Conclusions
Autoimmune encephalitis often is associated with an underlying neoplasm. We will present a rare case of voltage gated Ca2+ channel autoimmune encephalitis in the absence of underlying neoplasm. The exhibit will highlight the variable imaging findings of the different causes for encephalitis such as herpes, CMV, HIV and others.
Selective Optic Pathway Involvement in a Patient with Mitochondrial Oxidative Phosphorylation Deficit due to Mutations in the MTFMT Gene

R La Piana¹, L Ospina², I Leppert³, W Weraarpachai³, E Shoubridge³, B Brais³, D Tampieri⁴
Mitochondrial oxidative phosphorylation deficits are associated with several genes involved in the mitochondrial function, among which MTFMT recently has been identified. Even though a clear MR pattern has not been defined yet, patients with MTFMT mutations present bilateral striatal involvement associated with multifocal, variably confluent, nonspecific white matter abnormalities. The goal of our study is to report the unique, selective involvement of the optic pathway in a patient with MTFMT mutations and mild phenotype.

Materials and Methods
A 23-year-old woman with history of mild cognitive deficit, growth retardation and mitochondrial dysfunction (mild complex I deficit) was referred to our Clinics of Neurogenetics. She reported progressive visual loss which started subacutely at the age of 18. The neuro-ophthalmological examination, including visual acuity, visual evoked potentials and fundus oculi exam, performed before the onset of the visual deficit was completely normal. The last follow up in 2014 documented severely reduced visual acuity, marked optic nerve pallor and absent visually evoked response. The patient was discovered to be compound heterozygous for two mutations, one never reported before, in the MTFMT gene.

Results
The first brain MRI, performed before the onset of the visual deficit, documented multifocal white matter abnormalities and bilateral striatal involvement. No signal abnormalities were noted in the optic pathways. The follow-up MRI performed at the age of 19 revealed selective, bilateral and symmetric involvement of the optic radiations in their entire length. The optic nerves, visual cortex and lateral geniculate bodies did not present signal abnormalities or atrophy. No interval changes were noted in the last follow up performed in 2014.

Conclusions
Our patient presents unique MR pattern and evolution characterized by late-onset, selective involvement of the retrogeniculate visual pathway. This exceptional imaging pattern raises the question of tissue specificity in MTFMT-related oxidative phosphorylation deficits.

Pseudotumoral Hemicerebellitis in Adults: Infection or Just Another PRES Variant?

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Purpose
Pseudotumoral Hemicerebellitis (PHC) is a rare, potentially lethal clinical syndrome usually encountered in children and believed to be of infectious etiology. Pseudotumoral hemicerebellitis is characterized by reversible, predominantly unilateral, cerebellar edema and mass effect.
Occurrence in adults is exceedingly rare, with only three cases reported. We present five cases of this entity in acutely hypertensive adults and hypothesize that some cases of PHC actually may represent an unrecognized manifestation of hypertensive encephalopathy and not an infectious disorder.

Materials and Methods
CT and MR findings in five patients (4 women, ages 54-78 years) presenting with unilateral cerebellar edema, and mass effect were reviewed. All were known to have hypertension and presented emergently with elevated blood pressure. Two patients required placement of external ventricular drainage catheters. Follow-up imaging was available in all cases.

Results
Imaging findings resembled those of PHC reported in the literature and included overwhelmingly unilateral cerebellar hemispheric edema (not confined to one vascular territory), mass effect, petechial hemorrhage and meningeal enhancement. Three patients demonstrated subdural effusions along the surface of the affected cerebellar hemisphere, while in the other two, the adjacent dura was thickened. No supratentorial abnormalities were observed. Angiographic studies were unremarkable. No micro-organisms were identified in any patient. In all, abnormalities were observed to stabilize and/or resolve on follow-up imaging.

Conclusions
Strikingly consistent imaging findings resembling PHC, including predominantly unilateral cerebellar swelling, petechial hemorrhage, enhancement along the folia and adjacent meningeal involvement, were observed in our cohort. The association with severe hypertension, lack of an identifiable infectious organism, and resolution without antimicrobial treatment suggest that some cases of PHC, especially in adults, may represent an unrecognized manifestation of hypertensive encephalopathy.
Imaging Findings of Disseminated Bipolaris Presenting as Extra-Axial Fungal Granulomata and Intracranial Abscesses

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Purpose
Bipolaris is a mold that has been reported to cause endophthalmitis, sinusitis, and allergic bronchopulmonary disease. These infections are more common in immunosuppressed individuals. Before widespread MRI usage, bipolaris also was identified as a pathogen in intracranial fungal granulomatous disease. This study's purpose is to report the intracranial imaging findings of disseminated bipolaris which initially manifested as multiple extra-axial masses.

Materials and Methods
A 39-year-old immunocompetent, previously healthy woman, presented with a seizure and headache. Initial neuroimaging demonstrated bilateral temporal extra-axial masses. A differential of metastases, lymphoma, atypical meningiomata, or granulomatous disease was offered. Subsequent CT of the chest, abdomen, and pelvis demonstrated marked biliary tract thickening and retroperitoneal/internal mammary lymphadenopathy. The patient was taken to surgery for biopsy and resection of the right temporal lesion. The right lesion was resected subtotally as it was found to be invasive and densely adherent to the adjacent brain parenchyma. The biopsy specimen revealed fungal granulomata with bipolaris subsequently cultured. ERCP biliary sampling yielded cultures which grew bipolaris, pseudomonas aeruginosa, and Klebsiella pneumoniae. The patient was treated with antimicrobials; and follow-up MRI evaluation demonstrated new peripherally enhancing daughter lesions adjacent to the left temporal lesion. The patient was taken to surgery, and both sites were evacuated completely. Subsequent MRIs after treatment demonstrated no recurrent infection.

Results
Initial brain CT demonstrated bilateral extra-axial temporal hyperdense masses with surrounding edema. MR imaging demonstrated two extra-axial masses with the left lesion appearing solid with homogeneous enhancement. The right lesion demonstrated more lobulated margins and a medial necrotic component. MR imaging after biopsy/subtotal resection of the right lesion, demonstrated multiple peripherally enhancing, diffusion restricting daughter lesions adjacent to the left temporal lesion compatible with small abscesses formation.

Conclusions
Disseminated bipolaris with intracranial fungal granulomata and abscesses can represent a rare cause of extra-axial masses even in an immunocompetent patient without sinusitis.
Balamuthia mandrillaris is a free-living amoeba found in soil and dust. Balamuthia can cause a very rare but often fatal granulomatous amoebic encephalitis, with reported mortality rate of 95%. It spreads hematogenously after soil containing balamuthia enters through skin cuts/wounds or is inhaled. Both immunocompetent and immunosuppressed individuals may be affected. Only 200 cases of human balamuthia infections have been reported in the literature.
Materials and Methods
A 20-year-old female with no significant past medical history or recent travel presented with progressive diplopia, headaches, and left sided weakness over a few days. Patient was admitted and treated for presumed meningoencephalitis, but had progressive decline over the next few days. The combination of lesions on brain MRI, worsening clinical condition, and lack of definitive diagnosis prompted a brain biopsy. Biopsy demonstrated acute hemorrhagic necrotizing amoebic meningoencephalitis. The centers for disease confirmed balamuthia mandrillaris in the brain biopsy specimens. Despite decompressive craniectomy and optimal medical therapy with combination anti-ameobic drug therapy, the patient expired 2 weeks later.

Results
The initial head CT demonstrated heterogeneous lesions in bilateral frontal lobes with moderate surrounding hypodensity consistent with vasogenic edema, causing significant local mass effect. Contrast-enhanced MRI images showed several irregular enhancing lesions in the parasagittal frontal lobes involving both the cortex and subcortical white matter with moderate surrounding T2 prolongation, consistent with vasogenic edema. Moderate leptomeningeal enhancement also was present in the frontal lobes bilaterally.

Conclusions
Balamuthia mandrillaris may mimic more common central nervous system (CNS) infections such as pyogenic abscess, tuberculosis, and fungal infection, and high clinical suspicion is needed to consider this entity. This is particularly true when purulent cerebrospinal fluid is obtained and no bacterial, mycobacterial, or fungal organisms are identified.
Rituximab-Induced Progressive Multifocal Leukoencephalopathy in a Patient with Rheumatoid Arthritis

B Salehi1, R Venkatesh2, V Trinh1, B Yoo3
1UCLA, Los Angeles, CA, 2UCLA Medical Center, Los Angeles, CA, 3David Geffen School of Medicine at UCLA, Los Angeles, CA

Purpose
Increased risk of progressive multifocal leukoencephalopathy (PML) has been demonstrated in HIV-negative patients treated with Rituximab, including lymphoproliferative and rheumatologic disorders. We present an atypical manifestation of PML with infratentorial and thalamic involvement in a patient with history of rheumatoid arthritis (RA) previously treated with Rituximab.

Materials and Methods
A 57-year-old woman with a 2-month history of worsening altered mental status and dystonia was transferred to our institution for higher level of care regarding her progressive encephalopathy. Her past medical history was significant for RA, treated with Rituximab. An
extensive workup for malignant, infectious and inflammatory/autoimmune causes was nonrevealing. Brain imaging showed extensive FLAIR signal abnormality in the bilateral thalami and cerebellar hemispheres. She was treated empirically with antibiotics for infection, and given a course of steroids and IVIG for presumptive paraneoplastic syndrome, without clinical improvement. The patient underwent a right cerebellar biopsy, which revealed presence of JC virus in regions of white matter injury and overlying granule cells, consistent with PML. Despite intensive care, the patient continued to decline clinically, and was discharged on hospice care upon her family's request.

Results
Brain MRI shows extensive T2/FLAIR signal hyperintensity involving bilateral thalami and cerebellar hemispheres. There is no restricted diffusion or abnormal enhancement.

Conclusions
We report an atypical imaging presentation of PML with thalamic and cerebellum involvement, in association with Rituximab for RA treatment. While rarely reported in the literature, this case highlights the importance of considering PML in the differential diagnosis in patients treated with Rituximab with new neurologic symptoms and brain imaging abnormalities.

(Filename: TCT_E-93_PML-4.jpg)

E-94
5:45PM - 5:50PM

IG4 Hypertrophic Pachymeningitis of the Left Frontal lobe, a Rare Extraxial mass Lesion

T Snyder¹, A Sneider², J Poveda³, N Nagornaya⁴
¹University of Miami, Miami Beach, FL, ²University of Miami, Jackson Memorial Hospital, Miami, FL, ³University of Miami / Jackson Memorial Hospital, Miami, FL, ⁴Jackson Memorial Hospital, Miami, FL

Purpose
To present a case of IG4 hypertrophic meningitis, a rare cause of subdural mass/lesions.

Materials and Methods
A 46-year-old man was brought by ambulance to the hospital following crashing his car into a house. Subsequently tested positive for cocaine, alcohol, marijuana. CT and MR imaging were performed and the patient was taken to surgery for suspected left frontal lobe dural mass lesion. Surgery revealed a "hard lesion inseparable from the dura", intra-operative frozen section pathological diagnosis was lymphocytic granulation tissue, final pathology demonstrated IG4 hypertrophic pachymeningitis.
Results
CT demonstrated a extra-axial hyperdense mass in the left frontal lobe with a large amount of surrounding edema. MR imaging with contrast demonstrated a lobulated extra-axial left frontal lesion which is isointense on T1 and hypointense on T2 and susceptibility-weighted imaging (SWI) and with ill-defined contrast enhancement. Extensive vasogenic edema and adjacent thick dural enhancement which crossed midline involving the floor of the anterior cranial fossa and the frontal vertex.

Conclusions
IG4 hypertrophic pachymeningitis is a rare cause of extra-axial mass lesions, an entity which just recently is becoming more well known.
This Time not the Usual Suspects? Progressive Multifocal Leukoencephalopathy after Interferon Beta-1a Monotherapy

K Krueger, P Krueger, H Lehmann

Neurology Practice, Hennef, Germany, University of Geneva, Geneva 4, Switzerland, University of Cologne, Cologne, Germany

Purpose
Therapy-associated progressive multifocal leukoencephalopathy (PML) is a potentially fatal adverse event of disease modifying treatment (DMT) in multiple sclerosis (MS), mainly in patients receiving natalizumab (NTZ) alone or in combination with interferon beta-1a (IFb1a), but never after interferon monotherapy as in our case report.

Materials and Methods
A completely healthy 46-year-old female patient developed a cerebellar syndrome in 2009, and was diagnosed as clinically isolated syndrome (CIS) suggestive of MS [positive oligoclonal cerebrospinal fluid (CSF) bands]. After "wait and watch" a relapse occurred in 2013, and DMT with IFb1a was introduced. Nine months later a subacute severe neurologic deterioration occurred with left hemiparesis and progressing ataxia. MR imaging findings were atypical for MS progression and suggestive of PML (which was confirmed by CSF examinations). An in-depth immunological work up revealed a previously unrecognized and clinically inapparent common variable immunodeficiency (CVID). IFb1a was stopped immediately, and monthly intravenous immunoglobulin (IVIg) was administered. The patient improved markedly during the following 3 months, as did the MRI findings. In contrast to many NTZ-associated PML cases no clinical or MRI signs of an immune reconstitution inflammatory syndrome (IRIS) occurred. The patient is doing fairly well after 8 months.

Results
MR data include a longitudinal registration of the magnetization transfer ratio (MTR) during the entire observation period of more than 4 years. At CIS diagnosis one single bright T2 lesion in the right cerebellar hemisphere without diffusion restriction and Gd enhancement was seen. During "wait and watch" we observed a continuous and significant (p<0.0001) decrease of mean MTR values until the relapse, when multiple periventricular, callosal and some subcortical bright T2-lesions were found, partially with Gd enhancement. During 9 months of DMT mean MTR values were increasing, but when symptoms were progressing unexpectedly and severely, we found several new subcortical confluent bright T2 lesions mainly in the right hemisphere involving U fibers with diffusion restriction in the border areas and without significant Gd enhancement. Findings were suggestive of PML, and during pragmatic therapy (including discontinuation of IFb1a plus monthly IVIg) a marked improvement of imaging findings could be observed within 3 months. There were no signs of an IRIS.

Conclusions
To recognize PML, T2-weighted FLAIR and DIR sequences with CSF and white matter (WM) suppression seemed the "gold-standard". Subcortical U fibers are primarily involved, and oligodendrocyte swelling can cause diffusion restriction at the edges of the lesions. spreading
occurs from different foci like an invasion front at different speed and momentum, while upcoming spotty Gd enhancement marks transition to IRIS. If MS patients severely progress during DMT, PML must be considered regardless of the applied drug. Interferons may provoke PML in susceptible MS patients who are not fully immunocompetent. Thus, clinical and neuroradiologic vigilance is the key to a timely recognition of therapy-associated PML.

46 y/o Female, Late-Onset RRMS plus CVID during "Wait and Watch", Interferon-DMT and

Magnetization-Transfer-Ratio in Percent-Units

Examination-Dates

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E-97

Propionibacterium acnes Brain Abscess: an Uncommon Brain Bug
I Wright\textsuperscript{1}, N Birouti\textsuperscript{1}, J Pollock\textsuperscript{1}  
\textsuperscript{1}Oregon Health & Science University, Portland, OR

Purpose  
Propionibacterium acnes rarely causes intracranial infections, but when present, it has atypical imaging stability and clinical features including absence of systemic findings and negative bacterial cultures. In this excerpta we will review the imaging and clinical features of the rare brain abscess caused by this atypical organism.

Materials and Methods  
A 56-year-old man with stage IV lung adenocarcinoma status post left parietal metastasis excision 1.5 months ago presented with mild seizures. MR imaging showed fluid accumulation in the resection cavity, stable in size from imaging 1 month prior. As he remained afebrile and had normal labs, he was followed for the next few months, but eventually was readmitted 6 months later as a result of worsening seizures. At this time, his left parietal cavity was drained, without any purulence noted. Bacterial culture yielded no growth after 5 days, but 16S rRNA sequencing returned positive for Propionibacterium acnes.

Results  
Propionibacterium brain abscesses are similar to those caused by other bacteria. On MRI, mature lesions usually will be rim-enhancing with central diffusion restriction. Other findings can include a hypointense capsule on T2-weighted imaging and adjacent vasogenic edema. The lesions have an indolent imaging course reflective of the relatively benign clinical presentation and may remain stable on imaging for months despite an active infection and may present years after the surgical procedure.

Conclusions  
Propionibacterium is a gram positive bacillus commonly found on human skin and hair follicles. Although usually benign, it can rarely cause central nervous system (CNS) abscesses, particularly in patients with prior neurosurgery. Unlike other types of bacterial abscesses, patients will rarely develop fevers or a pronounced leukocytosis, and the time elapsed between a neurosurgical procedure and symptom onset can be months to years. As it is slow growing and anaerobic, cultures of the abscess frequently are negative, so allowing cultures to grow for up to 10 days and performing 16S rRNA sequencing have therefore been suggested to ensure early diagnosis of propionibacterium infections.
Figure 1. Left parietal cavity demonstrates linear enhancement on post contrast imaging (a) and a very hyperintense rim at the cavity with adjacent vasogenic edema on T2 imaging (b). DWI (c) and ADC (d) show mild diffusion restriction in case. This is less restriction than would be expected with a puru
Hippocampal Neurotoxicity in a patient with Glyphosate-based Herbicide Ingestion: A Case Report

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Purpose
Glyphosate is one of the widely used herbicides against which crops have been genetically modified to increase their tolerance. The toxicity for humans in the situation of glyphosate-based formulation ingestion range from gastro-intestinal damage, ventilation insufficiency by aspiration, through renal and hepatic impairment, loss of consciousness and hypotension to death. We describe herein a case of hippocampal neurotoxicity detected with magnetic resonance imaging (MRI) in a patient with commercial glyphosate-based herbicide ingestion.

Materials and Methods
A 60-year-old woman who was in the hospital with bipolar disorder was brought to our emergency department after ingestion of unknown dose of glyphosate-based herbicide while spending the night outside the hospital. Since she presented with acute renal failure, pulmonary damage, mixed acidosis and impaired consciousness, she was admitted to the intensive care unit and appropriately treated with tracheal intubation. Soon after the treatment, her general status improved; however, her short term memory impairment persisted and brain MRI was performed to search for the cause.

Results
A brain MRI 16 days after ingestion revealed that prolonged T2 and vasogenic edema with swelling were observed in the bilateral hippocampus with right side dominancy (Figure A-C). A cerebrospinal fluid examination showed no inflammation, therefore we diagnosed the neurotoxicity as being of glyphosate-based herbicide ingestion origin. A follow-up MRI 51 days after ingestion showed that the hippocampal swelling and restricted diffusion were improving, and a follow-up MRI 107 days postingestion demonstrated almost no abnormal intensity on the bilateral hippocampus without further treatment after the initial emergency care (Figure D). The patient's short term memory impairment was prolonged, but a slight improvement was seen during the period of admission.

Conclusions
We presented herein a case of bilateral hippocampal neurotoxicity detected on MRI in a patient with short term memory impairment after ingestion of a glyphosate-based herbicide. To the best of our knowledge, this is the first human case report of bilateral hippocampal neurotoxicity caused by glyphosate-based herbicide ingestion. Neurotoxicity in this case is considered as being due to the acute glyphosate toxicity; however, chronic glyphosate-related toxicity has not been reported well. For the safety and security of dietary intake even remotely connected with a glyphosate-based herbicide, further pathophysiological and toxicological investigations are required.
Case of Opiate Induced Spongiform Leukoencephalopathy

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Purpose
To describe a case of acute opiate (methadone)-induced spongiform leukoencephalopathy.

Materials and Methods
A 37-year-old male who was a known intravenous drug user. Has been on Methadone for 10 years. History of recurrent seizures, lives alone. Found unconscious at home with GCS 8. Intubated in emergency department, admitted following prolonged period of hypoxia. Acute kidney injury secondary to rhabdomyolysis. Admitted to ITU and supported with tracheostomy. Toxic screen positive for –Opioids, Methadone and Benzodiazepine.

Results
Previous MRI brain 4 months ago was within normal limits. CT brain - Diffuse white matter low density change. Initial diagnosis Watershed infarction? PRES? MRI - Confluent T2 hyperintensities in cortical white matter with patchy enhancement and central white matter necrosis, MR spectroscopy – double lactate peak. Brain Biopsy - White matter edema and gliosis but no inflation or demyelination. Diagnosis - Spongiform leucoencephalopathy.

Conclusions
Toxic spongiform leukoencephalopathy caused by acute ingestion of Methadone. Lack of diffusion-weighted imaging (DWI) restriction. Unlike Heroin toxicity there is sparing of the brainstem, Decreased NAA peak, double lactate peak on MR spectroscopy. Peaks are due to hypoxia and metabolic changes but no demyelination.
Purpose
We present a case of amyloid-β related angiitis (ABRA) to demonstrate its unique clinical, pathological, and imaging characteristics.

Materials and Methods
A 62-year-old white male with a history of hypertension and type 2 diabetes presented with 1 month of worsening headaches and 1 day of acute disorientation, confusion, and fever. Initial brain MRI findings described below. Laboratory results revealed an elevated white blood cell count, but cerebrospinal fluid analysis was negative for viral, fungal, or bacterial etiologies. The patient was treated with broad-spectrum antibiotics, dexamethasone, levetiracetam, and acyclovir. Clinical improvement was obtained within 7 days and the patient was discharged with a presumed diagnosis of encephalitis versus vasculitis. Symptoms recurred 4 months after initial treatment. Histology demonstrated prominent amyloid β deposition around small central nervous system (CNS) vessels primarily in the superficial cortex and subarachnoid space with associated full-thickness inflammation and T-cell infiltration of the affected vessels. Underlying white matter showed rarefaction and gliosis with perivascular widening. Six months after initial presentation, the patient suffered a fatal intraparenchymal hemorrhage.

Results
(A) Initial presentation, T2-weighted imaging (T2WI) sequence demonstrates large area of hyperintensity in the right cerebral hemisphere, predominantly in the white matter with regional mass effect. (B) Repeat MRI after 1 month of treatment shows near complete resolution of right hemispheric T2WI hyperintensities. (C) Five months after initial presentation, MRI demonstrates recurrence of inflammation in a pattern similar to initial presentation. (D) CT 6 months after initial presentation demonstrates a fatal intraparenchymal hemorrhage in the right parietal lobe with extension into the lateral ventricles.

Conclusions
ABRA is a rare granulomatous angiitis that can complicate cerebral amyloid angiopathy (CAA). ABRA often occurs at a younger age than classical CAA and often with findings of inflammation. Extensive hemorrhage as in the present case is unusual.
Insult to the Trigeminal Spinal Nucleus and Tract: A Potential Cause of Persistent Trigeminal Neuralgia

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Purpose
Trigeminal neuralgia (TN) associated with linear brainstem T2 hyperintensity conforming to the trigeminal spinal nucleus and tract rarely has been described as a postviral or more specifically, a postherpetic syndrome. We describe a patient presenting with TN with imaging findings suggesting trigeminal nucleus neuritis.

Materials and Methods
A 45-year-old woman presented with new onset of intermittent left eye and left-sided nose, maxilla, jaw and chin pain, which she described as a stabbing pain in the eye and burning skin. She also complained of new onset of near daily headaches. Initially, she was diagnosed with TN and attempts at pain relief using steroid injections were unsuccessful. After further clinical investigation, a postherpetic (shingles) etiology for the TN was considered and contrast-enhanced MRI was performed to evaluate for etiology of trigeminal pain.

Results
Linear T1 hypointensity and T2 hyperintensity was evident extending from the left medial middle cerebellar peduncle to the posterolateral cervicomedullary junction conforming to the left spinal trigeminal nucleus and tract. There was no associated restricted diffusion, mass effect or enhancement. This linear focus of signal abnormality. Subtle asymmetric enhancement of the cisternal left trigeminal nerve was noted extending to the porus trigeminus and gasserian ganglion. The masticator muscles were symmetric in size and signal intensity, without imaging evidence of denervation changes. Repeat MR at 23 months showed the linear signal to be much less clearly evident and there was resolution of neural enhancement without new lesions.

Conclusions
This T2 signal intensity conforms to the spinal trigeminal tract and nucleus which is responsible for transmission of pain and temperature from the ipsilateral face. Rare cases of TN associated with brainstem lesions on MR have been reported in the literature (1-4). In the acute-subacute phase imaging manifestations might be confused with ischemia or demyelinating disease although these entities isolated to the tract would be unusual. It is notable that at almost 2 years follow up, while the symptoms persisted the imaging manifestations were extremely subtle.
MRI differentiation of shunt responsive Normal Pressure Hydrocephalus, Alzheimer Disease and Normal Aging: Comparison of morphometric and categorical assessments to automated volumetric segmentation.

C Stanton¹, A Franceschi¹, N Miskin¹, B Damadian², J Golomb¹, O Gonen¹, H Rusinek¹, A George¹
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Purpose
Normal pressure hydrocephalus (NPH) has overlapping clinical and imaging features with Alzheimer disease (AD) and normal brain aging. We address three general approaches to differentiating these entities. Categorical assessments (including DESH or disproportionate enlargement of the subarachnoid spaces) are quick but subjective. Morphometric measures such as Evans' index (EI) and callosal angle (CA) potentially reduce subjectivity, however they can be impractical in routine clinical use. We recently have introduced an automatic predictive model based on brain tissue volume distributions to differentiate shunt-responsive NPH (srNPH), AD and healthy controls (HC). Our main goal was to compare the accuracy of the three approaches in distinguishing these populations.

Materials and Methods
N=72 consisted of 37 srNPH patients, 20 AD patients and 15 elderly HC. Each individual had high resolution T1-weighted MRI acquired using MPRAGE sequences on Siemens 1.5/3T units. Three observers with 1-3 years neuroanatomy experience were blinded to clinical data. Presence or absence of DESH was assessed by dichotomous global impression and five-point visual ordinal scales were used to assess prominence of sylvian fissures (SF) and grouped high convexity/medial cortical sulci (CS). Evan's index and CA were measured retrospectively and independently by each observer. Global gray matter (GM) volume was computed using SPM8 and ventricular volumes (VNT) were segmented using locally developed software. For subjective metrics we assessed interobserver variability using intraclass correlation coefficient (ICC). Each metric was tested in terms of its ability alone to diagnose each patient as either srNPH, AD, or HC. The categorical, morphometric and segmentation metrics also were group tested in multivariable predictive models using 3-way nominal regression. Finally, each model was tested using chi-square, including comparison of each observer's categorical and morphometric measurements with the automated volumetric segmentation.

Results
Intraclass correlation coefficients (ICC) showed very good interobserver agreement for DESH, sulcal prominence, EI and CA but only fair for SF. Predictive accuracy (Figure 1) was very good for automated volumetric segmentation (overall accuracy 91.7%) and only fair in the other
prediction models (overall accuracy 62.5 – 79.2%). Automated volumetric segmentation also showed superior accuracy in direct comparison with each observer's measurements, with a representative example for the observer with the median accuracy provided (Figure 2).

Conclusions
Automated volumetric segmentation demonstrates superior predictive accuracy to Evans' Index, callosal angle and DESH assessments in distinguishing srNPH from AD and normal aging.

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<thead>
<tr>
<th>Prediction Model</th>
<th>Overall Accuracy (%)</th>
<th>NPH Accuracy (%)</th>
<th>AD Accuracy (%)</th>
<th>HC Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESH, Sylvian Fissures &amp; Sulci Combined</td>
<td>72.2-76.4</td>
<td>81.6</td>
<td>38.9-72.2</td>
<td>50-93.8</td>
</tr>
<tr>
<td>Evan's Index &amp; Callosal Angle Combined</td>
<td>72.2-79.2</td>
<td>92.1-94.7</td>
<td>38.9-55.6</td>
<td>68.8</td>
</tr>
<tr>
<td>Evans' Index</td>
<td>62.5-70.8</td>
<td>89.5-92.1</td>
<td>22.2-38.9</td>
<td>43.8-68.8</td>
</tr>
<tr>
<td>Callosal Angle</td>
<td>62.5-69.4</td>
<td>86.8-89.5</td>
<td>23.2-50.0</td>
<td>18.8-68.8</td>
</tr>
<tr>
<td>Volumetric Segmentation</td>
<td>91.7</td>
<td>92.1</td>
<td>83.3</td>
<td>100</td>
</tr>
</tbody>
</table>

![Figure 1: Diagnostic Accuracy of Prediction Models](TCT_O-438_2NPHAbstractFigs.jpg)

![Figure 2: Comparison of Segmentation and Morphometric Model Performance](TCT_O-438_2NPHAbstractFigs.jpg)

**O-439**

**Relationship Between Ratio of Anterior and Posterior Pituitary Surface Area on Mid-sagittal MRI and Clinical Diagnosis of Hypogonadotropic Hypogonadism.**

Y Chang¹, D Cohen¹, A Migdal¹, K Smith¹, R Rojas¹, R Bhadelia²
¹Beth Israel Deaconess Medical Center, Boston, MA, ²Beth Israel Deaconess Medical Center, Boston, MA

**Purpose**
Idiopathic hypogonadotropic hypogonadism (IHH) is characterized by low testosterone levels with low (or inappropriately normal) gonadotropins with an otherwise normal hypothalamic-pituitary axis and no other contributing causes. Our purpose was to elucidate whether IHH patients demonstrated subtle differences in size of the pituitary compared to non-IHH patients.

**Materials and Methods**
A retrospective review of our institutional imaging database for dedicated MRI pituitary studies in males (ages 18-60 years) from 2013-2014 was performed. Patients with pituitary, sellar and suprasellar masses, empty sella, ectopic posterior pituitary, or where the anterior pituitary (Pa) and posterior pituitary (Pp) could not be reliably differentiated secondary to technical artifacts were excluded. Twenty-five cases were biochemically proven to have IHH. The control group comprised of 28 patients who were imaged incidentally or had endocrine disorders other than
IHH. Ages of the patients were recorded. The cross-sectional areas of the Pa and Pp on a single midline precontrast T1 3 mm sagittal image was calculated using a freehand tool available on the institutional PACS. A ratio of Pa/Pp then was calculated. Idiopathic hypogonadotrophic hypogonadism versus control comparisons were analyzed using a two-tailed Student's t-test. Linear regressions of Pa/Pp ratio with age also were performed. All data expressed as mean±SD.

Results
There was no difference in age between IHH (45.0 years±9.2) versus controls (41.3 years±12.3) or IHH Pa area (34.1mm²±9.2) versus controls (36.1mm²±11.7). Idiopathic hypogonadotrophic hypogonadism Pp (13.1mm²±1.7; p<0.01) was significantly larger versus controls (10.0mm²±1.4). Idiopathic hypogonadotrophic hypogonadism Pa/Pp ratio (2.8±1.0; p<0.01) was smaller versus controls (4.2±2.4). No correlation between age and pituitary areas or ratio was found.

Conclusions
We demonstrate that in the absence of overt anatomical abnormality, patients with IHH demonstrate decreased Pa/Pp ratio and increased mean Pp area versus controls. Thus, these findings may be useful as imaging correlates for IHH.

O-440

MR Pattern-Recognition in Undiagnosed Late-Onset Genetic Leukoencephalopathies

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¹Montreal Neurological Institute and Hospital, McGill University, Montreal, Quebec, ²Montreal Children's Hospital, Montreal, Quebec, ³Montreal Neurological Institute, Montreal, Quebec, ⁴Montreal Neurological Institute and Hospital, Montreal, Quebec

Purpose
Genetic leukoencephalopathies rarely are diagnosed in adults, especially in comparison with the pediatric population. However, adult-onset forms of genetic leukoencephalopathies may occur and their diagnosis might be delayed. Moreover, 30-40% of genetic leukoencephalopathies still remain without a precise diagnosis. MR imaging (MRI) has a central role as a diagnostic tool in white matter diseases. We hypothesize that, among subjects with undiagnosed leukoencephalopathies, clusters of patients could be identified based on shared MR data.

Materials and Methods
Patients with late-onset undiagnosed white matter disease were recruited; MR data and clinical information were collected. We performed a qualitative analysis aimed at identifying MR patterns of white matter involvement according to the MR pattern-recognition approach. All MR images were reviewed following a systematic approach including qualitative parameters (symmetry; pattern of involvement; presumptive nature of the pathological process; associated features) and regional analysis (extension; involved fibers; location).

Results
We have identified 31 patients (18 females, 13 males; mean age 48.3 years) with undiagnosed leukoencephalopathy of probable genetic origin. They belong to 24 families, 21 of which are of French Canadian ancestry. The MR images of all patients were reviewed and analyzed. We first distinguished patterns according to the predominance of the abnormalities. The white matter involvement was diffuse in 14 subjects (45.2%), multifocal in 14 subjects (45.2%) and
symmetrically limited to specific structures in three patients (9.6%). We then analyzed the three groups of MR pattern of involvement separately and we subdivided the patients according to the regional involvement and the associated features.

Conclusions

Our study confirmed that there are still a considerable number of cases of late-onset undiagnosed leukoencephalopathies. We documented a high variability of MRI patterns which reflects the heterogeneity of the clinical presentation. The MR classification of white matter involvement can orient the genetic testing and therefore facilitate the diagnostic process.

**O-441**

**Repeated exposure to hypobaria in U2 pilots is associated with reduced aggregate cortical thickness**

T Finnila¹, B Carra¹, P Kochunov², S McGuire³, P Sherman⁴

¹San Antonio Military Medical Center/59MDW, Lackland AFB, TX, ²University of Maryland, Baltimore, MD, ³U.S. School of Aerospace Medicine/Wilford Hall ASC, Lackland AFB, TX, ⁴U.S. School of Aerospace Medicine/Wilford Hall ASC, Boerne, TX

**Purpose**

To determine cerebral cortical thickness differences between high-altitude U2 pilots (U2P), altitude chamber technicians (AOP), and age-controlled and health-matched controls (DOC). United States Air Force U2P have experienced increased episodes of neurologic decompression sickness (NDCS) thought to be secondary to longer and more frequent exposures to hypobaria. Recent studies using magnetic resonance imaging (MRI) demonstrated an increased burden of white matter hyperintensities (WMH) in U2P and AOP compared to DOC. Computer-based neurocognitive testing revealed U2P performed significantly worse than age-matched pilots of other aircraft in certain cognitive domains such as memory and calculation. Research in neurodegenerative, psychiatric, and demyelinating diseases have consistently shown a relationship between cognitive performance and cerebral cortical thickness on MRI. The present study attempted to determine whether significant differences in cortical thickness exist between U2P, AOP, and DOC.

**Materials and Methods**

One hundred U2P, 83 AOP, and 162 DOC were studied using two Siemens 3T MRI scanners. The cortical thickness of the aggregate whole brain and predetermined subregions were measured with FreeSurfer software. The Kruskal rank sum test and the pairwise Wilcoxon rank sum tests (Bonferroni-corrected) were used to compare data among the three cohorts. Comparisons were performed both with raw and scaled U2P data.

**Results**

Median aggregate whole brain cortical thicknesses for U2P and AOP were reduced significantly compared to DOC (U2P 2.592mm, AOP 2.587mm, DOC 2.609mm; U2P:DOC p<0.001; AOP:DOC p<0.001). U2P:AOP was not significantly different (p=1.0 raw data; p=0.58 scaled data). At this time, no significant relationship between cortical thickness and white matter hyperintensity burden is demonstrated.

**Conclusions**

Repeat exposure to hypobaria among U2P and AOP is associated with reduced aggregate whole
brain cortical thickness compared to DOC. Analysis of individual subregions is ongoing. Further studies are needed to clarify the relationship between cortical thickness, WMH, and neurocognitive performance.

O-442

Retrospective review of MRI and MRS findings in hereditary diffuse leukoencephalopathy with spheroids and elderly asymptomatic carrier of causative gene, colony stimulating factor-1 receptor: a single institution study.

T Abe¹, T Kawarai², Y Obama¹, S Irahara¹, S Kaji², R Miyamoto², W Sakai², A Tsukamoto-Miyashiro², N Matsui², Y Izumi², R Kaji², M Harada¹
¹Department of Radiology, Tokushima University Graduate School, Tokushima, Tokushima, Japan, ²Department of Neurology, Tokushima University Graduate School, Tokushima, Tokushima, Japan

Purpose
Hereditary diffuse leukoencephalopathy with spheroids (HDLS) is a rare neurodegenerative disorder suffered by dementia, Parkinsonism, seizure and spasticity, which is caused by the mutation of colony stimulating factor-1 receptor (CSF1R). To date, elderly asymptomatic mutation carriers rarely are reported. Neuroimaging analysis of asymptomatic carriers in CSF1R (CSF1R carrier), especially elderly individuals, is intriguing and important to understand the underlying pathomechanisms in the disease.

Materials and Methods
Five patients with HDLS and 2 CSF-1R carriers were enrolled in the analysis. The distribution of abnormal intensity and atrophy were analyzed retrospectively on conventional MRI by two experienced neuroradiologists. MR spectroscopy (MRS) was performed on centrum semiovale, and metabolites were quantified by LCModel.

Results
Five cases with HDLS showed fronto-parietal lobe dominated generalized brain atrophy and atrophy of corpus callosum. They also demonstrated DW-hyperintensity in cerebral WM and brainstem. On the other hand, MRI of asymptomatic carriers showed periependymal T2W-hyperintensity, which was absent in the symptomatic probands. They also showed weak DW-hyperintensity at periependymal area of lateral ventricle and, which was not seen in the symptomatic probands. MR spectroscopy demonstrated decreased NAA and glutamate, increased choline-containing compound and myo-inositol in all symptomatic cases. Increased choline-containing compound was observed in the asymptomatic carriers; however, other metabolites remained normal.

Conclusions
This study demonstrated that the disease progression of CSF1R-HDLS is not uniform clinically and neuroradiologically. MR spectroscopy study can detect insidious progression of the disease at the normal-appearing white matter in asymptomatic elderly carriers.
CSF-1R carrier
Magnetic Resonance Elastography of Normal Pressure Hydrocephalus

N Fattahi¹, A Arani¹, A Perry², F Meyer², R Ehman², J Huston¹
¹Mayo Clinic, Rochester, MN, ²Mayo Clinic, Rochester, MN

Purpose
Normal pressure hydrocephalus (NPH) is a neurologic disorder characterized by a classic triad of gait disturbance, cognitive impairment and urinary incontinence in older adults. Shunt tube placement is currently the mainstay therapy for NPH. However, unpredictable therapeutic responses as well as associated surgical complications necessitate better characterization of surgical candidates. The purpose of this study was to compare brain tissue stiffness in NPH patients with age- and sex-matched healthy controls.

Materials and Methods
MR elastography (MRE) was performed on 11 NPH patients (age range of 67-79 years) and 21 age- and sex-matched healthy controls (age range of 67-80 years). Studies were performed on a 3T scanner with a single-shot spin-echo EPI pulse sequence. Shear waves were introduced into the brain through an external source of vibration using a frequency of 60 Hz. We applied a highly reliable MRE postprocessing technique with minimal noise and atrophy-related artifact which commonly affect brain MRE methods. We calculated the elasticity of different regions of interest in the brain including the whole brain excluding the cerebellum (cerebrum), frontal, temporal, parietal, occipital lobes, deep gray matter/white matter and the cerebellum.

Results
The stiffness value of the cerebrum among NPH patients was 2.64 +/- 0.1 kPa, which was significantly higher than the stiffness of the cerebrum in normal controls, 2.55 +/- 0.1 kPa (p = 0.02). Significantly increased stiffness also was found in the occipital lobe of the NPH group (p = 0.007) as well as the parietal lobe (p = 0.02) (Figures 1 and 2). However, no significant difference was noted in other regions of the brain.

Conclusions
Brain MRE of patients with NPH revealed increased stiffness of the cerebrum, occipital and parietal lobes compared with age- and sex-matched normal controls and may prove to be a useful diagnostic tool for these patients.
Brain Contrast Enhancement in Neuromyelitis Optica: Its Relation to Acute Attacks and Clinical Disease Severity

G Orman\textsuperscript{1}, Y Pekcevik\textsuperscript{1}, C Thompson\textsuperscript{2}, M Mealy\textsuperscript{3}, M Levy\textsuperscript{4}, I Izbudak\textsuperscript{5}

\textsuperscript{1}Johns Hopkins School of Medicine, Baltimore, MD, \textsuperscript{2}Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, \textsuperscript{3}Johns Hopkins Transverse Myelitis & Multiple Sclerosis

Figure 1: Summary of the Normal Control (NC) and Normal pressure hydrocephalus (NPH) cere stiffnesses. Significant increased stiffness was noted in the cerebral, occipital and parietal region in NPH group compared with age and sex matched NC group.
Centers, Baltimore, MD, 4Johns Hopkins Hospital, Baltimore, MD, 5Johns Hopkins University, Baltimore, MD

Purpose
Neuromyelitis optica (NMO) is an autoimmune disorder of the central nervous system that presents with acute transverse myelitis (TM) and/or optic neuritis (ON). Recently it has been associated with antibodies to aquaporin 4 (AQP4). Aquaporin 4 protein is highly concentrated in astrocytic end-feet at blood-brain barrier. Brain findings are described in approximately 60% of patients with NMO but not those with multiple sclerosis. The purpose of this study is to investigate if contrast enhancement (CE) on brain MRI is more likely to occur during acute attack (AA) and if CE is correlated with clinical disease severity.

Materials and Methods
A retrospective study was designed including patients diagnosed with NMO or NMO spectrum disorders. Brain MRIs were evaluated by a neuroradiologist and a radiologist in consensus. Epidemiological data, attack status, NMO IgG status, CE presence, diffusion-weighted imaging results, disease duration and relapse rates (RR) were noted. Fisher's exact and Mann-Whitney tests were used for statistical analysis.

Results
Seventy-seven patients (11 male, 66 female) were included in the study. The mean age at last follow-up brain MRI was 47.6 years (range 6-91 years). There were 47 African-American, 24 Caucasian and six Hispanic patients. Sixty-six patients were NMO IgG positive, nine were negative and two were not tested. Fifty-nine were scanned during AA. Twenty-one of 59 patients (35.6%) showed CE during AA and 5/18 (27.8%) showed CE during nonacute phase (p=0.78). Acute attack patients with CE were more likely to have shorter disease duration (p=0.05), higher RR (PE: p=0.03, Total CE: p=0.02), and increased diffusion (p=0.05).

Conclusions
Our results suggest that brain contrast enhancement may be seen during both AA and non-AA of NMO. Contrast enhancement during AA correlates with the clinical disease severity.

O-445
5:56PM - 6:04PM

Ipiilimumab-induced hypophysitis: Predictive findings on surveillance FDG PET/CT

J Guerin1, C Hunt1, R Witte1
1Mayo Clinic, Rochester, MN

Purpose
Patients treated with ipilimumab for metastatic melanoma are at risk for hypophysitis. The purpose of this study is to describe the metabolic activity of the pituitary gland in patients with ipilimumab-induced hypophysitis and how significant changes in FDG uptake in the pituitary gland on surveillance PET/CT can suggest this diagnosis and allow imaging follow up for monitoring resolution.

Materials and Methods
We retrospectively identified six metastatic melanoma patients treated with ipilimumab with ipilimumab-induced hypophysitis (1 female, 5 males: 65.3±10.5 years) who were diagnosed by MRI. The diagnosis was confirmed by cessation of ipilimumab and subsequent resolution of the
findings of hypophysitis on follow-up MRI. All six patients had whole body FDG PET/CT for surveillance of their metastatic melanoma prior to initiation of ipilimumab, within 3 weeks of the MRI where the diagnosis of hypophysitis was made, and on follow up after the resolution of the MRI findings (5 of 6 patients with followup PET/CT). Metabolism within the pituitary was measured via maximum standardized uptake value (SUVmax).

Results
There was a significant increase in the degree of metabolic activity in the pituitary gland in all patients with ipilimumab-induced hypophysitis compared to their baseline pituitary metabolic activity both qualitatively (Figure 1) and quantitatively (SUVmax: pre-ipilimumab, 3.15+/−1.0; with hypophysitis, 7.4+/−3.4, p<0.013). After cessation of ipilimumab, the metabolic activity of the pituitary gland returned to normal in all of the patients with follow-up PET/CT without significant difference compared to baseline (mean difference in SUVmax=0.18, p=0.78).

Conclusions
An increase in pituitary metabolic activity on surveillance PET/CT is highly suspicious for ipilimumab-induced hypophysitis, especially in patients with the recent initiation of therapy. Further imaging with MRI is warranted to confirm this reversible diagnosis. Long term follow-up monitoring for resolution can be performed with regularly scheduled surveillance PET/CTs.
Signal Intensity of the Globus Pallidus and Dentate Nucleus on Non-contrast T1-weighted Images in Multiple Sclerosis: Correlation with Cumulative Gadolinium Contrast Administration and Clinical Course of Multiple Sclerosis.

S Metting¹, B Bigjahan¹, L Amezcua¹, S Cen¹, M Shiroishi¹, O Boyko¹, A Lerner¹

¹USC Keck School of Medicine, Univ of So CA, Los Angeles, CA

Purpose
High signal intensity (SI) on T1-weighted (T1W) imaging has been described in the dentate nuclei in association with radiation therapy (1) and multiple sclerosis (MS) (2). Kanda et al. reported a positive correlation between prior gadolinium (Gd) administrations and increased noncontrast T1W SI of the globus pallidus (GP) and dentate nucleus (DN) (3). Errante et al. reported a similar correlation of Gd exposure and T1W SI in DN of MS and brain metastasis patients (4). However, clinical parameters of MS, and GP SI were not investigated. We sought to confirm that high DN SI is associated with cumulative Gd dose received by MS patients, rather than with MS type, disease duration or disability status. GP SI also was investigated.

Materials and Methods
A retrospective analysis of MS brain MRI studies was performed. Studies performed on the 3T GE MRI unit at our institution from May to October 2014 were identified, and clinical and radiologic records confirmed the diagnosis of MS. Patients who had received >=3 or <=1 prior Gd administrations were analyzed. Only the first and last scan were recorded in patients with >1 GE scan in each category. Regions of interest (ROIs) were placed to obtain SI ratios for DN:pons and GP:thalamus. Ratios also were created with bilateral measurement averages. Spearman correlation of ratios to number of Gd administrations and clinical factors was performed. The linear trajectory of SI ratio was assessed using a random effect model (REM). The difference in trajectory slopes between levels of Gd exposure was compared using the interaction term in the REM. Signal intensity ratio differences between first and second scans was examined using Wilcoxon signed rank test.

Results
Thirty-two MS patients were included in the study. At the first scan, patients are 45.9±10.9 years old with 4.2±3.7 Gd administrations. At the second scan, patients are 50.5±9.1 years old with 7.8±3.7 Gd administrations. Spearman correlation showed no significant correlation between number of Gd administrations and SI ratios for DN:pons (r=0.19, p=0.31) and GP:thalamus (r=0.26, p=0.16). The median of changes from the first scan to the second scan in SI ratios for GP:thalamus and DN:pons are 0.014 (Q1: 0.007, Q3: 0.032) p=0.06, and -0.008 (Q1: -0.045, Q3: 0.007) p=0.84, respectively. The mean increase of Gd exposure from the first to the second scan is 4.7±3.1. There is no statistically significant difference in trajectory slopes of SI ratio between patients with ≥6 versus <6 Gd administrations.

Conclusions
Previously reported GP and DN hyperintensity may reflect Gd deposition or other tissue changes due to repeated Gd-enhanced MRI evaluation of MS. Our study showed a potential new association of high GP SI and Gd administrations in MS patients. However, no significant
correlation of DN SI and Gd administrations was identified. The increased use of the newer high relaxivity Gd agents at our institution may play a role, with possible different effects on the DN and GP. Lastly, variation in imaging techniques and equipment may partly account for the differences.

O-447

Observations of Compartmentalization of Gadolinium on Delayed Brain Imaging

O boyko\textsuperscript{1}, M Shiroishi\textsuperscript{2}, V waluch\textsuperscript{1}, A Lerner\textsuperscript{3}, C Zee\textsuperscript{1}, P Kim\textsuperscript{4}, J Go\textsuperscript{5}, M Law\textsuperscript{6}

\textsuperscript{1}University of Southern California, Los Angeles, CA, \textsuperscript{2}USC Keck School of Medicine, Univ of So CA, Los Angeles, CA, \textsuperscript{3}USC Keck School of Medicine, Los Angeles, CA, \textsuperscript{4}University of Southern California, Los Angeles, CA, \textsuperscript{5}LAC/USC Medical Center, Los Angeles, CA, \textsuperscript{6}University of Southern California, Keck School of Medicine, Los Angeles, CA

Purpose
Observations of compartmentalization of gadolinium on delayed brain imaging.

Materials and Methods
With recent publications on observations of possible gadolinium deposition in the brain, we looked for possible recirculation potential of gadolinium by reviewing 30 patients who had
delayed imaging after completion of routine postgadolinium sequence. Short term (less than 1 hour) delayed imaging was either to repeat T1 and/or FLAIR localized images for MR spectroscopy acquisition and long term (greater than 6 hours). Delayed time ranged from 12 minutes over 48 hours.

Results
As expected 22 or 25 cases where imaging was acquired within 1 hour of contrast administration demonstrated continued enhancement of lesions including tumor and inflammatory lesions and posttraumatic subdural collections. Unexpectedly five patients imaged 6 or more hours postcontrast administration demonstrated delayed gadolinium enhancement and persisting enhancement without complete washout. This included inflammatory lesions (neurocysticercosis), subarachnoid hemorrhage, tumor and pineal cyst.

Conclusions
Compartimentalization of gadolinium on delayed brain imaging due to presumed local concentration gradients can occur, creating the possibility of gadolinium "retention" in lesions. A possible clinical neuroimaging pitfall of delayed/continued enhancement can occur which is not to be mistaken for blood products and hemorrhage.

O-448

6:20PM - 6:28PM

Superselective delivery of chemotherapy through the ophthalmic artery: Interobserver diagnostic for retinal circulation.

W Escobar¹, C Alarcon², A Castro³, A Pedroza⁴

¹Imbanaco Medical Center, Cali, Valle, ²Centro Médico Imbanaco, Cali, Valle, ³Clinica Oftalmologica de Cali, Cali, Valle, ⁴Imbanaco Medical Center, Cali, Valle

Purpose
To review results of retinal flurescein angiography performed after intra-arterial chemotherapy (chemosurgery) for treatment of retinoblastoma to assess the association of angiographic findings in retinal circulation with tumor response and vascular complications.

Materials and Methods
Retrospective study.

Results
Ten catheterizations of ophthalmic artery were performed with 5 mgs melphalan application for 30 minutes. All patients had MRI studies with contrast, clinical assessment and evaluation fundus retinal Retcam with module pre- and post-treatment of selective intra-arterial chemotherapy ophthalmic artery with melphalan. All patients received melphalan 5 mgs. The intra-arterial chemotherapy (chemosurgery) was performed as primary treatment in two eyes and secondary treatment (after systemic chemotherapy) in eight eyes. None of the patients received external radiotherapy before intra-arterial chemotherapy (chemosurgery). At the moment of the retinal flurescein angiography (FA) showed good choroidal circulation and only viasualize findings of hyperfluorescence in areas of active tumor. After treatment all patients showed hypofluorescence had decreased the area of the tumor, no ophthalmic artery obstruction was found. But sectorial choroidal abnormalities in six eyes was found.

Conclusions
Fluorescein angiography could evaluate superselective delivery of chemotherapy through the
ophthalmic artery and suggests that vascular perfusion to the retina and the choroid can be compromised after intra-arterial chemotherapy (chemosurgery) for retinoblastoma. The most common vascular abnormality was choroidal sector nonperfusion.

Thursday
7:30AM - 8:30AM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

20A - SAM SESSION: SPINE CASE BASED (AR) (SAM)
20A-1

Brain and Neck Angiography

Santos, M.
The Ottawa Hospital
Ottawa, Ontario

20A-2

Diagnostic Spine: Myelography

Kranz, P.
Duke University Medical Center
Durham, NC

20A-3

Diagnostic Spine: MRI

Torres, C.
Montreal General Hospital, McGill University Health Centre
Montreal, Quebec

Thursday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

21A - SNIS: SOCIOECONOMIS IN NEURO-INTERVENTIONAL SURGERY
21A-1

Accountable Care Organizations: What the Neuro-Interventionalist Should Know
Nicola, G.
Hackensack Radiology Group
River Edge, NJ

21A-2

Quality and Patient Outcomes in Neuro-Interventional Surgery

Meyers, P.
Columbia University
New York, NY

21A-3

The International Subarachnoid Hemorrhage Trial (ISAT): Long-Term Follow-up and Its Effects on Practice Patterns in the UK

Molyneux, A.
John Radcliffe Hospital
Headley, Oxford

21A-4

Neuro-Interventional Surgery in the Era of ICD-10

Barr, J.
California Center for Neurointerventional Surgery
La Jolla, CA

Thursday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)

21B - ASSR: THE WORLD OF SPINE INTERVENTION

21B-1

Spine Injections: To Stick or Not to Stick?

Shah, L.
University of Utah
Salt Lake City, UT
21B-2

Vertebroplasties and Kyphoplasty: Where are the Benefits?

Lekht, I.
Keck Hospital of USC
Los Angeles, CA

21B-3

The Role the Spinal Interventionalist Plays in Oncology

Lawler, G.
Neuroimaging and Interventional Spine Services
Danbury, CT

21B-4

The RUC: Pain Management and Government Intervention

Nicola, G.
Hackensack Radiology Group
River Edge, NJ

21B-5

If You Built It, They Will Come: Growing an Outpatient Spine Intervention Service Line

Muller, C.
Fairfax Radiological Consultants, P.C.
Oakton, VA

21B-6


Jarvik, J.
Univ of Washington
Seattle, WA
Thursday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)

21C - ASFNR: ADVANCED TUMOR IMAGING

21C-1
MR Spectroscopy: Beyond the Routine Metabolites
Young, R.
Memorial Sloan-Kettering Cancer Center
New York, NY

21C-2
MR Spine Perfusion: Detection of Treatment Response and Tumor Progression
Karimi, S.
Memorial Sloan Kettering Cancer Center
New York, NY

21C-3
PET of Brain Tumors: Beyond FDG
Weber, W.
Memorial Sloan Kettering Cancer Center
New York, NY

21C-4
Hyperpolarized MR: Imaging Metabolism in Real Time
Wilson, D.
University of California, San Francisco
San Francisco, CA

Thursday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)
21D - NEURO-NUCLEAR IMMERSION: THE MERGING OF ANATOMIC AND FUNCTIONAL IMAGING: ONCOLOGIC IMAGING PART I: IMAGING OF EPILEPSY

21D-1

Imaging in Epilepsy

Zeineh, M.
Stanford University
Stanford, CA

21D-2

Dementia: Amyloid, Tau and FDG-PET Imaging

Nasrallah, I.
Hospital of University of Pennsylvania
Philadelphia, PA

21D-3

Dementia: MR Imaging and Voxel Based Morphometry

Chiang, G.
Weill Cornell Medical College
New York, NY

21D-4

Dopaminergic Imaging in Differential Diagnosis of Atypical Tremor and Parkinsonism

Frey, K.
University of Michigan
Ann Arbor, MI

21D-5

Questions & Answers
Thursday
8:30AM - 10:00AM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

**21E - EVIDENCE BASED MEDICINE: PATIENT CENTERED OUTCOMES IN NEURORADIOLOGY: WHAT IS IT, WHY WE CARE, AND HOW TO GET INVOLVED?**

**21E-1**

What is the Difference Between PCOR and Traditional Research?

Sanelli, P.
North Shore - LIJ Health System
Manhasset, NY

**21E-2**

How Neuroradiologists Can Get Involved?

Jarvik, J.
Univ of Washington
Seattle, WA

**21E-3**

How Do We Incorporate Health IT into PCOR

Luetmer, P.
Mayo Clinic
Rochester, MN

**21E-4**

How to Make Radiology Results Minable?

Anzai, Y.
University of Utah
Salt Lake City, UT

L Stromberg¹, K Xu¹, D Rusinak¹, S Futterer¹, S Giri¹, J Carr¹, R Edelman², I Koktzoglou², J Collins¹
¹Radiology, Northwestern University, Chicago, IL, United States, ²Radiology, NorthShore University HealthSystem, Evanston, IL, United States

Purpose
First-pass gadolinium contrast-enhanced magnetic resonance angiography (CEMRA) is used in the evaluation of carotid artery stenosis in cerebrovascular disease. However, some patients cannot undergo CEMRA. Hybridized arterial spin labeling (hASL), combining pseudocontinuous and pulsed labeling of arterial spins, has been developed recently for nonenhanced imaging of the extracranial carotid arteries. The purpose of this study was to assess the utility of hASL MRA to diagnose carotid artery stenosis in patients with suspected cerebral infarct.

Materials and Methods
Twenty-four patients receiving clinically indicated MRA examinations of the neck had imaging at 1.5T (MAGNETOM Aera, Siemens AG, Healthcare Sector, Erlangen, Germany) or 3T (MAGNETOM Skyra, Siemens AG). Patients were recruited prospectively under an IRB-approved protocol. Patients had the prototype noncontrast hASL MRA protocol and CEMRA of the carotid arteries. Hybridized ASL MRA was used using an undersampled 3D radial balanced steady-state free precession imaging readout with the following parameters: spatial resolution: 1.0 mm isotropic, receiver bandwidth: 558Hz/pixel, flip angle: 90°, acquisition time: 4 minutes. Contrast-enhanced MRA was performed with injection of Gadavist (0.1 ml/kg, injection rate 2 cc/sec) with the following parameters: spatial resolution: 0.9 x 0.9 x 0.95 mm³, sequence: spoiled gradient echo, bandwidth: 488Hz, flip angle: 25°, slice thickness: 0.95mm, acquisition time: 18 seconds. Exams were reviewed in separate sessions by a neuroradiologist and scored on the basis of 4 criteria. Quality was scored from 1-4 for lumen delineation, intravascular signal...
homogeneity, venous signal/artifact, and diagnostic confidence, where four was excellent quality in all categories except venous signal/artifact, where one was excellent quality. The degree of stenosis at the left and right common carotid artery, carotid bulb, and proximal internal carotid artery was categorized using quartiles. Rating data were aggregated and differences between hASL MRA and CEMRA were assessed using the Student's t-test. Sensitivity and specificity of hASL in detecting stenosis at the common carotid artery, carotid bulb, and proximal internal carotid artery, defined as a stenosis score greater than one, was determined using CEMRA as the reference exam. If stenosis was not detected on CEMRA, sensitivity was not reported.

Results
Hybridized ASL MRA was performed successfully in all 24 patients. The quality of vascular lumen delineation, venous signal/artifact, and diagnostic confidence, were similar between hASL MRA and CEMRA, whereas intravascular signal homogeneity was superior with CEMRA than with hASL MRA (3.88 versus 3.46, p < 0.01). No stenosis was encountered in any patient at the common carotid on CEMRA or hASL MRA. Sensitivity at the proximal internal carotid was 100% for one patient. Sensitivity at the carotid bulb was 100% for one patient. Specificity was 100% at all three locations.

Conclusions
Hybridized ASL MRA is a promising noncontrast angiographic technique to rule out carotid artery stenosis, particularly in patients with reduced renal function.
Figure 1 (right): A. MIPs of the carotid arteries from a single patient obtained using hASL MRA (left) and gadolinium CEMRA (right) showing normal vasculature.

Figure 2 (bottom): Average quality rating scores for hASL and gadolinium CEMRA.
Vitamin D and Vulnerable Carotid Plaque

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Purpose
Magnetic resonance imaging (MRI)-detected intraplaque hemorrhage (IPH) is associated with acute ipsilateral stroke and elevated recurrent stroke risk despite standard medical therapy (1, 2). Recent research points to the importance of the angiotensin pathway in the development of IPH. In a mouse model of atherosclerosis, Apo E⁻/⁻ mice treated with angiotensin II develop IPH.3 Vitamin D is an endogenous inhibitor of the angiotensin system through its action on the vitamin D receptor (VDR). With this in mind, we hypothesized that 1) vitamin D levels may be lower in patients with IPH and 2) VDR may be expressed in carotid plaques, thereby representing a potential treatment target.

Materials and Methods
In this IRB-approved prospective cross-sectional study, 27 patients, with known carotid disease were recruited for carotid MRI and vitamin D analysis. Demographics were recorded, including race (white, 27/27), male (21/27), age (mean=74 years, S.D.=9.5, range 46, 88), current smoking (4/27), prior smoking (19/27), hypertension (27/27), diabetes (13/27), hyperlipidemia (25/27), and medications including antiplatelet agents (25/27), anticoagulation (6/27), antihypertensives (24/27) and statins (25/27). Recent stroke also was recorded (10/27). Linear regression was used to determine significant differences in vitamin D levels between patients with or without IPH after adjusting for age. Intraplaque hemorrhage was detected with the Magnetization Prepared Rapid Acquisition Gradient-recalled Echo (MPRAGE) sequence. Vitamin D receptor expression was detected by immunohistochemistry of carotid endarterectomy specimens from 10 patients who underwent surgery.

Results
Vitamin D levels in all patients were: mean=32.9 ng/ml (S.D.=13.3, range 12.4, 66.5). Vitamin D insufficiency (defined as <30 ng/ml) was common in our population (11/27, 40.7%), similar to the general U.S. population. Vitamin D levels were significantly lower in patients with IPH compared to those without IPH: 26.7 versus 37.8, p=.029. After adjusting for age, IPH+ patients had lower vitamin D levels versus IPH patients (12.5 ng/ml lower, 95%CI 22.4, 2.6, p=.037). Vitamin D receptor was expressed in human carotid plaque and is highest near the adventitia and fibrous cap.

Conclusions
Vitamin D insufficiency is common in patients with carotid disease, similar to the U.S. as a whole. However, vitamin D levels are significantly lower in patients with IPH than in those without. Given the expression of VDR within carotid plaque, lower levels of vitamin D may allow disinhibition of the angiotensin pathway leading to IPH. Though this work should be replicated in larger samples, it is intriguing since, as an angiotensin system antagonist, vitamin D
could represent a potential carotid disease treatment target to help prevent future stroke in those with vulnerable carotid plaque.

\[
\text{IPH+, vitamin D = 20.9 ng/ml}
\]

O-451

The Effect of Sex and Age on Intraplaque Hemorrhage Prevalence in Low-Grade Carotid Stenosis

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\textit{University of Toronto, Toronto, ON}

Purpose

Strokes occur more frequently in males at a younger age; however, with increasing age the difference is eliminated (1). Carotid intraplaque hemorrhage (IPH), a component of unstable atherosclerosis, is an emerging predictive marker of stroke (2-3). Intraplaque hemorrhage may be depicted by 3D carotid MRI and age-specific differences in stroke may be related to IPH. We therefore investigated whether age-specific differences in IPH exist by evaluating two separate cohorts with low grade carotid stenosis from a 10-year 3D carotid MRI experience.

Materials and Methods

Carotid arteries (n=4060) of 2030 patients that underwent neurovascular MRI including 3D carotid evaluation between 2003 and 2014 from our academic tertiary care center were available. Study inclusion criteria were carotid stenosis less than 50% without any history of carotid intervention. Carotid arteries (n=143) were excluded due to unavailable clinical records or imaging evaluation. Patients from two cohorts routinely undergo 3D carotid MRI at our institution: i) Suspected neurovascular disease (sNVD) patients, and ii) Established peripheral vascular disease (ePVD) patients. 3D carotid MRI includes an inversion recovery fat suppressed
gradient echo black blood sequence (3D MRIPH) that has been optimized and validated for the detection of IPH. Chiefly descriptive statistics were used to evaluate age-specific sex differences in IPH.

Results
Of the available carotid arteries, 78.5% (n=3124/3977) met inclusion criteria. Intraplaque hemorrhage was identified in 6.7% (209/3124) of carotids. The ePVD and sNVD cohorts had a carotid IPH prevalence of 10.3% (117/1136) and 4.6% (92/1988), respectively. Sex differences in age-specific carotid IPH prevalence were found in both cohorts. The carotid IPH prevalence in males versus females in the NVD cohort in each age group was: 55-65 years (5.9 versus 0%), 65-75 years (7.9 versus 1.0%), >75 years (11.4 versus 5.4%). Similarly, the PVD cohort had a higher carotid IPH prevalence in males versus females in each age group: 55-65 years (12.8 versus 5.0%), 65-75 years (15.0 versus 7.1%), >75 years (19.9 versus 8.3%). Pooled carotid IPH prevalence for males versus females in each age group was: 55-65 (8.3 versus 1.7%), 65-75 (10.7 versus 3.3%), and >75 (15% versus 6.5%) (Figure 1).

Conclusions
Male carotids have a greater age-specific prevalence of IPH as demonstrated in two separate cohorts with low grade stenosis (<50%). Onset of IPH in women may be delayed. Studies examining sex differences in age-specific IPH, their etiology, and relationship to the stroke age-specific sex differences may be warranted.
Persistent Intraplaque Hemorrhage is Associated with the Progression of Preexisting Low and Moderate Grade Carotid Stenosis: Results of a 10-Year 3D Carotid MRI Clinical Experience

N Singh, A Moody

University of Toronto, Toronto, ON
Purpose
Carotid intraplaque hemorrhage (IPH), a component of complicated atherosclerosis, is an emerging predictive marker of stroke (1). Patient guidelines use the degree of carotid stenosis to suggest follow up; however, IPH also has been reported in low grade stenosis (2). Whether patients with IPH may benefit from follow up remains unclear. We therefore investigated whether the progression of carotid stenosis grade (<50, 50-70, 70-99, 100%) occurs in persistent IPH patients with low grade (<50%) and moderate grade (50-70%) stenosis using a 10-year clinical 3D carotid MRI experience.

Materials and Methods
Carotid arteries (n=4060) of 2030 patients that underwent neurovascular MRI including 3D carotid evaluation between 2003 and 2014 were available. Carotids (n=442) that had two clinical MRI scans, ≤ 70% stenosis at baseline, and no history of ipsilateral endarterectomy were included. Patients routinely undergo 3D carotid MRI at our institution including an inversion recovery fat suppressed gradient echo black blood sequence (3D MRIPH) that has been optimized and validated for the detection of IPH. Carotid stenosis grade was obtained from the clinical reports of experienced academic tertiary care center neuroradiologists with experience in IPH imaging. Multivariable regression was used to determine whether persistent IPH is associated with the progression of carotid stenosis grade.

Results
Of the 442 carotids included, progression of stenosis grade in carotids with and without persistent IPH was found in 29.6% (8/27) and 3.6% (15/415), respectively (P<0.001) (See Table 1). Persistent IPH was associated with progression to the next stenosis grade in carotids with both pre-existing low grade and moderate grade stenosis. In carotids with pre-existing low grade stenosis, progression was found in 23.1% (3/13) versus 2.3% (9/383) in carotids with and without persistent IPH. In carotids with pre-existing moderate grade stenosis, progression was found in 35.7% (5/14) versus 18.8% (6/32) in carotids with and without persistent IPH. Multivariable regression including age, sex, hypertension, and smoking, confirmed that carotids with persistent IPH had a greater odds of progression in stenosis grade compared to those without persistent IPH (OR=6.35, 95% CI=2.18 to 18.50, p<0.001) (See Table 2).

Conclusions
Carotid arteries with IPH persisting on serial imaging at ~18 months have a greater odds of progression of carotid stenosis grade. Patients with persistent IPH may require closer clinical follow up and patients with IPH identified in low or moderate grade stenosis may benefit from serial imaging.
**Table 1:** Differences in Baseline Demographics and Outcomes between Carotid Persistent Intraplaque Hemorrhage

<table>
<thead>
<tr>
<th></th>
<th>Persistent Intraplaque Hemorrhage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No (n=415)</td>
</tr>
<tr>
<td>Age, mean +/- SD</td>
<td>69 +/- 14</td>
</tr>
<tr>
<td>Male Sex, n (%)</td>
<td>220 (53.0)</td>
</tr>
<tr>
<td><strong>History, n (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>275 (66.3)</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>272 (65.5)</td>
</tr>
<tr>
<td>Smoking</td>
<td>140 (33.7)</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td></td>
</tr>
<tr>
<td>Scan Interval, mean days +/- SD</td>
<td>549 +/- 571</td>
</tr>
<tr>
<td>Progression of Carotid Stenosis Grade, n (%)</td>
<td>15 (3.6)</td>
</tr>
</tbody>
</table>

NS = not significant

(Filename: TCT_O-452_Table1.jpg)

**Table 2:** Multivariable Regression Analyses—Persistent IPH Increases the Odds of among Patients with Preexisting Low and Moderate Grade Stenosis

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>95%CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.03</td>
<td>0.99 to 1.08</td>
<td>0.164</td>
</tr>
<tr>
<td>Sex</td>
<td>1.17</td>
<td>0.43 to 3.16</td>
<td>0.758</td>
</tr>
<tr>
<td>Hypertension</td>
<td>2.80</td>
<td>0.61 to 12.83</td>
<td>0.184</td>
</tr>
<tr>
<td>Smoking</td>
<td>1.59</td>
<td>0.65 to 3.91</td>
<td>0.313</td>
</tr>
<tr>
<td>Persistent IPH</td>
<td>6.35</td>
<td>2.18 to 18.50</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

(Filename: TCT_O-452_Table2.jpg)
Quantitative Evaluation of Vessel Wall Volume and Intraplaque Hemorrhage by 3D Carotid MRI

N Singh¹, A Moody¹, T Maraj¹, T Marvasti¹, P Tyrrell¹, M Afshin¹, A Zavodni¹
¹University of Toronto, Toronto, ON

Purpose
Magnetic resonance imaging (MRI) depicted carotid intraplaque hemorrhage (IPH) and vessel wall (VW) volumes are emerging markers of plaque instability and progression, respectively. 3D carotid MRI at 3T may allow for evaluation of IPH and VW volumes, but little is known about measurement reproducibility. This study investigated the reliability of volume quantification on 3D carotid MRI, and assessed agreement with 2D carotid MRI.

Materials and Methods
Twenty-two consecutive patients were recruited from an ongoing multicenter 3T serial MRI trial. Carotid VW volumes ranged from 746 to 2444 mm³. 3D to 2D MRI coregistered axial images were created for each carotid among 10 patients (n=320 comparisons) to assess inter- and intrarater reliability, as well as compare measurements between 3D and 2D carotid MRI. 3D carotid MRI scan-rescan axial images (n=160 comparisons) from 6 additional patients were used to assess scan-rescan reliability. Intra-class correlation coefficients (ICC) and Bland and Altman plots were used to evaluate VW and IPH volumes measurement reliability and agreement.

Results
3D carotid MRI had excellent reliability for the quantitative evaluation of volumes of IPH (ICCintra=.998, ICCinter=.996, ICCscan-rescan=.949) and VW (ICCintra=.951, ICCinter=.976, ICCscan-rescan=.928). 3D carotid MRI systematically overestimated VW volume compared to 2D carotid MRI (mean bias, 235±188 mm³, p < 0.01), however, both methods had excellent relative agreement (ICC3D-2D=0.873, 95% CI 0.796 to 0.922, p<0.01).

Conclusions
In vivo quantitative evaluation of IPH and VW by 3D carotid MRI at 3T is highly reliable and has excellent relative agreement with 2D carotid MRI. 3D carotid MRI may provide the opportunity to improve cardiovascular risk stratification by quantifying plaque progression and burden of unstable plaque.
**Figure 1:** 3D MRIPH Depicts Intraplaque Hemorrhage. Intraplaque hemorrhage (arrowheads) is indicated by high signal intensity in the vessel wall, as shown on the coronal 3D MRIPH (a) and the corresponding magnified sagittal-oblique reformat (b). 3D MRR for coverage of the entire neck and allows for vessel wall visualization. The 3D TOF (c) delineates the lumen.
Figure 2: Bland and Altman Plots of 3D and 2D Carotid MRI Depicting the Relative Agreement for the Quantitative Evaluative Vessel Wall Volumes.
2D versus 3D Techniques for Vessel Wall Imaging Evaluation of Vasculitis in the Cervical Arteries

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¹University of Washington, Seattle, WA, ²University of Washington, Seattle, WA

Purpose
MR vessel wall imaging (VWI) can improve evaluation of vasculitis, and multiple techniques have been developed to acquire black blood images. This study compares 2D and 3D VWI pulse sequences in patients with clinically suspected vasculitis.

Materials and Methods
Cervical VWI images were acquired on a Phillips Ingenia 3T MR scanner. Cardiac-gated 3D T1 VISTA and 2D double inversion recovery T1 pre and postcontrast sequences of the cervical arteries performed in patients with clinically suspected large vessel vasculitis were compared. Signal to noise ratio (SNR) was calculated for vessel lumen, vessel wall, and paraspinal muscle for a soft tissue control. Contrast to noise ratio (CNR) was calculated for the vessel wall. Three measurements were taken from each imaging sequence examined for each SNR and CNR evaluation. Blinded review was performed by two experienced diagnostic neuroradiologists. The number of branch arteries visualized was recorded. A four-point Liekert scale was utilized to evaluate the quality of blood signal suppression, image quality, and diagnostic confidence. Two-tailed t-tests were performed to compare differences between 2D and 3D pulse sequences.

Results
Images were reviewed for a total of 10 patients. Signal-to-noise ratio and CNR results were better with 2D imaging. More branches were visualized and could be evaluated with 3D techniques, while blood suppression and image quality ratings were higher for 2D techniques.

<table>
<thead>
<tr>
<th>Table 1: Reliability of 3D and 2D Carotid MRI at 3T for the Quantitative Evaluation of Vessel Wall and Intraplaque Hemorrhage.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICC (95% CI)</td>
</tr>
<tr>
<td>3D Carotid MRI</td>
</tr>
<tr>
<td>Lumen</td>
</tr>
<tr>
<td>Outer Wall</td>
</tr>
<tr>
<td>Vessel Wall</td>
</tr>
<tr>
<td>Intraplaque Hemorrhage</td>
</tr>
<tr>
<td>2D Carotid MRI</td>
</tr>
<tr>
<td>Lumen</td>
</tr>
<tr>
<td>Outer Wall</td>
</tr>
<tr>
<td>Vessel Wall</td>
</tr>
</tbody>
</table>
There was no significant difference in diagnostic confidence scores between sequence types. Results are summarized in the Table.

Conclusions
Blinded examiners rated image quality and blood suppression higher for 2D sequences, and 2D also demonstrated increased SNR and CNR; however, there was no significant difference in diagnostic confidence. Overall, 2D techniques provide more favorable images as indicated by radiologists, but tailoring studies to anatomy imaged should be considered.

<table>
<thead>
<tr>
<th>SNR/CNR</th>
<th>2D</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminal SNR</td>
<td>137</td>
<td></td>
</tr>
<tr>
<td>Vessel Wall SNR</td>
<td>1549</td>
<td>3</td>
</tr>
<tr>
<td>Vessel Wall CNR</td>
<td>1412</td>
<td>3</td>
</tr>
<tr>
<td>Soft Tissue SNR</td>
<td>886</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reviewer Scoring</th>
<th>2D</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Branches Seen</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>Mean Suppression Rating</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Mean Image Quality Rating</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>Mean Diagnostic Confidence Score</td>
<td>3.3</td>
<td></td>
</tr>
</tbody>
</table>

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O-455
Is CTA plaque component thickness measured on an axial slice representative of the entire plaque: evaluation in TIA patients with moderate stenosis.

C Lum¹, S Duan², J Perry¹, T Al Mansoori³, R Thornhill⁴
Purpose
Recent studies have suggested carotid soft-plaque thickness measured on a single axial CTA slice in patients with moderate stenosis is related to symptomatic stroke or TIA (1). However, this technique may be influenced by factors such as an oblique orientation of plaque relative to the imaging plane and variability in interpretation of caliper placement. Thus, measurement of plaque composition in a single axial slice may not be representative of the entire composition of the plaque volume. CT angiography plaque segmentation techniques now are readily available via thin-client software and recently have been used to categorize carotid plaque volumetrically into lipid, fibrous and calcific components. Soft plaques are considered more vulnerable than calcified plaques and may be a target for revascularization techniques. The purpose of our study was to investigate plaque composition using CTA segmentation in a large, prospective cohort of symptomatic patients with moderate 50-69% stenosis patients presenting with TIA.

Materials and Methods
Between Nov 2006-Aug 2011, 2612 prospectively enrolled, consecutive patients with TIA or minor stroke assessed in the emergency department at two large tertiary care hospitals were evaluated in a specialized stroke clinic. Computed tomography angiography (CTA) images demonstrating moderate stenosis by NASCET criteria were identified prospectively. The maximal thickness of soft and calcified plaque on an axial slice representing the maximal degree of narrowing by NASCET criteria was measured by a neuroradiologist. A second radiologist experienced in neurovascular imaging, blinded to clinical outcome and axial plaque measurement, segmented the carotid plaque in a semi-automated fashion. The volume and percentage composition of plaques was calculated using the following HU thresholds: lipid<60, fibrous<130, calcium>130. The proportion of soft plaque (lipid+fibrous) was compared to calcified plaque using a t-test. We evaluated the correlation between maximal soft plaque thickness and soft plaque volume(r=0.49, p=0.0055) and calcified plaque thickness with calcified volume(r=0.59, p=0.0006).

Results
There were 31 patients with TIA and moderate stenosis. Forty-two percent were females and 42% of patients presented with left hemisphere symptoms. The proportion of soft to hard plaque was 61% versus 39% (p= 0.0021). There was fair correlation between maximal soft plaque thickness and soft plaque volume(r=0.49, p=0.0055) and calcified plaque thickness with calcified volume(r=0.59, p=0.0006).

Conclusions
Symptomatic TIA patients with moderate stenosis on CTA have significantly greater volume of soft plaque compared to hard plaque measured with CT segmentation. Soft and hard plaque thickness measurement is only moderately correlated with overall soft and hard plaque volume. This may inform future studies assessing potential imaging biomarker predictors of symptomatic moderate degree carotid stenosis.
Evaluation of recurrent transient ischemic events with morphological assessment of carotid plaque on CT angiography

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¹The Ottawa hospital, University of Ottawa, Ottawa, Ontario

Purpose
Patients with transient ischemic or stroke are at risk for recurrent events. Revascularization is recommended to reduce future stroke in patients with >70% stenosis. The optimal management of patients with mild to moderate stenosis is less clearly defined. Computed tomography angiography (CTA) segmentation is readily available with thin-client software and can be performed on stenotic areas classifying plaque into lipid, fibrous and calcified components. Identifying which TIA patients are most at risk of future stroke or TIA would be useful. We aim to compare the CTA plaque segmentation characteristics in a cohort of prospectively identified TIA patients with recurrent neurological symptoms and mild to moderate stenosis.

Materials and Methods
Between Nov 2006-Aug 2011, 2612 prospectively enrolled, consecutive patients with TIA or minor stroke assessed in the ER and followed up in a specialty stroke clinic were identified. Computed tomography angiography segmentation was performed in order to classify plaque into lipid, fibrous, and calcium. A T-Test was performed to identify possible predictors of recurrent TIA. A p-value of < 0.05 was considered statistically significant.

Results
There were 73 patients with mild to moderate stenosis on CTA (41 patients had mild < 50% and 32 patients had moderate 50-70% carotid stenosis). Of these, nine patients had recurrent
TIA/stroke within 90 days. There were eight patients with recurrent TIA and one with recurrent stroke. The mean age of patients in the asymptomatic group compared to symptomatic was 69 versus 71 years. The mean plaque volume in the asymptomatic was 1.01 versus 0.89. The mean percentage for lipid, fibrous and calcifications in the no recurrent TIA/stroke group compared to the recurrent TIA or stroke group was 27% versus 22% \( p = 0.2014 \), 32% versus 33% \( p = 0.7185 \) and 40% versus 45% \( p = 0.2525 \) respectively. The proportion of soft plaque to hard plaque in the nonrecurrent TIA/stroke versus the recurrent TIA/stroke was 59% versus 55% \( p = 0.47 \).

Conclusions
Using CTA plaque segmentation, there was no significant plaque composition predictor for recurrent TIA or stroke in this cohort of patients presenting initially with TIA or minor stroke. There was no difference in the proportion of soft to hard plaque in patients with recurrent TIA or stroke.
Purpose
Optimal management of carotid artery disease relies critically on accurate measurement of carotid artery stenosis (CAS). CT angiography (CTA) is being used increasingly to measure CAS in both asymptomatic and symptomatic patients. Here, we compare various methods of measuring CAS on CTA using catheter-based digital subtraction angiography (DSA) as the gold standard.

Materials and Methods
Eighty-three internal carotid arteries evaluated by both CTA and DSA within a 3-month time interval were identified and reviewed retrospectively. Twenty-five (30%) of these demonstrated at least 50% stenosis on DSA. Two blinded radiologists independently obtained ten different measurements of CAS for each artery using axial source, oblique multi-planar reconstruction (MPR), curved MPR, thin maximum intensity projection (MIP), and thick MIP images, via visual estimation, stenosis grading by narrowest diameter, stenosis measurement by NASCET criteria, and a semi-automated method. The degree of stenosis was categorized as <50% stenosis, 50-69% stenosis, 70-99% stenosis, and 100% occluded, and then compared to the degree of stenosis identified on DSA.

Results
Relative to DSA, the original CTA misclassified 18 (21.7%) of the 83 vessels. Of the 10 CTA methods for measuring CAS, visual estimation was most consistent and most accurate, misclassifying 13 (15.7%) of the 83 analyzed vessels for both readers. Densely calcified plaque greatly affected the misclassification rate; in the absence of dense calcifications the average misclassification rate was just 5.5%, but was at best 35% in the presence of dense calcifications (see Figure).

Conclusions
In the absence of densely calcified plaque, visual estimation of CAS on CTA is highly accurate, with a misclassification rate comparable to that reported for DSA. However, no method accurately measured CAS on CTA in the presence of densely calcified plaque.
Comparison of Catheter and CT Angiogram for Arterial Distensibility at the Site of Carotid Stenosis During Catheter Angiography.

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\textsuperscript{1}University of Massachusetts Memorial Healthcare, Worcester, MA, \textsuperscript{2}University of Massachusetts Medical School, Worcester, MA

Purpose
During catheter angiogram (CA) there is momentary increase in intravascular volume and pressure that can potentially cause vascular distention particularly at the stenotic site, whereas on CT angiogram (CTA) this is unlikely due to intravenous administration.

Materials and Methods
Catheter angiogram and CTA of the carotid artery from 29 patients were included. For CA, two orthogonal views were obtained with 8 cc hand injection of Isovue 250 at approximately 5 cc/s. Catheter angiogram images were auto calibrated for magnification. CT angiography was performed with 80 cc of Isovue 350 at 120 kVp, 0.9 mm slice thickness, 0.5 pitch, 22 cm FOV
and 512×512 matrix resulting in 0.43 mm voxels. Sagittal 0.45 mm MPRs mirroring the plane of the CA were generated (VOXAR-3D). On both CA and CTA, the narrowest diameter at stenosis and the distal lumen diameter were measured. Mural plaque calcium content was graded on axial CTAs. Grade 1 is <1 mm thick calcification regardless of circumferential involvement. Grade 2 is 1 mm≤thick<1.9 mm and ≤180 degree. Grade 3 is 1 mm≤thick<1.9 mm and >180 degree or 2 mm≤thick<2.9 mm regardless of circumferential involvement. Grade 4 is calcification thickness >3 mm regardless of circumferential involvement. The CA and CTA measurements were evaluated on a PACS workstation (IDX-IMAGECAST). Two independent neuroradiology fellows performed the measurements. Appropriate parametric and nonparametric tests were chosen after testing for normality. All statistical analyses were performed either using SAS or GraphPad Prism. Effects associated with p<0.05 were considered statistically significant.

Results
Accounting for repeated measurements, the likelihood that the lumen diameter from CA will be larger than CTA was higher at stenosis than distal to it (OR: 5.57, 2.4-12.9, p<0.001), but the difference in lumen diameters between CA and CTA at stenosis was similar to CTA voxel size; 0.24(±0.13) mm and 0.64(±0.09) mm in sagittal and axial CTA, respectively. Hence, there is insufficient evidence that intra-arterial hand-injection during CA leads to vessel dilation. Percentage stenosis using the NASCET criteria differed between the three measurements, with post hoc analysis showing significant difference between CA and axial CTA (p<0.0001), but not between CA and sagittal CTA (p>0.99). The difference in lumen diameter measured at stenosis site between CA and axial CTA did not depend on calcium grading (p=0.484).

Conclusions
There is insufficient evidence to suggest that intra-arterial hand-injection contributes to vessel distension and possible underestimation of percent stenosis during CA. Calcium grading scale does not affect the lumen diameter measurement on CTA suggesting minimal or no effect of beam hardening. Importantly, sagittal CTA should be used for measuring stenosis whenever possible as it does not differ from CA.
Box-plot of percent stenosis (A), lumen diameter at stenosis (B) and lumen diameter distal to stenosis (C) from CA (Angio), sagittal CTA and axial CTA. The 3 estimates statistically differed (p<0.001, Friedman’s test). Post hoc Dunn’s test indicates that axial CTA differed from CA, but sagittal CTA did not differ from CA. (D) Difference in lumen diameter at stenosis between CA and axial CTA did not depend on calcium grade (p=0.484).

(Filename: TCT_O-458_ASNRplot.jpg)

O-459

9:50AM - 9:58AM

Diagnostic Accuracy, Observer Reproducibility and Agreement of Semiautomatic Internal Carotid Artery Stenosis Assessment on CTA.
Purpose
To assess the diagnostic accuracy and reproducibility of commercially available semiautomatic carotid stenosis measurement on CTA and estimate the agreement between different software packages.

Materials and Methods
We selected thin slice CTA image data of 90 consecutive patients with TIA or ischemic stroke and ultrasound proven carotid artery stenosis. We analyzed 141 arteries. Two blinded neuroradiologists manually measured the degree of stenosis of the ICA according to NASCET criteria. Semiautomatic measurements of four commercially available methods (3Mensio, Philips, TeraRecon, and Siemens) were performed by two observers. Diagnostic accuracy was estimated by comparing semiautomatic with manual measurements as a reference. Interobserver reproducibility and agreement between different packages was assessed by calculation of the intraclass correlation coefficient (ICC) and Bland-Altman 95% Limits of Agreement (LoA). False negative measurements were inspected retrospectively by a neuroradiologist. A measurement is labelled as false negative if the degree of stenosis was ≥50% or ≥70% according to manual measurement but <50% or <70% for the semiautomatic measurement.

Results
There was no significant difference in the diagnostic performance of the four semiautomatic methods. The sensitivity for detecting ≥50% and ≥70% degree stenosis was between 76%–82%, and 46%–62% respectively. The specificity and overall diagnostic accuracy was between 92%–97% and 85%–90%, respectively. The interobserver ICC was between 0.83–0.96 for semiautomatic measurements and 0.81 for manual measurement. The LoA between each pair of semiautomatic packages ranged from -18%–24% to -33%–31%. False negative measurements were caused by ulcerative plaques and observer variation in stenosis and reference measurements.

Conclusions
All packages have a low to moderate sensitivity and a good specificity and overall diagnostic accuracy. The high observer reproducibility makes semiautomatic stenosis measurement valuable for clinical practice. However, semiautomatic measurements require inspection by an experienced radiologist.
Purpose
The purpose of this study is to quantify segmented volume loss in posterior reversible encephalopathy syndrome (PRES) patients using open source toolboxes for MATLAB (SPM 12b, Wellcome Trust). Quantitative gray matter volume metrics were applied to both simple and complex PRES patients. We propose that such quantitative methods at the time of initial insult and upon longitudinal follow up may reveal subtle chronic volume loss that correlates with the severity of PRES.

Materials and Methods
Retrospective review of MR images of PRES was performed from 2009-2014. All patients with MPRAGE image with at least 2x2x2 mm isotropic resolution were included. Demographic and clinical information was evaluated. Routine MR imaging was used to grade cases as mild, moderate, or severe/complicated (hemorrhage, diffusion restriction). Gray matter segmentation (SPM12b, normalized to MNI space, thorough clean) was performed and number of gray matter voxels within 116 regions of the AAL brain atlas was compared to an age-matched database. Quantitative maps of segmental atrophy were generated and compared to routine whole brain imaging. When available, longitudinal follow-up examinations were processed and segmental atrophy maps and conventional MR sequences then were compared to imaging obtained at time of initial PRES presentation. Study is limited by small sample size, confounding factors of underlying dementia pattern, and limited number of patients with longitudinal followup.

Results
Over a 5-year period, 85 cases of PRES were identified. Of those, 28 cases with data amenable to volumetric processing were identified with 11/28 patients having longitudinal data available for review. Mean follow-up time was 179 days (range 6 – 665). Of those with longitudinal data available for review, mild uncomplicated PRES patients demonstrated a difference of 0.31 SD of age-matched control volume (left occipital pole; p=0.03, t-statistic= -2.47) and 0.59 SD (right occipital pole; p=0.079, t-statistic= -1.95) on follow-up exam compared to initial exam. In some patients with longitudinal data available, regions of cortical volume loss and segmental atrophy extended beyond FLAIR signal abnormality detected on initial exam. Figure legend: Uncomplicated PRES case Axial FLAIR showing abnormality right occipital lobe, age-matched segmental atrophy (upper right), age-matched gray matter density (lower right) and standard deviation scale.

Conclusions
Significant quantitative gray matter volume loss was observed in the occipital poles in follow-up examinations following cases of PRES, suggesting a nonreversible component. The volume loss extended beyond the initial FLAIR signal abnormality.
O-461

Susceptibility Etching: A Review of 9 Cases

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Purpose
"Susceptibility etching" consists of susceptibility effect, lining the supratentorial gray-white junction with variable involvement of susceptibility effect in the posterior fossa, the corpus
callosum, and the deep white matter. This "etching" corresponds to various coagulation abnormalities. The goal of this study is to evaluate "susceptibility etching" in its various imaging appearances and correlate it with coagulation abnormalities. 1. To illustrate the MR spectrum of "susceptibility etching" artifact in adults with coagulation abnormalities. 2. To discuss "susceptibility etching" distribution and location. 3. To review the typical clinical history, epidemiology, symptomatology, and prognosis in relation to "susceptibility etching."

Materials and Methods

We reviewed nine cases of patients with "susceptibility etching" and correlated this imaging finding with their coagulation profile values. We reviewed PT, PTT, fibrinogen values, D-dimer values, and platelet counts. We reviewed additional clinical parameters in the nine cases including clinical history, gender, clinical outcomes as well as cognitive and motor deficits. We cataloged "susceptibility etching" as well as involvement of susceptibility effect in additional locations in the brain, which were variable and included the deep white matter, cerebral cortices, posterior fossa and brainstem.

Results

Three of the patients passed away within a few days of the MR imaging demonstrating "susceptibility etching," one patient developed subcortical dementia and five patients were lost to long term follow up, of which three had various motor and memory problems at the time of imaging. Seven of the nine patients had variably reduced platelet count, ranging from mildly reduced to severely decreased (ranging from 36,000 platelets/mcL to 133,000 platelets/mcL) and all who were tested had a significantly elevated D-dimer (ranging from 957 mcg/L to >10,000 mcg/L). A strong correlation between "susceptibility etching" and coagulation abnormalities, specifically in relation to elevated D-dimer, were noted. The fibrinogen values also were variably elevated, likely due to fibrinogen's role as a marker as an acute phase reactant.

Conclusions

After a review of nine patients with "susceptibility etching," we found a correlation with coagulation abnormality. The location of "susceptibility etching" is intriguing and may provide insight to the pathophysiology of intravascular coagulopathy in the brain. The involvement of the gray-white matter junction may relate to the sudden reduction of vascular caliber in this region (1). This "etching" effect may correspond to microvascular thromboemboli lodged into an area of sudden vascular caliber reduction, in the setting of coagulation abnormalities.
Cerebral Microbleed Detection Guidelines, Prevalence, and Quantification in a Cohort of Relapsing Remitting Multiple Sclerosis Subjects Using Magnetic Resonance Imaging

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Purpose
Increased incidence of cerebral microbleeds (CMBs) is associated with stroke, traumatic brain injury and vascular dementia. Although increased CMBs also are suspected in relapsing remitting multiple sclerosis (RRMS), a systematic investigation along with a clear set of CMB guidelines is lacking. We propose a novel approach leveraging susceptibility-weighted imaging (SWI) and mapping (SWIM) for CMB detection.

Materials and Methods
Fifty RRMS subjects (36 female/14 male) aged 47.4+/-11 years were analyzed (mean disease duration: 11.7+/- 9 years). Conventional MRI along with a dual echo SWI (TR=30ms, TE1=6ms, TE2=21ms, FA=15°, resolution=0.5x0.5mm², slice thickness=1/1.5mm) were acquired on a 3T Siemens Scanner. Images were processed using SPIN software (Detroit, MI). Cerebral microbleeds were identified as the concurrence of (1) Round or ovoid in plane and through plane, (2) Black on T2*W MRI with blooming, (3) Dipole effect in SWI phase, (4) Bright on SWIM, (5) Isolated, (6) At least half surrounded by brain parenchyma or CSF and not air, (7) Not continuous with venous structures, and (8) Distinct from other potential mimics. In SWIM, the CMB were included in ROI and thresholds of 50ppb were applied to determine the CMB's volume and susceptibility. Three reviewers assessed the presence and volume of the CMBs with an ICC2 statistic >0.9.
Results
Nine (18%) subjects were identified with at least one CMB; seven females had one CMB and two males each had two CMBs. Age and disease duration were not factors in CMB presence. Using the 50ppb threshold, the average volume was 9.3 +/- 7mm3 with a mean \chi of 171.2 +/- 66ppb. Mimics observed included calcium, flow vessel voids, local iron deposition in gray matter, white matter lesions, and cusp artifacts which were differentiated successfully using the proposed set of criteria.

Conclusions
Using SWI and SWIM, a clear set of rules can be defined to reliably determine microbleeds.

O-463
10:54AM - 11:02AM

Over-diagnosis of Cavernoma: Pitfalls of Susceptibility-Weighted MR Imaging That Can Lead to Masking of Cavernoma Mimics

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Purpose
Susceptibility-weighted imaging (SWI) is a powerful and useful imaging sequence that can identify and accurately diagnose intracranial lesions with blood products and/or mineralization such as cavernoma. However, its sensitivity to detect subtle susceptibility and subsequent blooming artifact on imaging can at times lead to masking of underlying mass. The purpose of our study was to determine the incidence of over-diagnosis of cavernoma based on SWI and to evaluate other imaging features that can accurately differentiate cavernoma and its mimics.

Materials and Methods
A retrospective search of our imaging teaching file database from 1998 to 2014 yield 519 cases with cavernoma in the differential diagnosis. Among these, a total of 26 cases were identified as having been diagnosed erroneously initially as a cavernoma either by our own neuroradiologists, by radiologists from an outside institution, or by neurosurgeons. All 26 lesions subsequently were shown to be an entity other than cavernoma based on pathology or with clinical and imaging follow up. The characteristics of these cavernoma mimics on MR imaging then were studied carefully by two neuroradiologists from our institution and compared to those of pathology proven cavernoma.

Results
Of the 26 cases of cavernoma mimics, gliomas were the most common (n=10; 38%) followed by equal number of metastases (n=3) and other primary CNS neoplasms (n=3), vascular thrombosis (n=2), cerebral amyloid angiopathy (n=1), abscess (n=1), and other (n=6). One common imaging feature of all 26 cases was marked blooming artifact on SWI. However, compared to path-proven cavernomas, these cavernoma mimics contain three other imaging features not seen in cavernomas - lack of robust and relatively demarcated T1 shortening, lack of cystic or bubbly component with blood products of varying age, and presence of definite but ill-defined intra-lesion enhancement.

Conclusions
While SWI has revolutionized the imaging diagnosis of cavernomas, it's pitfalls can lead to
erroneous diagnosis of important brain lesions with blood products as cavernomas. This pitfall can be potentially avoided by recognizing three conventional MR imaging features that can correctly identify these important cavernoma mimics and can in turn improve both surgical and medical management of patients.

O-464

Not all that Bleeds is Black: T1 Shine Through on SWI of Intracranial Hemorrhage.

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Purpose
Susceptibility-weighted imaging (SWI) is a magnetic resonance imaging technique sensitive for detecting intracranial hemorrhage based on the concept of signal loss due to magnetic susceptibility effects of blood products. Our purpose was to demonstrate whether intracranial hemorrhage can have a varied appearance on SWI and to evaluate the contribution of T1 effects on the SWI signal.

Materials and Methods
A retrospective search of the electronic medical record was performed to identify patients with intracranial hemorrhage who subsequently had MRI with SWI and T1-weighted images. Forty patients (age 3 months to 86 years) with a total combined 57 MRI scans with SWI and T1-weighted images were identified. Images were obtained at 1.5T or 3T. Signal intensity of blood products was characterized on SWI and T1 as either hyperintense, mixed intensity (heterogeneous intensity lesions and isointense lesions), or hypointense.

Results
Seventeen intracranial hemorrhages (30%) were hyperintense on SWI. Nineteen intracranial hemorrhages (33%) were hypointense on SWI. Twenty-one intracranial hemorrhages (37%) were mixed intensity on SWI. All hemorrhages which were either hyperintense or mixed intensity on SWI were also either hyperintense or mixed intensity on T1-weighted images. Hemorrhages which were hypointense on SWI were either hypointense or mixed intensity on T1-weighted images. Table 1 demonstrates the numbers of hemorrhagic lesions characterized by T1 and SWI appearance. The two provided axial MR images demonstrate a left posterior cerebral convexity subacute subdural hemorrhage which is hyperintense on T1 (A) and SWI (B).

Conclusions
Intracranial hemorrhage can have a varied appearance on SWI. The hyperintense appearance of intracranial hemorrhage on SWI is likely due to shine through of high T1 signal in subacute hemorrhage.
New surrogates for vascular cognitive impairment (VCI) in Cerebral Small Vessel Disease (CSVD) patients: A preliminary Enhanced T2*-weighted Angiography (ESWAN) sequence study

X Liu¹, L Huang², X Ling², L Zhao², L Huang², C Li³

Table 1: Number of Hemorrhagic Lesions Categorized by Signal Intensity

<table>
<thead>
<tr>
<th>T1 Signal Intensity</th>
<th>SWI Signal Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hyperintense</td>
</tr>
<tr>
<td>Hyperintense</td>
<td>13</td>
</tr>
<tr>
<td>Mixed Intensity</td>
<td>4</td>
</tr>
<tr>
<td>Hypointense</td>
<td>0</td>
</tr>
</tbody>
</table>

(Filename: TCT_O-464_TableandImages.jpg)
University of Occupational and Environmental Health (UOEH) and First Affiliated Hospital of Jinan Un, Guangzhou, Guangdong, The 1st affiliated hospital of Jinan University, Guangzhou, Guangdong, Guangzhou eight people’s hospital, Guangzhou, Guangdong

Purpose
Cerebral small vessel disease (CSVD) is a major cause of vascular cognitive impairment (VCI). This study was aimed to detect new radiological surrogates of VCI.

Materials and Methods
A total of 50 CSVD patients were enrolled in this study and performed on 1.5T MRI scanner with conventional sequences and enhanced T2*-weighted angiography (ESWAN) sequence. We analyzed the clinical and demographic information, total MoCA score, and MRI data, including the numbers of lacunar infarcts (LIs) and cerebral microbleeds (CMBs), scores of periventricular hyperintensity (PVH) and deep subcortical white matter hyperintensity (DWMH), and T2* values and R2* values of white matter (WM) adjacent to the anterior horns of the lateral ventricle (AHLV) and posterior horns of the lateral ventricle (PHLV), centrum semiovale, caudate head and putamen in each subject.

Results
Of 50 CSVD patients, 34 (68%) met the criteria for VCI and 16 (32%) were for non-VCI. The total MoCA scores of VCI subgroup were significant lower than non-VCI subgroup (p < 0.001, two-tailed). ESWAN sequence can detect CMBs, leukoaraiosis, LIs and iron deposition. VCI subgroup had significant higher scores of PVH than non-VCI subgroup (p < 0.05, two-tailed). Enhanced T2*-weighted angiography sequence easily can detect the CMBs, leukoaraiosis, LIs and iron deposition. Vascular cognitive impairment subgroup had significant higher scores of PVH. Significant higher T2* values and lower R2* values on WM adjacent to the AHLV and centrum semiovale, as well as lower, lower T2* values and higher R2* values on the caudate head and putamen were seen in VCI subgroup (p < 0.05, wo-tailed). Noncondition regression demonstrated that T2* values of left WM adjacent to AHLV (0.96, 95% CI 0.92-1.00, p < 0.05) and left caudate head (0.90, 95% CI 0.82-0.99, p < 0.05), and score of PVH (7.07, 95% CI 2.03-24.70, p < 0.01) were contributed independently to VCI.

Conclusions
Enhanced T2*-weighted angiography was a useful sequence which could reflect radiological characteristic, pathological and metabolic changes in CSVD with VCI. In light of this was the first study including T2* values and R2* values in regression model. T2* values were thought to be the new imaging surrogate for VCI in CSVD patients.
Figure 1 The reconstructive mapping of ESWAN sequence.

a. phase mapping, b. manitude mapping, c. T_2* mapping, d. R_2* mapping

a-b. CMBs lesions presented foci hypointensities on phase mapping and magnitude mapping.

c-d. LIs and Leukoaraiosis lesions were showed green color on T2* mapping and blue color on R2* mapping. CMBs and the area of caudate head and putamen were showed blue color on T2* mapping and green color on R2* mapping.

(Filename: TCT_O-465_Figure1.jpg)

Figure 2 ROIs placement on the T2* mapping and R2* mapping

a-c. T2* mapping, d-f. R2* mapping

a and d. ROIs of bilateral white matter adjacent to posterior horns of the lateral ventricle (PHLV), caudate head and putamen.

b and e. ROIs of bilateral white matter adjacent to anterior horns of the lateral ventricle (AHLV).

c and f. ROIs of bilateral centrum semiovale

(Filename: TCT_O-465_Figure2.jpg)
Structural connectivity changes in stroke patients following rehabilitation

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Purpose
To assess DTI-based structural connectivity changes in the brain as a result of rehabilitation after stroke, in relation to clinical improvement.

Materials and Methods
This longitudinal study includes nine stroke patients (age = 57.7 ± 16.8 years) who underwent rehabilitation (robotic therapy or occupational therapy, range 15-99 months) and had post-stroke DTI imaging before and after rehabilitation. The pre-therapy MRI was acquired after patients became stable post-injury. Motor activity was assessed using Fugl-Meyer (FM) scores before and after therapy. Diffusion tensor imaging-based analysis of motor function was based on the diffusion-based measures computed from the corticospinal tract (CST), extracted using streamline tractography based on manual placement of ROIs in the motor cortex, cerebral peduncle and the posterior limb of internal capsule (Figure 1-A and 1-B). The change in fiber density (FD = number of fiber/intracranial volume) and mean of fiber length (MFL) (both adjusted for intracranial volume) were computed on ipsilesional and contralesional side before and after rehabilitation and correlated with FM score changes before and after rehabilitation using Spearman's correlation.

Results
On the contralesional side of the CST, there is significant negative correlation between the change in MFL and FM scores before and after rehabilitation (p = 0.018, Spearman correlation = -0.76, Figure 2-A), and also between the change in FD with those in motor function (p = 0.005, Spearman correlation = -0.84, Figure 2-B). The ipsilesional CST did not show statistically significant changes.

Conclusions
The decrease in fiber density and length of CST on the contralesional side in stroke patients with functionally improved outcome is compatible with the "interhemispheric imbalance" hypothesis in neuroplasticity originally described in PET/fMRI studies, which states there is an imbalance between the hemispheres after stroke and with functionally improved cases exhibiting an increase in activity in ipsilesional hemisphere and a decreased activity on contralesional side to restore the previous balance (1). Besides rehabilitation, the natural history of stroke also may have a role in the observed results. Fiber changes as a result of rehabilitation that correlate well with clinical outcomes suggest the applicability of tracking as a means of assessing neuroplasticity.
Intracranial Gadolinium Deposition Following Contrast Enhanced MRI

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Purpose

Intravenous gadolinium-based contrast agents (GBCAs) are used widely in MR imaging, yet
their safety and chemical stability remain topics of active investigation. In the current study, we sought to determine if repeated intravenous exposures to GBCAs are associated with neuronal tissue deposition.

Materials and Methods
In this single center study, we compared T1-weighted signal intensities from MRI exams and post-mortem neuronal tissue samples on 13 patients who underwent four or more gadolinium-enhanced brain MRIs between 2000-2014 (contrast exposed group) to 10 gadolinium-naïve patients (control group). Antemortem consent was obtained from all study participants. All contrast exposed patients had relatively normal renal and hepatobiliary function at the time of examination. Neuronal tissues from the dentate nuclei, pons, globus pallidus, and thalamus of these 23 deceased patients were harvested from our institutional biospecimen archive and subsequently analyzed by inductively coupled mass-spectrometry (ICP-MS), transmission electron microscopy with x-ray microanalysis (TEM) and light microscopy to quantify, localize, and assess the effects of gadolinium deposition. Results were correlated with Pearson's test.

Results
Among control patients who underwent more than one unenhanced MRI, no significant change in normalized T1 signal intensity was detected in any neuroanatomical location ($r^2=0.01-0.06$, $p = .89-.96$, e.g. Figure A). In comparison, gadolinium-exposed individuals demonstrated a significant, positive dose-T1 signal correlation in all neuroanatomical locations ($r^2 = 0.41-0.85$, $p <.0001$, e.g. Figure B). Compared to neuronal tissues of control patients, all of whom demonstrated undetectable levels of gadolinium using ICP-MS, neuronal tissues of GBCA-exposed patients contained between 0.2-58.8 micrograms of gadolinium per gram of neuronal tissue, in a significant dose-dependent relationship ($r^2 = 0.75-0.79$, $p <.0001$). ICP-MS results strongly correlated with signal intensity changes on precontrast T1-weighted MR images ($\rho=0.38-0.95$); the dentate nucleus contained the highest concentrations of elemental gadolinium ($F = 5.2$, $p = .0035$) and greatest changes in T1 signal intensity of the sampled neuroanatomical locations. Gadolinium deposition in the capillary endothelium and neuronal interstitium was only detected in contrast-exposed tissue samples using TEM (Figures C, D). Further, light microscopy and TEM results suggest that gadolinium neuronal tissue deposition occurs in the presence of an intact blood-brain barrier.

Conclusions
Intravenous gadolinium contrast material exposure is associated with neuronal tissue deposition in the setting of relatively normal renal and hepatobiliary function and an intact blood-brain barrier. Additional studies are needed to investigate the mechanism of this deposition and clinical significance of these findings.
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Purpose

Image-guided cervical nerve root blocks commonly are performed in patients with cervical radiculopathy for therapeutic pain alleviation and diagnostic presurgical planning. Physicians performing cervical nerve root blocks generally assume that placing the needle tip as close as possible to the symptomatic nerve root will result in most effective pain relief. However, aggressive needle positioning must be balanced against risks of injuring or injecting into the adjacent vertebral artery. Optimal needle tip position for cervical nerve root blocks remains unknown. The aim of this study is to determine whether immediate postprocedural pain relief is dependent upon needle tip location or contrast dispersion.

Materials and Methods

A retrospective evaluation of all single level, unilateral cervical nerve root blocks performed at our institution between January and December 2014 was performed. All patients underwent CT-guided nerve root blocks using a fixed amount of contrast, local analgesic, and steroid. Final needle tip position was classified as extraforaminal, at the junction of the neural foramen, or within the neural foramen. Contrast dispersion was classified as extraforaminal, foraminal, or central epidural, with more than one classification possible. Immediate relative pain relief was calculated from preprocedure and 10-minute postprocedure 10-point pain scores. Parametric ANOVA and nonparametric Wilcoxon testing were used to assess differences between treatment group and percent decrease in pain score. Statistical testing was performed in JMP 11.

Results

A total of 141 patients underwent 162 cervical nerve root blocks without complication at levels including C3 to C8 with 51% on the right side. Forty-nine percent of the patients were male and 51% of injections were right sided. The median preprocedure pain score was six (quartiles: 5 and 8) and the median postprocedure pain score was one (quartiles: 0 and 4). The median percent decrease in pain score was 75% (quartiles: 33 and 100). There was no statistically significant difference in pain score decrease based on needle position (p = 0.58) or contrast dispersal (p = 0.34).

Conclusions

Immediate pain reduction from cervical nerve root blocks is independent of needle location or contrast dispersal. Our findings suggest that aggressive needle positioning close to the nerve root may not be necessary to obtain optimal diagnostic and therapeutic response.
Purpose
Epidural glucocorticoid injections often are used to treat symptoms of lumbar spinal stenosis. Using data from a large multicenter trial we aimed to test whether response to treatment following an epidural injection of glucocorticoid plus lidocaine versus lidocaine alone was associated with baseline imaging findings of lumbar spinal stenosis.

Materials and Methods
In a double-blind, multicenter trial, we randomized 394 subjects with symptoms of moderate-to-severe leg pain and disability and imaging findings of at least mild lumbar central spinal stenosis to receive epidural injection of glucocorticoid plus lidocaine versus lidocaine alone (1). A study

Figure 1. Percent change in pain after nerve block by needle position (left sal (right). There was no statistically significant difference in pain deci variable (p >> 0.05). E = extraforaminal, I = intraforaminal, C

(Filename: TCT_O-470_CervicalNRBRetroImmediatePainAbstractTable.jpg)
clinician familiar with the participant's symptoms reviewed the enrollment CT or MRI to determine the severity of central spinal canal stenosis. At the completion of the study, six trained readers not involved in the initial enrollment assessment of stenosis and without knowledge of clinical status retrospectively performed qualitative assessment of central spinal canal stenosis (2). The primary clinical outcome was Roland-Morris Disability Questionnaire (RMDQ) score obtained 6 weeks after epidural injection.

Results
At 6 weeks, regardless of treatment, there were no significant differences in RMDQ scores among groups based on severity of stenosis as assessed by the enrolling clinician \[F(2, 373) = 1.39, p = 0.25\] or the independent trained readers \[F(2, 373) = 0.87, p = 0.42\]. Furthermore, the effectiveness of the injection by injection type did not differ by stenosis severity. In other words, there was no effect modification (interaction between severity of stenosis on imaging with treatment effect of epidural steroids with lidocaine versus lidocaine alone) as assessed by the enrolling clinician \[F(2, 371) = 0.45, p = 0.63\] or as assessed by the independent trained readers \[F(2, 371) = 0.31, p = 0.74\].

Conclusions
In a large cohort of nonsurgical patients with clinical findings and imaging consistent with lumbar stenosis, the imaging findings of lumbar spinal stenosis predicted neither the response to epidural lidocaine versus epidural glucocorticoid and lidocaine injections nor the overall response to any injection.

O-472

Utilizing body mass index (BMI) to predict needle length in lateral oblique angle fluoroscopic guided lumbar punctures

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Purpose
Predicting the appropriate needle length to use in lateral oblique angle fluoroscopic-guided lumbar punctures (FGLP) in patients with larger body habitus is difficult. Using the wrong needle length could lead to increased radiation dose and patient discomfort. The purpose of this study is to determine if body mass index (BMI) could help predict the appropriate needle length to use in lateral oblique angle fluoroscopic-guided lumbar punctures.

Materials and Methods
We selected patients with cross-sectional imaging of the lumbar spine (CT/MRI abdomen/pelvis, PET/CT, or MRI lumbar spine) and BMI measurement close to the date of the FGLP (August 2013–June 2014). We measured the distance from the skin to the mid lumbar spinal canal at the level of the lumbar puncture using the right lateral oblique angle of 8.6° (average oblique angle used by physicians performing the procedure).

Results
Our data pool consisted of 50 patients (mean age=49.1 ± 17.2 years). Twenty-eight of 50 patients underwent FGLP with a 3.5 inch needle and 22 patients underwent FGLP with a 5 or 7 inch needle. The BMI and distance from the skin to the mid lumbar spinal canal measured at 8.6° was significantly higher in patients who underwent FGLP with a 5 or 7 inch needle (average
BMI = 40.1 ± 9.8; average distance to mid canal = 4.1 inches ± 0.6 inches) compared to patients who underwent FGLP with a 3.5 inch needle (average BMI = 25 ± 4.7; average distance to mid canal = 2.7 inches ± 0.6 inches). We determined the formula to predict the needle length in lateral oblique angle FLGP to be: Inches from skin to center of lumbar spinal canal = 0.08 x BMI + 0.84 (R^2 = 0.71).

Conclusions
We propose a formula that utilizes BMI to help predict the appropriate needle length to use in lateral oblique angle fluoroscopic-guided lumbar punctures.
Purpose
To determine if percutaneous vertebral augmentation (PCA) provides long term stability without significant changes in height over time in patients treated for osteoporotic compression fractures.

Materials and Methods
A single institution PACS database query was conducted to determine the number of patients who underwent either vertebroplasty or kyphoplasty for back pain secondary to vertebral osteoporosis-induced compression fracture. Augmented vertebral height measurements were analyzed from images during pre-intervention, immediate postintervention, and at varying points during follow up examinations. Vertebral height measurements were measured and standardized against an internal control depending on the imaging modality. Controls were designated using a stable vertebral body and/or using an imaging device of a known constant dimension. The ratio of heights between two values (injected vertebral body versus internal control) were recorded over time and compared to other ratio values at various time intervals.

Results
Forty-five patients met inclusion criteria (42 women/3 men) with the distribution of kyphoplasty to vertebroplasty being 48 and 77 respectively. Of the 45 patients, 110 vertebral bodies were augmented. Forty of the 45 were on supplemental pharmacologic management for osteoporosis. Average imaging follow up was 4.7 years. All augmented vertebral bodies demonstrated adequate endplate-to-endplate filling. Follow-up imaging of the 110 injected vertebral bodies demonstrated no statistically significant change in vertebral height over time with a p-value of 0.46.

Conclusions
The findings of the study demonstrate that vertebral augmentation yields stable vertebral bodies with no change in overall vertebral body height over time. There was no statistically significant difference between the two techniques or pharmacologic treatment. Limitations of the project included comparison of relative vertebral heights versus absolute values. Further analysis utilizing a prospective cohort with absolute internal controls is needed to further add validity to the current findings.

O-474 11:02AM - 11:10AM

Augmentation of failed human vertebrae with critical un-contained lytic defect restores their structural competence under functional loading: An experimental study

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Purpose
Lytic spinal lesions reduce vertebral strength and may result in their fracture. Vertebral augmentation (VA) is employed clinically to provide mechanical stability and pain relief for vertebrae with lytic lesions. Although VA commonly is employed to provide mechanical stability and pain relief in patients with metastasis, remarkably little is known about the extent to which VA strengthens fractured bodies containing such lesions. This study employed a lytic defect human vertebral model to investigate the efficacy of VA in strengthening the structural competence of vertebrae having been tested previously to failure.
Materials and Methods
Eighteen unembalmed human lumbar vertebrae, having simulated uncontained lytic defects and tested to failure in a prior study, were augmented using a transpedicular approach and retested to failure using a wedge fracture model. Axial and moment-based strength and stiffness parameters were used to quantify the effect of VA on the structural response of the failed vertebrae. Effects of cement volume, bone mineral density and vertebral geometry on the change in structural response were investigated.

Results
Augmentation increased the failed lytic vertebral strength [compression: 85% (p<0.001), flexion: 80% (p<0.001), anterior-posterior (A-P) shear: 95%, p<0.001] and stiffness [(40% (p<0.05), 53% (p<0.05), 45% (p<0.05)]. Cement volume correlated with the compressive strength (r2=0.47, p<0.05) and A-P shear strength (r2=0.52, p<0.05) and stiffness (r2=0.45, p<0.05). Neither the geometry of the failed vertebrae nor its prefracture bone mineral density correlated with the volume of cement.

Conclusions
Vertebral augmentation is effective in bolstering the failed lytic vertebral compressive and axial structural competence, showing strength estimates up to 50-90% of historical values of osteoporotic vertebrae without lytic defects. This modest increase suggests that lytic vertebrae undergo a high degree of structural damage at failure, with strength only partially restored by VA. The positive effect of cement volume is self-limiting due to extravasation.
Fluoroscopic Guided Facet Joint Injections: Comparison of Intra-Articular and Peri-Articular Injections on Immediate and Short-Term Pain Relief

L Kershen\textsuperscript{1}, M Fox\textsuperscript{1}, N Nacey\textsuperscript{1}

\textsuperscript{1}University of Virginia, Charlottesville, VA

\textbf{Figure 1.} Deformation curves for the compressive [A] and forward [B] of the intact (OL), failed (OL-F) and augmented (OL-FA) L3 vertebrae show high residual deformation compared to the OL-FA vertebrae. OL-FA vertebrae show a large degree of structural damage due to the mechanical failure.

O-476

11:18AM - 11:26AM
Purpose
To determine if immediate and short-term pain relief varies between intra-articular and peri-articular facet joint injections.

Materials and Methods
All fluoroscopic-guided facet injections performed over a 5-year period were identified. Patients were injected with 0.5 mL Bupivacaine-0.25% and methylprednisolone 20 mg (n=96) or equivalent steroid (n=10). Patients were excluded if the pre or immediate postinjection pain scores were not recorded or if injected for pars defect. One-week postinjection pain scores were recorded (n=52). Two MSK radiologists with 2 and 16 years experience reviewed images to determine intra- or peri-articular placement, with a final consensus reached on all cases. Mann-Whitney and chi-square statistical analysis was performed.

Results
One hundred six patients (72F:34M; mean age 52 years) met the inclusion criteria with 214 injections performed. Injections were completely intra-articular (CIA) (57 patients;106 facets), partially intra-articular (PIA) (26 patients;72 facets) and peri-articular (PA) (23 patients;36 facets). Pre- and immediate postinjection pain scores for the CIA, PIA and PA injections were 5.7/2.0, 6.8/2.7 and 5.7/3.0 respectively. Pre-injection and 1-week postinjection pain scores for the CIA, PIA and PA injections were 6.2/4.9, 6.9/5.9 and 6.5/5.1 respectively. All groups had significant immediate postinjection pain reduction (p=<0.001). The CIA group had significant 1-week postinjection pain reduction (p=0.04), unlike the PIA (p=0.26) or PA groups (p=0.16). Median fluoroscopic time (FT) was significantly less for the CIA (42 s) group, unlike the PIA (54 s; p=0.014) or PA (59.5 s; p=0.011) groups.

Conclusions
Significant immediate postinjection pain relief occurred with CIA, PIA and PA injections; however, only CIA facet injections provided significant 1-week postinjection pain relief. Completely intra-articular injections utilize significantly less FT.

A Novel Image-Guided Pain Treatment: Selective Deletion of Nociceptors Using Resiniferatoxin

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¹University of California, San Francisco, San Francisco, CA

Purpose
The discovery of enriched expression of the capsaicin receptor (TRPV1) in pain-transmitting nociceptive neurons and sensory ganglia makes it an attractive target for selective analgesia. Resiniferatoxin (RTX) is a TRPV1 agonist like capsaicin, only many times more potent, causing a large influx of intracellular Ca2+ that can be cytotoxic to cells. Importantly, TRPV1 is minimally expressed or absent in motor neurons and myelinated sensory pathways, allowing RTX to selectively delete pain transmitting neurons while leaving "bystander" motor and sensory neurons intact. With this project we seek to develop an important new capability in personalized pain medicine by combining the molecular selectivity of RTX with the precision of CT-guided delivery of medicine to block peripheral pain generators.
Materials and Methods

Injections: RTX was delivered to dorsal root sensory ganglia along the lumbar spine (L3, L4, L5, L6 levels) using CT guidance in two farm pigs. Ganglia on one side of the animal were injected with either 500 or 2000 ng RTX. The contralateral side was injected with vehicle only.

Behavioral Analysis: Four-week observation included lameness scoring, gait analysis and periodic stimulation with an infrared diode laser capable of stimulating pain fibers.

Immunohistochemistry: Lumbar ganglia and cord were dissected and CGRP positive nerve terminals were quantified with immunofluorescence intensity. Gene Expression: Relative TRPV1 expression was determined using quantitative real-time PCR to detect difference in transcript levels between vehicle and RTX-treated ganglia.

Results

Postinjection CT scan confirms precise RTX delivery in a periganglionic distribution covering the dorsal root ganglia (Figure 1A). After treatment, animals have no observable motor deficits and normal gait. Injecting 500 ng RTX/ganglion results in a 59% increase in withdrawal latency to laser stimulus (vehicle 6.8 +/- 0.7 sec vs RTX 10.9 +/- 1.0 sec) and injecting 2000 ng RTX/ganglion resulted in an 81% increase in withdrawal latency (vehicle 6.5 +/- 0.3 sec vs RTX 11.7 +/- 1.0 sec). There is a corresponding decrease in TRPV1 mRNA expression in RTX-treated ganglia (5.6% +/- 3.4) compared with vehicle (100%) (Figure 1B). In addition, RTX injection reduced CGRP + pain terminals in the dorsal horn 35% when compared to the contralateral horn at L5.

Conclusions

CT guidance can be used to precisely deliver the novel therapeutic RTX directly to sensory ganglia in a higher order mammal. Behavioral studies confirm selective deletion of pain fibers by decreased response to noxious stimulus with no "bystander effect" on motor neurons. Consistent with known mechanism of action, there is a significant decrease in TRPV1-expressing pain fibers following treatment, diminishing the transmission of pain. These results introduce a new capability in personalized and selective pain medicine by injecting RTX directly at the site of peripheral pain transmission for a highly localized treatment effect. This targeted approach also reduces unwanted side effects common to many current strategies for controlling severe pain.
Treatment of Symptomatic Tarlov Cysts by CT-guided Percutaneous Injection of Fibrin Sealant in 213 patients

k murphy¹, G Elias², s kathuria³, D Long⁴, a oaklander⁵

¹University of toronto, toronto, - Choose State/Province -, ²university of toronto, Toronto, ontario, ³Johns Hopkins, baltimore, MD, ⁴johns hopkin, baltimore, MD, ⁵MGH, boston, MA

Purpose
To test this hypothesis, we analyzed efficacy and safety of intervention in 213 consecutive patients with symptomatic Tarlov cysts treated by CT-guided two-needle cyst aspiration and fibrin sealing.

Materials and Methods
Study Design: This study, initiated in 2003 after institutional approval, was designed to retrospectively assess outcomes in all 213 patients who underwent CT-controlled aspiration and injection of one or more sacral Tarlov cysts (TC) at Johns Hopkins Hospital between the years of 2003 and 2013. Assessments were repeated at 3 months postprocedure, 1 year postprocedure, and yearly thereafter. Method of Aspiration-Injection. The conducted procedures all followed the technique described by Murphy et al. (1) using two needles for aspiration and injection of the cyst. All procedures were carried out with local anesthesia and intravenous analgesia. Aspiration was preceded by performance of diagnostic CT followed by CT fluoro guidance. Two 18-gauge needles were advanced into the cyst with the aid of intraoperative image guidance provided by CT fluoroscopy. The tip of the first needle typically was placed deep in the cyst, while the second was placed more superficially. The stylets were removed from both needles and was aspirated via the deeper positioned needle. A commercially available fibrin sealant composed of human/bovine fibrin, fibrinolysis inhibitor, thrombin, and calcium chloride then was injected into the cyst through the deep needle (Tisseel VH; Baxter Healthcare, Westlake Village, California).

Results
The 213 patients had 289 cysts treated. The patients all have been followed for at least 6 months with 90% of them followed for 1 year and 83% of them having been followed for 3 and 6 years. Local pain in the region of the cyst was the most common problem though S-1, 2 sciatica and neuropathy also was prevalent. Common complaints included incontinence, urinary frequency, and inability to fully empty the bladder, and bowel dysfunction. One year postprocedure, excellent results had been obtained in 104 patients (48.8%) and good or satisfactory results had been obtained in 53 patients (24.8%). Thus, 157 patients (73.6%) in all were satisfied initially with the outcome of treatment. 61.4% were satisfied with treatment at 3 to 6 years follow up. There were nerve injuries and significant complications.

Conclusions
Despite widespread belief to the contrary, it has been known for some 70 years that perineural cysts are sometimes symptomatic. Indeed, associated symptoms and neurological signs may be relieved by successful treatment of the troublesome cyst. The aspiration-injection technique described herein constitutes a safe and efficacious treatment option – one that holds promise for relieving cyst-related symptoms in many patients with very small risk.
First North American Trial of Ozone for treatment of contained Herniated Lumbar Discs and Investigation of the use of Cone beam CT guidance of the procedure in an angio suite

k murphy 1, G Elias 2, T Meaders 3, P Munk 4, J Steppan 3

1 University of toronto, toronto, - Choose State/Province -, 2 university of toronto, Toronto, ontario, 3 Active 0, salt lake, UT, 4 university of british columbia, vancouver, british columbia

Purpose
We report the first North American trial of 2% Ozone in the treatment of contained lumbar spine disk herniations. We evaluated the speed and accuracy of CT guidance (the standard Europe approach) to conventional angio suite fluoro guidance with cone beam CT confirmation of gas distribution.

Materials and Methods
Percutaneous image-guided intra discal oxygen/ozone treatment was performed in 36 patients in two centers. The Active O AO 1000 hand-held disposable device was used in all cases. Twenty-four were treated at Vancouver General Hospital (VGH) with CT guidance. Twelve were treated at the Toronto Western Hospital (TWH), two initially under CT and then the following 10 under fluoro guidance with Cone beam CT. A fluoro-guided discogram type technique is used for nucleus pulposis access. Twenty-two g 15-20 cm long needles were used. Three ccs of ozone was injected in the disc and 7ccs just lateral to the annulus. This was followed with 1cc of 0.5% Marcaine and 40mg of depomedrol. IRB and Health Canada approval was obtained for this multicenter study.

Results
One patient was treated under fluoro guidance at L3/4. Fourteen patients were treated at L4/5, eight under CT guidance, six under fluoro guidance. Twenty-one patients were treated at L5 S1, 17 under CT guidance, four under fluoro guidance. There were no failures to access L3/4 or L4/5. Access at L5/S1 was difficult under CT guidance. In 16 cases a co-axial curved needle approach was needed (18 g needle with curved 22 g), in one case we failed to access the disc. Four patients were treated at L5S1 under fluoro with extreme cranio caudad ipsilateral oblique angulation without difficulty. Twenty-two g 15-20 cm long needles were used. The average time for CT-guided studies was 36 minutes. The average time for fluoro guidance was 24 minutes. Cone beam CT reconstructions confirmed gas distribution better than conventional CT images as greater cranio caudad coverage was obtained. There were no device or procedural or postprocedural complication, or disc infections.

Conclusions
Oxygen/ozone therapy has been used in Europe to treat herniated discs for over a decade, with approximately 30,000 patients treated safely. Ozone's MOA in relieving low back pain associated with a contained, herniated disc is volume reduction by ozone oxidation of proteoglycans in the nucleus pulposus into CO2 and H20 (1). This study reports the first North American experience with Ozone in contained herniated disc. We saw faster procedural times and better disc access with Angio fluoro guidance. Ozone gas distribution was confirmed accurately with Cone beam CT.
Thursday  
10:30AM - 12:00PM  
Sheraton Chicago Hotel & Towers, Chicago Ballroom VI (Level 4)  

22C-THE BARE ESSENTIALS: SPINAL INTERVENTIONAL PROCEDURE WORKSHOP  

22C-1  
10:30AM - 10:45AM  
Pre-, Peri, and Post-Procedure Assessment  

Silbergliet, R.  
William Beaumont Hospital  
Royal oak, MI  

22C-2  
10:45AM - 11:00AM  
Tools of the Trade  

Johnson, M.  
Yale University School of Medicine  
New Haven, CT  

22C-3  
11:00AM - 11:15AM  
Spine and Disc Biopsy  

Doshi, A.  
Mount Sinai Hospital  
New York, NY  

22C-4  
11:15AM - 11:30AM  
Pain Management Procedures: Facet, Nerve and Epidural Blocks  

Nguyen, D.  
Penn State Milton S Hershey Medical Center  
Hershey, PA  

22C-5  
11:30AM - 11:45AM  
Kyphoplasty
22C-6
Vertebroplasty

Brook, A.
Montefiore Medical Center
Bronx, NY

Thursday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)

22D - NEURO-NUCLEAR IMMERSION: THE MERGING OF ANATOMIC AND FUNCTIONAL IMAGING: ONCOLOGIC IMAGING PART II: PHYSIOLOGIC AND ENDOCRINE APPLICATIONS
22D-1
Evaluating for Brain Death

Lewis, D.
University of Washington
Seattle, WA

22D-2
Evaluating Shunt Failure

Yeom, K.
Stanford University, School of Medicine
Pal Alto, CA

22D-3
Evaluating Hyperparathyroidism

Lewis, D.
University of Washington
Seattle, WA
HydroCoils Are More Effective than Bare Platinum Coils in Treatment of “Difficult to Treat” Aneurysms: a Subgroup Analysis of the HELPS Trial

W Brinjikji¹, D Kallmes¹, H Cloft¹, P White²
¹Mayo Clinic, Rochester, MN, ²Institute for Ageing and Health, Newcastle University, Newcastle-upon-Tyne, England, Newcastle-upon-Tyne, United Kingdom

Purpose
The HydroCoil endovascular aneurysm occlusion and packing study (HELPS) was a randomized controlled trial comparing HydroCoil to bare platinum coils. We performed a subgroup analysis of angiographic and clinical outcomes of “difficult to treat” aneurysms, defined as irregularly shaped and/or dome-to-neck ratio<1.5, in HELPS.

Materials and Methods
Separate subgroup analyses comparing outcomes of HydroCoil and bare platinum coils were performed for irregularly-shaped aneurysms and aneurysms with dome-to-neck-ratio<1.5. For each subgroup analysis, the following outcomes were studied at last follow up (3-18 months): 1) any recurrence, 2) major recurrence, 3) retreatment, and 4) mRS≤2. Multivariate logistic
regression analysis was performed to determine if HydroCoil was associated independently with improved outcomes compared to bare platinum coils in these subgroups.

Results
Among irregularly shaped aneurysms, HydroCoil use was associated with lower rates of major recurrence compared to bare platinum coils (17/66, 26% versus 30/69, 44%, P=0.046). Among small dome-to-neck ratio aneurysms, HydroCoil was associated with lower rates of major recurrence compared to bare platinum coils (18/73, 24.7% versus 32/76, 42.1%, P=0.02). In the irregular shape subgroup, when adjusting for aneurysm size, D:N, rupture status and use of assist device; HydroCoil use was associated with decreased odds of major recurrence (OR=0.42, 95%CI=0.19-0.89, P=0.02). In the small D:N aneurysm subgroup, adjusting for aneurysm size, shape, rupture status and use of assist device, HydroCoil use was associated with decreased odds of major recurrence (OR=0.42, 95%CI=0.19-0.89, P=0.02).

Conclusions
In this post-hoc subgroup analysis, compared with bare platinum coils, HydroCoils are associated with improved angiographic outcomes in the treatment of irregularly shaped aneurysms and aneurysms with dome-to-neck-ratio <1.5. These findings indicate that inclusion of such "difficult to treat" aneurysms in future clinical trials may help in demonstrating the benefits modified coils have compared with conventional bare platinum coils.

O-481

Long-Term Angiographic Outcome of Stent-Assisted Compared to Non-Assisted Coiling of Intracranial Saccular Aneurysms

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Purpose
To compare angiographic result during long term follow up between stent-assisted (SAC) and nonassisted coiled (NAC) intracranial saccular aneurysms, and assess whether rates of recurrence and progressive occlusion differ between these two groups.

Materials and Methods
Retrospective review identified 260 patients with 283 saccular aneurysms who had long term angiographic follow up (more than 12 months) successfully treated with SAC (89 aneurysms) or NAC (194 aneurysms) in University Hospital Center, Zagreb from June 2005 to July 2012.
Initial and control angiographic results in both groups were graded using Roy/Raymond scale, converted to descriptive terms and evaluated for statistical significance. A multivariate analysis was performed to identify demographic, anatomical and technical factors related to progression of aneurysm occlusion and recurrence at follow up.

Results
There were more progressively occluded aneurysms in SAC group (42.7%, 38/89) than in NAC group (23.7%, 46/194) (P=0.0019), but significant differences in rates of recanalization (6.7% versus 15.9%, P= 0.0511), regrowth (14.6% versus 16.5%, P=0.8195) and stable result (35.9% versus 43.8%, P=0.2642) were not observed. Multivariate logistic regression identified use of stent as the most important factor associated with progressive occlusion (P= 0.0002, OR 2.9381, 95% CI 1.6573 - 5.2088), and large aneurysm size (P= 0.0002, OR 3.5397, 95% CI 1.8160 -
6,8996) and posterior circulation location (P= 0.0354, OR 1.9502, 95% CI 1.0466 - 3.6339) as most predictive of aneurysm recurrence.

Conclusions
The use of stent is associated with delayed occlusion of initially incompletely coiled aneurysms during follow up, but does not reduce the rate of recurrence compared to coiling alone. Long erm angiographic follow up is needed for both stent-assisted and nonassisted coiled aneurysms.

New Single layer WEBs - Intrasaccular flow disrupters for intracranial aneurysms treatment : preliminary results of a European multicenter study


1Hôpital Beaujon - Assistance Publique Hôpitaux de Paris, Clichy, France, 2Helios Klinikum Erfurt Institut für diag. und interv. Radiologie und Neuroradiologie, Erfurt, Germany, 3Universitätsklinikum Köln Institut und Poliklinik für Radiologische Diagnostik Neuroradiologie, Köln, Germany, 4Leeds teaching hospital, Leeds, United Kingdom, 5Universitätsklinikum Knappschaftskrankenhaus Bochum Institut für Diagnostische und Interventionelle, Bochum, Germany, 6Universitetssykehus Oslo, Neuroradiology, Oslo, Norway, 7Klinikum rechts der Isar Abt. für Neuroradiologie, München, Germany, 8Hôpital Purpan, Toulouse, France, 9Klinikum Nürnberg Süd, Nürnberg, Germany, 10Hôpital Beaujon - Assistance publique Hôpitaux Paris, Clichy, France, 11Hôpital Beaujon - Assistance publique Hôpitaux Paris, Paris, Paris

Purpose
The safety and efficiency of the dual-layer WEB device already has been published. However, this international multicenter study sought to evaluate the safety of single-layer WEB devices, which are the newest generation of the WEB intrasaccular flow disrupter family. They have been designed to offer smaller size devices with a lower profile in order to optimize navigability (through smaller catheters) and delivery, which may in turn broaden their range of use.

Materials and Methods
Data from all patients treated with a single-layer WEB device, in 10 centers, across 4 different countries, from June 2013 to May 2014 were included in this study. Clinical presentations, technical details, pre and perioperative complications, and outcomes at discharge were recorded. Clinical and angiographic data at last follow up also were analyzed when available.

Results
A total of 90 patients with 98 WEB-treated aneurysms were included in this study. Of these, 65 aneurysms were unruptured (66%). In 93 cases (95%) WEB placement was possible. Complete occlusion at the end of the procedure was obtained in 26 instances (26%). Additional treatment during the procedure (coiling and/or stent placement) was necessary in 12 (12.7%) cases. Procedure-related complications occurred in 13 cases, leading to permanent neurologic deficits in four patients. Early vascular imaging follow-up data were available for 44 patients (57%) with an average time interval of 3.3 months. Treatment-related morbidity and mortality rates at last follow up were 2.2% and 1.1%, respectively.
Conclusions

In this study, the feasibility and safety of the single-layer WEB device was comparable to that of the double-layer device. However, further studies are needed to evaluate long term efficacies.

O-483

Initial Experience with the PulseRider for Endovascular Treatment of Bifurcational Wide-Neck Aneurysms

G Gál, G Benndorf

University Hospital Odense, Odense, Denmark, University of Southern Denmark, Odense M, Denmark

Purpose

To report our experience with a recently developed adjunctive device for the endovascular treatment of bifurcational wide neck aneurysms.

Materials and Methods

Between May and November 2014, 5 nonruptured, wide-necked aneurysms, in five patients were treated with coils and the PulseRider® (Pulsar Vascular, San Jose, CA, USA), serving as a scaffold, placed at the aneurysm neck. Three aneurysms were located at the MCA bifurcation and two at the AComA. All aneurysms were considered "difficult to treat" lesions, one of them previously treated with coils and WEB. All patients were premedicated with standard platelet inhibition. The device was introduced through a 0.021" microcatheter and deployed at the neck of the aneurysms. In three cases, one device "arm" had to be placed into the aneurysm sac and the other into the branching artery, while both "arms" could be placed in the lumen of the bifurcational branches in the remaining two. A 0.017" microcatheter was navigated through the PulseRider® into the aneurysm, which subsequently was occluded with coils. Following completion of the coil packing, the device was detached electrically.

Results

In all cases the device could be navigated to and deployed at the target site without technical difficulties. Crossing the device with a second microcatheter for coil placement was possible in all five cases allowing for successful and complete aneurysm occlusion. No complications occurred during the procedures. The patients were discharged on the second day after the treatment, and are awaiting follow-up angiograms.

Conclusions

The PulseRider® is a promising new device that can be deployed easily through a low profile guiding (6F) catheter. It expands the neurointerventional armamentarium for "difficult to treat" cerebral aneurysms that would otherwise require double stenting or flow diverter. The lesser amount of intraluminal metal may allow for its future use in acutely ruptured cases.

O-484

Pre-Clinical Testing of a Novel Thin Film Nitinol Flow-Diverter in a Rabbit Elastase Aneurysm Model

Y Ding, D Kallmes, R Kadirvel, C Kealey, V Gupta, D Johnson
Purpose
Flow diverters (FDs) are a relatively recent advancement in the endovascular treatment of intracranial aneurysms (IAs) and have expanded the types of aneurysms addressable with endovascular techniques. Despite their success there are risks associated with FDs including incomplete aneurysm occlusion, delayed aneurysm rupture, in-stent thrombosis and perforator occlusion. NeuroSigma, Inc. is developing a next-generation FD based on Thin Film Nitinol (TFN) technology that may have advantages over current generation devices. The TFN-FD is constructed from a porous TFN cylinder approximately five micrometers thick that is used to cover a self-expanding nitinol stent backbone. The resulting device has both a lower percent metal coverage (<20%) and a higher pore density (pores per mm2) than currently-available FDs. Here we present preliminary results from preclinical testing of the TFN-based flow-diverter in a rabbit elastase aneurysm model.

Materials and Methods
Thin film nitinol flow diverters were used to treat 13 simulated IAs in the rabbit elastase aneurysm model. In addition, TFN-FDs were placed over 10 lumbar arteries off the abdominal aorta to simulate perforating arteries of the cranial circulation. Intra-aneurysmal and branch artery flow was assessed immediately and 10 minutes after device placement using angiography.

Results
Thirteen simulated IAs (Figure A) and 10 lumbar arteries (Figure D) were treated with the TFN-FD. There were no acute complications associated with device deployment. Dramatically reduced intra-aneurysmal flow was observed on angiography both immediately (Figure B) and 10 minutes (Figure C) after device placement in all simulated IAs. Of the 10 lumbar arteries treated, all were patent 10 minutes (Figure F) after device placement (Figure E).

Conclusions
Preliminary results from preclinical testing of NeuroSigma's TFN-FD are encouraging. Dramatic reductions in intra-aneurysmal flow were observed acutely in all aneurysms treated. Additionally, all lumbar arteries treated with the device were patent acutely and 10 minutes after device placement. Additional results from this ongoing study will be presented including increased numbers of animals and longer term follow up.
Intra-aneurysmal hemodynamic ratio using optical flow imaging: Predicting outcome of flow diverting stents for saccular intracranial aneurysms.

V Mendes Pereira¹, P Bouillot², O Brina², T Grunhagen³, R Ouaied², D Ruijters³, K Lovblad⁴, T Krings⁵
Purpose
The aim of this study was to evaluate the performance of a novel digital subtraction angiography (DSA)-based flow assessment tool using optical flow imaging in predicting complete occlusion for intracranial aneurysms (IAs) treated with flow diverter stents (FDS).

Materials and Methods
We included patients harboring unruptured IAs, which were treated with flow diverter stents (FDS). Pre- and post-DSA sequences in combination with 3D rotational angiography were acquired and the flow change was assessed with the mean aneurysm flow amplitude ratio metric (MAFA-R), a potential marker for positive outcome from a FDS treatment. MAFA-R test performance was assessed to determine results at 3, 6 and 12 months, with receiver operating characteristics analysis considering significant (p-value=0.05) area under curve (AUC) along with MAFA-R threshold.

Results
We included 61 consecutive patients treated with single layer FDS. All the cases were treated successfully. At 3 months imaging follow up, 13 aneurysms were fully occluded (21%) out of N=61, and 48 displayed residual circulation (79%). The performance of MAFA-R test was: AUC=0.60, p=0.287 and threshold=0.85. At 6 months (N=60, n=37 (62%) occluded), AUC=0.63, p=0.090, threshold=0.96. At 12 months (N=56, n=40 (71%) occluded), AUC=0.70, p=0.045, threshold=1.03. For the large aneurysm group (size larger than 10mm), the results were: a/ at 3 months (N=24, n=4 (20%) occluded): AUC=0.9, p=0.014, threshold=0.83; b/ at 6 months (N=23, n=10 (43%)occluded): AUC=0.84, p=0.007, threshold=0.95; c/ at 12 months (N=20, n=14 (70%) occluded): AUC=0.88, p=0.008, threshold=1.03. Figure label - A - Representation of the projected velocity fields with their respective MAFApre and MAFApost computed within the region of interest. The MAFA ratio R is calculated further automatically from these measurements (equation). Receiver operating characteristic (ROC) performance curves for MAFA-R: B, for all the small- and large-sized aneurysms at 12 months; C for the large-sized (>10mm) aneurysms at 3 months and D, for 12 months.

Conclusions
Preprocedural DSA-based MAFA-R is a reliable treatment marker at 12 months for IAs treated with FDS (threshold=1.03). The accuracy of the method was more significant on the sub-group of large aneurysm in which a short term (3 months) threshold (MAFA-R condition - 0.83) was identified considerably.

O-487
11:26AM - 11:34AM

Efficacy of Circum-RF Balloon Catheter for Aneurysm Ablation in a Rabbit Model

G Shengelaiia, N Kipshidze1, G Dangas2
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Purpose
To evaluate efficacy of Circum-RF balloon catheter for promotion of localized fibrosis and narrowing of aneurysm neck.

Materials and Methods
Elastase-induced aneurysms were created at the origin of right common carotid artery in 24 rabbits. At 4 weeks angiography was performed for the aneurysm identification. Animals were divided equally into 4 groups. Group I animals served as a control group. Aneurysms of Group II, III and IV animals were treated by platinum coils, combination of coil-packing and de-endothelialization of aneurysm neck using Circum-RF balloon catheter, and by only treatment of aneurysm neck with the last method respectively. Animals were followed for 6 months and underwent angiography prior to sacrifice.

Results
Aneurysms were patent in all groups at the first angiography and at the second angiography of Group I. At the second angiography the aneurysms of the Group II animals were obliterated by 67.3% in five cases, all aneurysms of the animals of Group III were completely occluded, whereas Group IV animals showed slow filling of the aneurysms due to narrowed ostium by 72.1%. Comparison of the thicknesses of aneurysm walls at the neck, mid-level and apex between the control and experimental groups demonstrated thickening of the wall by 17.3%, 25.7% and 39.7% in Group II, 38.9%, 49.2% and 82.4% in Group III, and 47.5%, 41.7% and 87.3% in Group IV. Histological evaluation of specimens of Group II animals demonstrated presence of thrombus and marked recanalization with laminated blood products. All specimens of Group III showed complete obliteration of aneurysms. The aneurysm ostiums of Group IV animals were narrowed. The average thickness of ostium wall at the neck was 0.81 ± 0.12 mm. The last two groups demonstrated deposition of dense, collagen-rich granulation tissue at the ostium wall.

Conclusions
Removing the intima of the neck of aneurysm with Circum-RF balloon enhances the biological processes responsible for promotion of localized fibrosis, thickening of the wall and may prevent aneurysm regrowth.

Factors influencing the clinical outcome after endovascular coiling of unruptured intracranial aneurysms

R Moreland, M dos Santos, A Sabri, C Lum, H Lesiuk

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Purpose
To identify the factors associated with clinical outcome of coiling of unruptured intracranial aneurysms (UIA).

Materials and Methods
Retrospective analysis of all patients with UIA treated with endovascular coil embolization at the Ottawa Hospital period 2002-2013. Parent artery occlusion and flow-divertion were excluded.
We identified patient, periprocedural, procedural and aneurysm characteristics associated with predischarge and long term clinical outcome; modified Rankin Scale (mRS) 0-2 (favorable) versus 3-6 (unfavorable). We used logistic regression analysis to identify risks associated with poor clinical outcome.

Results
A total of 233 UIA in 202 patients (mean, 55.3 years) met criteria, including 155 (74.7%) females. The mean follow up was 55 months. Preoperatively, 224 cases had an mRS of 0-2, and 14 had an mRS of 3-5. Complete/near-complete occlusion was achieved in 194 (83.3%) of the UIA, and sac residual in 39 (16.7%). The baseline aneurysm occlusion did not interfere with predischarge disability (OR 0.601 95%CI, 0.133-2.728). Thirteen (6.4%) patients were lost to follow up. Multiple aneurysms (44.2%) were not a risk factor for long term disability (OR 1.287 95%CI, 0.492-3.370). Maximum aneurysm size (<=7,>7), dome size (<=7,>7), neck size (<=4,>4), width (<=7,>7), dome/neck ratio (<=2, >2), and width/neck ratio (<=2, >2) had no significant effect on clinical outcomes. Nine cases (4.02%) had worsening disability ≤30 days after coiling. Our peri-operative mortality (≤30 days) was 0.86%. The total peri-operative complications were 18 (4%), including vasospasm occurred in 12% of the cases. Thirty (88.2%) patients were recoiled; the recoiling did not impact the outcome. Conventional coiling technique was associated significantly with worse predischarge outcome (OR 4.660 95%CI, 1.60-13.56) as compared to nonconventional techniques.

Conclusions
In our practice, the safety of coiling embolization of UIA was comparable to the available literature. Aneurysm characteristics and baseline occlusion status did not correlate with clinical outcomes. Retreatment did not influence clinical outcomes. Nonconventional coiling techniques showed significantly favorable predischarge and long term clinical outcomes over conventional technique.

O-489
11:42AM - 11:50AM

Intraarterial Infusion of Milrinone in The Treatment of Severe Symptomatic Cerebral Vasospasm in Patients with Aneurysmal Subarachnoid Hemorrhage: First Experience

F Thaher, A Hickmann, P Kurucz, M Aguilar, W Kurre, O Ganslandt, H Henkes

Purpose
The treatment of secondary cerebral vasospasm (CVS) still poses a challenge in the treatment of patients with aneurysmal subarachnoid hemorrhage (SAH). Lately continuous intra-arterial infusion of calcium channel blockers has been used in severe symptomatic CVS. Milrinone, a phosphodiesterase inhibitor, which combines vasodilating and inotropic properties may become an alternative. We report of our first experiences with intra-arterial infusion of Milrinone in the treatment of severe CVS secondary to SAH.

Materials and Methods
Ten patients with severe symptomatic CVS have been treated. All patients were monitored by transcranial Doppler sonography (TCD) and serial clinical evaluation of neurologic status. In intubated and sedated patients brain tissue oxygenation (ptiO2) was monitored. If symptomatic
vasospasm became apparent (pathologic TCD velocity, pathologic ptiO2 value, new neurologic deficits), conservative treatment was initiated. If symptoms did not improve CT angiography (CTA) was performed. In case of suspected vasospasm by CTA digital subtraction angiography (DSA) was conducted for confirmation and possible intervention. In case of confirmed vasospasm Milrinone (8 mg) was administered intra-arterially in the involved cerebral territories as a single infusion over 30 minutes. Post-interventionally neurological status, TCD, vessel size by DSA, and clinical outcome at discharge using the modified ranking scale (mRS). was analyzed.

Results
Immediate visible increase in arterial diameter by DSA could be stated in 9 of 10 patients. Seven patients experienced neurologic improvement following Milrinone infusion. In five patients a decrease in blood flow velocity measured by TCD was documented. Two intubated and sedated patients showed a relevant increase in ptiO2. Recurrence of vasospasm was seen in three patients. In two of them redilatation could be achieved by another intra-arterial infusion of Milrinone. The remaining patient was treated with Nimodipin infusion via microcatheters. One patient died after initial successful treatment of CVS due to major blood loss from the punctuation site and consecutive cerebral hypoperfusion.

Conclusions
Intra-arterial single Milrinone application appears to be safe with an immediate and persisting effect on CVS in seven of 10 patients. Therefore, it could be an alternative to the continuous intra-arterial infusion of Nimodipin via microcatheters or Papavarin.

Thursday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Michigan AB (Level 2)

22F - PARALLEL SCIENTIFIC PAPER SESSION-ADVANCED NEUROIMAGING TECHNIQUES
O-491 10:30AM - 10:38AM

Magnetization Transfer Imaging in The Progressive Evaluation of White Matter Integrity in Patients with Moderate to Severe Traumatic Brain Injury

F Macruz¹, F Feltrin¹, V Guirado¹, A Zaninotto¹, K Chaim¹, M Otaduy², C Andrade¹, M Martin¹, C Leite¹
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Purpose
It is well known that the available imaging methods, whether by CT or conventional MRI, underestimate the real brain tissue damage in diffuse axonal injury (DAI). This leads to a clinical-radiological dissociation that delays early intervention and impairs an adequate treatment. New quantitative methods are required to allow a more reliable estimation of cerebral lesion's extension and, perhaps, to provide a more trustworthy prognosis and therapeutic orientation. Magnetization transfer sequence, a method that provides a potential measurement of white matter integrity, could be used with this purpose. It has been shown that the main cerebral
damage occurs in the white matter and is not limited to the acute phase of the trauma. However, the progressive character of the extension of the injury is not well known. The purpose of our study was to quantify the damage in the white matter in both acute and subacute phases of the trauma and to evaluate its progression in a more chronic phase, through magnetization transfer ratio (MTR).

Materials and Methods
A prospective study was conducted in 28 patients with traumatic brain injury (group 1) and 28 healthy control subjects, with similar age (group 2). In group 1, three MRIs were performed in the acute (2 months), subacute (6 months) and chronic (12 months) stages, in a 3T machine (Phillips Achieva, Best, The Netherlands) and the T2-weighted, FLAIR, T1 FSPGR and magnetization transfer sequences were evaluated by two neuroradiologists. In group 2, the same sequences were obtained in the same equipment, but only once, since no changes in the exam were expected in cognitively normal subjects. MT images were coregistered to MR images and the white matter, both damaged and apparently spared one in structural images, was segmented. Comparison of MTR was done between group 1 and 2, and among the sequential studies of each patient of group 1.

Results
The mean MTR in the white matter was lower in group 1 whether with 2, 6 or 12 months after the trauma, than in group 2. Comparative analysis between tests performed in the same patient 2, 6 and 12 months after the trauma, also showed a progressive decrease of the average MTR over time.

Conclusions
These findings are consistent with previous observations that the real extension in the cerebral white matter is greater than the one shown in the structural MRI sequences, and involves the apparently preserved parenchyma. Furthermore, a progressive character was observed over time, in spite of the patients rehabilitation treatment.
Principle Component Analysis of Diffusion Tensor Images to Determine White Matter Injury Patterns Underlying Post-Concussive Headache

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Purpose

Principle component analysis (PCA) is a data reduction algorithm that generates a set of principal components that are linear combinations of the original dataset and orthogonal to each other in order to maximally explain the variance of the dataset. This allows redundant variables to be condensed into a relatively few new variables or principle components (PCs) that give the most information about the data. These PCs then can be analyzed to determine which correlate with outcomes of interest. The purpose of our study was to utilize PCA of fractional anisotropy
(FA) maps to identify white matter injury patterns that correlate with post-traumatic headache (PTH) after mild traumatic brain injury (mTBI).

Materials and Methods
The institutional review board approved this study, with waiver of informed consent. Diffusion tensor imaging and neurocognitive testing with the Immediate Post-Concussion Assessment and Cognitive Test were performed in 40 mTBI patients with PTH. Controls consisted of 24 mTBI patients without PTH. Fractional anisotropy maps were generated as a measure of white matter integrity and were registered to a standard brain atlas using a 12-parameter affine transformation. Using a custom Matlab script, PCA of the FA maps was performed. The first 20 PCs were screened with univariate analyses for correlation with PTH. Forward-stepwise nominal regression with PCs whose univariate p-value was <0.25 then was used to identify correlation with the presence of PTH. Finally, each PC that correlated with the presence of PTH was screened against other postconcussive symptoms and demographic factors (age, sex).

Results
Principal component 4 (mean: 7.1 SD: 10.3) correlated with the presence of headache in mTBI patients with a unit odds ratio of 1.13 (95%CI: 1.05–1.26, p=0.01). Decreasing PC4 corresponded to decreased FA in the mid-splenium of the corpus callosum. Abnormalities in the splenium of the corpus callosum commonly are seen after mTBI (1) and non-traumatic migraine, where they are associated with a more chronic disease course, greater headache frequency, and comorbid neuropsychiatric conditions (2). This principle component uniquely correlated with the presence of PTH and did not correlate with any other postconcussive symptom or demographic factor.

Conclusions
Principal component analysis can be used as a data mining method to identify white matter injury patterns on DTI that correlate with clinically relevant symptoms in mTBI. A pattern of reduced FA, identified by PCA, in the splenium of the corpus callosum correlates with increased odds of postconcussive headache in mTBI patients.
"When pigs fly" - Sus Scrofa Domestica as an MRI model for hypobaric non-hypoxic exposure effects upon the brain

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Purpose
We postulated repeated exposure to hypobaric nonhypoxic environments will induce subcortical white matter injury in Sus scrofa domestica. The purpose is to prove a valid animal model for further investigation of hypobaric exposure related white matter injury demonstrated in high altitude pilots and aerospace physiology technicians.

Materials and Methods
Eight mini-pigs were exposed to six 8-hour repeated episodes of nonhypoxic hypobaria following 1 hour of denitrogenation (100% oxygen prebreathing) over a 2-week period. The pigs were under general anesthesia and veterinary technician/nurse monitoring. MR imaging was used pre and postexposure as well as 4 weeks postexposure for characterization of structural change (3 MRI exams for each animal). Additionally inflammatory serological markers and brain necropsy were performed. Three additional control group mini-pigs were placed in the altitude chamber and remained at sea level on room air oxygen concentration. Control animals underwent a total

Figure 1. Mean DTI slice (middle) and effect of changing principal component 4 by +/- 2 standard deviations (left and right respectively). Decreasing principal component 4 reduces FA in the splenium (white arrow).
of two MRI exams, prior to and post sham exposure only. Laboratory data and necropsy also were performed. MR imaging was performed on a 3T Siemens Verio magnet. The protocol included six sagittal MPRAGE sequences with TI varying from 766-801, MRS with TE 30 and 135 within the right and left frontal regions, 3D sagittal FLAIR, sagittal T2 FSE, susceptibility-weighted imaging, diffusion imaging (55 directions), diffusion tensor Q space imaging, and contrast-enhanced echo planar perfusion imaging (approximately 3 hour exam). Necropsy was performed by a veterinary pathologist and the brain specimens were evaluated by a fellowship trained neuropathologist.

Results
The initial two swine experimental group animals experienced fatal pulmonary decompression sickness. After revising the protocol, no FLAIR signal abnormality, hemosiderin deposits, or other structural change was observed in the eight remaining pigs. A swine anatomical atlas is under construction from the first 10 animal subjects. Analysis of MRS, DTI and perfusion imaging is in process and will be presented. Initial neuropathologic results are not conclusive for evidence of neurological decompression sickness.

Conclusions
This study demonstrated that swine can survive repeated exposure to hypobaric conditions in a tightly controlled environment; in other words, pigs can fly. However preliminary results suggest this may not be an ideal model for hypobaric exposure-related brain injury investigation. Further research is required including the inclusion of more subjects prior to rejecting this as a model for neurological decompression sickness and white matter injury.

O-494

10:54AM - 11:02AM

Positive Association of Diffusion Tensor and Kurtosis Imaging Metrics with Volume Loss and Small Vessel Disease Burden in Patients with Mild Cognitive Impairment.

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Purpose
Mild cognitive impairment (MCI) is an intermediate stage between normal aging and Alzheimer disease. We hypothesize an association between diffusion tensor (DTI) and kurtosis (DKI) metrics and the degree of volume loss and small vessel disease (SVD) burden in patients with MCI.

Materials and Methods
A total of 23 patients diagnosed with MCI who underwent clinical and neurocognitive testing were included in this study. Brain MRI were performed on a 3T Siemens scanner with a 12-channel matrix head coil. In addition to standard clinical images, diffusion imaging was performed using 30 gradient encoding directions and three b-values: 0, 1000, 2000. Image processing was performed with diffusion kurtosis estimator (DKE) software. Anatomical regions of interest (ROIs) were placed bilaterally on the hippocampus, anterior centrum semiovale, posterior centrum semiovale, thalamus, internal capsule posterior limb, corpus callosum genu and corpus callosum splenium. Axial, radial, and mean kurtosis (MK); axial, radial, and mean diffusivity (MD) and fractional anisotropy (FA) were calculated for each ROI. Automated quantitative measurements of segmented brain were generated using NeuroQuant software.
Small vessel disease (SVD) was estimated using white matter T2 hyperintensity using Fazekas method, including periventricular (PVH) and deep white matter (DWMH) hyperintensity, number of cortical and lacunar infarcts, and the degree of perivascular space (PVS) enlargement. Overall SVD score was calculated using Staals et al. method. Kendall tau coefficient was used to measure the association between diffusion parameters and anatomical metrics. P values were declared statistically significant only when <0.05 and trending when <0.10.

**Results**

Significant correlation between anatomical metrics and diffusion parameters were observed. Right anterior and posterior centrum semiovale MK, MD, and FA correlated with PVH scores; with the exception of a trend of FA in the anterior right centrum semiovale. PVH scores also were correlated with right internal capsule posterior limb MK and FA; left internal capsule posterior limb MK and MD, with a trend for FA; and left thalamus MK, MD, and FA. Right internal capsule posterior limb MK, MD, and FA correlated with overall SVD score. Size of the left and right lateral and inferior lateral ventricles correlated with corpus callosum genu MK and MD. Corpus callosum splenium MD also correlated with size of ventricles. Trends were seen for several other corpus callosum metrics and ventricular size. Correlation between enlarged basal ganglia PVS and bilateral internal capsule posterior limb MD and FA was seen, possibly due to inclusion of PVS within these ROIs.

**Conclusions**

We observed statistically significant and potentially meaningful correlations in diffusion and kurtosis parameters with volumetric measurements and with SVD in patients with MCI. Correlation of these metrics and neurocognitive testing may help further stratify these patients and longitudinal studies may illuminate which factors may be associated with development of Alzheimer disease.

**O-495**

**11:02AM - 11:10AM**

**Sex Differences in Brain-Behavior Relationships in Substance Dependence**

M Regner¹, M Dalwani¹, Y Dorothy¹, R Perry¹, J Sakai¹, J Honce¹, J Tanabe¹

¹University of Colorado, Aurora, CO

**Purpose**

Men and women differ in the natural history of substance dependence. While prior neuroimaging studies demonstrated relationships between brain volumes and behavior in substance dependent individuals (SDI) compared to healthy controls, the effect of sex on these relationships is incompletely understood. We investigated the effects of sex and group on the relationships between behavioral traits and brain structure in SDI and healthy controls.

**Materials and Methods**

One hundred twenty-seven age- and sex-matched participants (28F/40M controls, 28F/31M SDI) were scanned on a 3T MR system. Substance dependent individuals met DSM-IV criteria for dependence on psychostimulants. Substance dependent individuals were abstinent an average of 13.5 months. T1-weighted SPGR-IR images were acquired, segmented using SPM8 and VBM8 toolboxes, and registered using diffeomorphic anatomical registration through exponentiated lie algebra. Behavioral measures of drug use severity, impulsivity, approach to reward, and negative affect were obtained using standardized questionnaires. Main effects of group, sex, and sex by
group interactions on brain-behavior correlations were analyzed over the whole brain using ANCOVA, adjusting for age and intracranial volume by modulation (SPM8), and corrected for multiple comparisons using family-wise error p<0.05.

Results
Significant sex by group interactions in brain-behavior relationships were observed for approach to reward (bilateral middle frontal gyri; p<0.001), impulsivity (left insula, superior temporal gyrus; p<0.001), and negative affect (bilateral cerebellar hemispheres; p<0.001). In women, the direction of correlation between gray matter volumes and behavior differed in SDI compared to controls. In men, the brain-behavior relationships were similar in SDI compared to controls.

Conclusions
Differences in cortical and subcortical gray matter volumes across group and sex corresponded to differences in impulsivity, approach, negative affect, and drug use severity across group and sex. These findings may elucidate mechanisms underlying the different clinical profiles in the natural history of substance dependence in men compared to women.

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O-496 11:10AM - 11:18AM
Natural History of Endoscopic Third Ventriculostomy Defects Followed with High Resolution MRI

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Purpose
Endoscopic third ventriculostomy (ETV) is a procedure commonly utilized to treat
noncommunicating hydrocephalus. The natural history of ETV has not been well described. The purpose of this study is to evaluate the morphologic change seen in ETV stomas over time with constructive interference in steady state (CISS) high resolution MRI.

Materials and Methods
A retrospective review of postsurgical MRI studies in patients who underwent ETV and high resolution MRIs from 2009-2013 including high resolution 3D sagittal CISS images through the midline was performed. Patients who underwent ventriculostomy tube placement were excluded. The ETV defect was measured in AP and TV dimension and presence of flow void evaluated as absent, mild or robust. Bowing of the lamina terminalis and floor of the third ventricle if present was measured on presurgical and postsurgical studies.

Results
For this IRB approved retrospective study we searched our database of 235 dedicated post-ETV protocol high resolution MRIs performed at our institution from 2009-2013 for patients who underwent multiple post-ETV MRI examinations. Patients who underwent ventriculostomy tube placement were excluded. Eleven patients with 24 studies were included. Patients had up to four follow-up studies up to 4 years after ETV surgery. The average defect size on the immediate postsurgical study was 3.2 x 2.8mm. All studies showed a subsequent increase in size of ETV stoma. The average increase was of 1.6mm/year in both the AP and TV dimension.

Conclusions
Sequential postoperative high resolution MRI in adult hydrocephalus patients who underwent ETV showed an increase in size of the ETV stoma on sequential follow-up imaging. Such findings may be helpful in evaluating patients with imaging in the setting of suspected ETV occlusion.

Hyperbaric Oxygen Treatment increases angiogenesis in patients with chronic mild traumatic brain injury and improves clinical function

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Purpose
Postconcussion syndrome due to mild traumatic brain injury (mTBI) is associated with unrepairable diffuse axonal due to microvascular damage correlating with chronic cognitive impairment. Dynamic susceptibility contrast MRI (DSC) and dynamic contrast-enhanced MRI (DCE) can be used as a marker for angiogenesis. Hyperbaric oxygen treatment (HBOT) can induce angiogenesis in animal models. Even though HBOT can induce neuroplasticity in postconcussion patients, the HBOT effect on brain angiogenesis in humans has not been validated yet. The aim is to evaluate the effect of HBOT on brain angiogenesis and cognitive function in patients with chronic neurocognitive impairment due to mTBI.

Materials and Methods
Hyperbaric oxygen treatment was provided for nine patients with postconcussion syndrome, 1-20 years after the acute mTBI. The HBOT protocol included 60 daily sessions at 1.5 ATA. MR imaging studies were performed before and after treatment. MR imaging included conventional sequences with DSC and DCE sequences. From DCE were calculated $K_{trans}$, extra-cellular volume ($V_e$) and plasma volume ($V_p$). From DSC were calculated CBF, CBV, and MTT maps. Cognitive function before and after treatment was measured by Neurotrax Mindstreams™ Cognitive Health Assessment.

Results
Significant increase was demonstrated in CBF ($p=0.0065$) and CBV ($p=0.005$). Mean transit time (MTT) decrease did not reach significant. Plasma volume increase showed borderline significance ($p=0.08$). The increased brain angiogenesis correlated with the significant improvement in their neurocognitive tests.

Conclusions
Dynamic susceptibility contrast and DCE findings imply that HBOT can induce angiogenesis in patients with chronic brain injury due to mTBI. Dynamic susceptibility contrast changes correlated with the clinical improvement and can be used as a marker for biological response to HBOT.

**O-498**

11:26AM - 11:34AM

“Fixed Region of Interest (Fixed ROI)” Technique for Clinical Measurement of Aqueduct Cerebrospinal Fluid (CSF) Flow in Phase Contrast MRI is Reliable and Accurate

E Lui\textsuperscript{1}, W Wang\textsuperscript{1}, C Steward\textsuperscript{1}, D Liew\textsuperscript{1}, P Desmond\textsuperscript{1}

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Purpose
Aqueduct stroke volume (ASV) and peak systolic velocity (PSV) are considered markers of shunt responsiveness in normal pressure hydrocephalus (NPH) (1, 2). Measurement techniques and reported values have been variable, with little in the literature on workstation measurement methods and reliability. We aim to: (i) assess reproducibility & noise correction on our devised "fixed ROI" method 1 (ii) compare accuracy of method 1 with conventional "variable ROI" method 2 (iii) establish our normal range in aged normal subjects

Materials and Methods
Twenty-one normal subjects (age 65-82 years; 8 male) were recruited prospectively for CSF cine
acquisition. Gated-phase contrast images were obtained perpendicular to the line of the aqueduct at the level of its largest cross section on Siemens 3T Trio, VENC=10-20cm/s, matrix=192x256mm, slice thickness=4mm, TR=36.9ms, TE=6.08ms, flip angle=20 degrees. Postprocessing was performed with Argus analysis (Siemens, Erlangen, Germany) using two methods to obtain ASV and PSV: (i)"fixed ROI", circular ROI on frame with the largest aqueduct cross section, copying the same size ROI to all frames, (ii)"variable ROI", best fit circular ROI for each frame. For both methods, the same size ROI for each frame was moved to adjacent midbrain to obtain a measurement of the background noise. Rater 1 measured with method 1 twice, and method 2 once. Rater 2 measured with method 1 once. Statistics performed on SPSS 22(IBM).

Results
Aqueduct stroke volume inter and intrarater reproducibility was high with intraclass correlation coefficients (ICC) >0.99 without and with noise correction. Noise correction reduced systemic differences between raters from differing size ROI. Peak systolic velocity inter and intrarater reproducibility was high (ICC=1). Aqueduct stroke volume in our aged normal subjects from methods 1 and 2 were 51+/-31 microliter (mean +/- standard deviation) and 48+/-29 microliter respectively (ICC 0.99, p>0.5). Peak systolic velocity for both methods was 7.5+/-2.3cm/second.

Conclusions
The fixed ROI method is highly reproducible, accurate, and also faster and easier to perform compared to the conventional variable ROI method, making it useful clinically.

O-499

The utilization of texture analysis to detect osseous changes of renal osteodystrophy on head CT

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Purpose
Renal osteodystrophy is a term encompassing the skeletal pathology in patients with chronic renal failure, some of which may include demineralization, or osteomalacia, and shows mixed osteolysis and osteosclerosis. These findings generally are not seen until later stage of the disease. The purpose of this study is to investigate the feasibility of using texture analysis as a postprocessing, objective tool to detect osseous changes of renal osteodystrophy on head CT.

Materials and Methods
Following IRB approval, 20 patients with renal osteodystrophy who underwent noncontrast head CT from January 2011 to November 2014 were included in this study and compared to 20 age- and gender-matched controls. Five osseous regions (clivus, bilateral sphenoid triangles and mandibular condyles) were contoured manually, segmented and imported into a novel texture analysis software developed in-house and 42 texture features were calculated for each of the five regions. Differences in texture parameters were evaluated using t-test.
Results
Statistically significant differences were found in 25 texture parameters including six histogram, three gray level co-occurrence matrix (GLCM) features, three gray level run length (GLRL) features, 11 Law's features, and two gray level gradient matrix (GLGM) features in all five regions (P<0.01). All the Law's features and most of the GLCM features showed the differences significantly.

Conclusions
A majority of texture features demonstrated statistically significant differences between renal osteodystrophy and normal controls in all five segmented regions. This study demonstrates that texture analysis potentially can be a reliable objective tool to detect osseous changes of renal osteodystrophy.

O-500
11:42AM - 11:50AM

Histogram Analytic Anomalies of Interstitial Gadolinium Between Brain and Spinal Cord in MR Myelography in Anesthesized Rats Suggests Two Independent States of T1 Shortening in the Brain

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Purpose
Nuclear medicine and MR myelographic studies have demonstrated communication between cerebrospinal and interstitial fluid within both the cerebral cortex and spinal cord (1, 2). Using a rat model, we have compared the voxel histograms of cerebral cortex and spinal cord gray matter penetrated by gadolinium from MR myelography and describe an intriguing difference between the two histograms that might be explained by a two-state model of the gadolinium-induced T1 shortening.

Materials and Methods
MR imaging was performed on an Agilent/Varian 9.4T horizontal bore MRI. Images were collected using 2D T1-weighted spin echo (TR/TE=400/10 ms; in-plane resolution=110x110 µm²; slice thickness=1.0 mm; 8 averages) and 3D GRE T2*-weighted sequences (TR/TE=13/7 ms; flip angle=8 degree; pixel resolution=110x110x250 µm³; 4 averages). MR myelography was performed on three anesthetized white rats by first diluting Gadoterate Meglumine 10:1, followed by injection of 0.1 ml into the lumbar thecal sac under CT guidance. Rats were recovered and then inverted to mix and pool contrast in the SAS before reimaging with identical parameters.

Results
T1-weighted images revealed visible penetration of contrast into the cerebral cortex, periventricular structures and spinal cord. T1-weighted postcontrast histograms became bimodal in the cerebral cortex but not the spinal cord. Postcontrast GRE images of the same regions demonstrated down-shifted histograms, but no histogram splitting.

Conclusions
Our findings demonstrate that interstitial gadolinium characteristically splits the cortical T1 signal histogram, inspiring us to propose either a two-state process of gadolinium T1 shortening or superimposed T2* effects from confinement of the paramagnet agent. Analogously, interstitial
gadolinium mimics either deoxyhemoglobin-methemoglobin conformational change or intracellular methemoglobin T2* shortening. As histogram splitting occurs only in the cortex on T1-weighted images and not the spinal cord or on T2* images in anesthetized animals, we propose a voltage-sensitive T1 transition, although voltage-sensitive T2* effects have been described previously in gels (3).

(Filename: TCT_O-500 ASNR2015Final.jpg)

O-501

Molecular Imaging to Assess Retinal Ganglion Cell Reserve: Retinography

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Purpose

To develop a NIR fluorescent probe for nerve imaging based on the fast retrograde neural transport mechanism to visualize retinal ganglion cells (RGCs) in a glaucoma model.

Materials and Methods

A well characterized model of excitotoxic glaucoma was induced in rat (n=3) eyes by injecting NMDA (N-methyl-D-aspartic acid, 50 nmol/2.5 µL) into the vitreus of one eye. This model is known to induce apoptosis in RGCs. Twenty-four hours after the NMDA injection, the NIR fluorescent neural imaging probe consisting of the nontoxic, C-fragment of Tetanus Toxin (TTc790) also was injected into the vitreus of both the contralateral normal (control) eye and the NMDA-treated eye (8 µg TTc790/2µl PBS). In vivo imaging of the distribution of TTc790 was performed using a confocal-scanning laser ophthalmoscopy (cSLO) (Retinal Angiograph II, Heidelberg, Germany). Both eyes and associated neural tissues were harvested at 2-3 hours after
TTc790 injection for ex vivo microscopic imaging using an epi-fluorescent microscope with NIR imaging capabilities (AxioZoom16, Zeiss Microscopy, Germany).

Results
Images were consistent with RCGs showing the most TTc790 uptake. The RGCs are the final projection neurons of the retina, responsible for carrying information from the eye through the optic nerve, to the lateral geniculate nucleus. RGC axons are the principal component of the optic nerve. Live animal and ex vivo neural uptake studies within the rat retina demonstrate: a) avid TTc790 uptake in RGCs, b) that both in vivo and ex vivo imaging is feasible and c) that an NMDA-induced model of glaucoma shows greatly reduced uptake and transport of TTc790 that can be detected by live cSLO imaging. Preliminary statistical data analysis of raw fluorescent output from the retina showed 11,460 +/- 1,601 AU for normal and 9,255 +/- 224 NMDA-treated eyes (p<0.05, two-tailed paired t-test).

Conclusions
A novel fluorescent NIR probe, TTc790, allows the visualization and quantitation of retinal ganglion nerve cells. We show significant decreases in neuronal uptake and transport of TTc790 in a glaucoma model, a condition in which the hallmark pathology is loss of RGCs. There are clear implications for clinical staging and monitoring of patients at risk of blindness from glaucoma.

Thursday
10:30AM - 12:10PM
Sheraton Chicago Hotel & Towers, Superior AB (Level 2)

22G - PARALLEL SCIENTIFIC PAPER SESSION-ADULT BRAIN: METASTASES/OTHER TUMORS
O-502
10:30AM - 10:38AM

Differentiation of Solitary Brain Metastasis from Glioblastoma Multiforme: A Predictive Model Using Combined MR Diffusion and Perfusion

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Purpose
Solitary brain metastasis (MET) and glioblastoma multiforme (GBM) can appear similar on conventional MRI. The purpose of this study was to identify MR perfusion and diffusion-weighted biomarkers that can differentiate MET from GBM, using voxel-based analysis.

Materials and Methods
In this retrospective study, patients were included if they met the following criteria: underwent resection of a solitary enhancing brain tumor and had preoperative 3.0T MRI encompassing DTI, dynamic contrast-enhanced (DCE) and DSC perfusion. Using coregistered images, voxel-based FA, MD, Ktrans and rCBV values were obtained in the enhancing tumor and nonenhancing peritumoral T2 hyperintense region (NET2). Data were analyzed by logistic regression and analysis of variance. Receiver operating characteristic (ROC) analysis was performed to determine the optimal parameter(s) and threshold(s) for predicting GBM versus MET.
Results
Twenty-three patients (14 M, age: 32-78 years) met inclusion criteria. Pathology revealed 13 GBMs and 10 METs. In the enhancing tumor, rCBV, Ktrans, and FA were significantly higher (p<0.0001) in GBM than in MET, whereas MD was significantly lower (p<0.0001) in GBM than in MET. In the NET2, rCBV and FA were significantly higher (p<0.0001) in GBM than in MET, but MD and Ktrans were significantly lower (p<0.0001) in GBM compared to MET. The best discriminative power was obtained in NET2 (not in enhancing tumor) from a combination of rCBV > 0.78, FA > 0.12, MD < 1700 x 10−6 mm2/s, and Ktrans < 0.25 1/min, resulting in an AUC of 0.92 superior to any individual or combination of other classifiers (Figure 1).

Conclusions
Our multiparametric MRI model is able to distinguish GBM from MET by using a combination of rCBV, Ktrans, FA, and ADC in NET2 with an AUC of 0.92 superior to any individual or combination of other classifiers.
Which contrast-enhanced T1-weighted sequence should be used to evaluate brain metastases at 3 Tesla?

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Purpose
To assess the contrast-enhanced T1-weighted sequence that scores best in evaluating brain metastases at 3T.

Materials and Methods
One hundred thirty-nine oncologic patients (61 men, 78 women; mean age 59.7 ± 17.4 years), examined between January 2010 and October 2013, who had undergone clinically indicated contrast-enhanced MR imaging of the brain at 3T for suspicion of brain metastases were included retrospectively. Two neuroradiologists who were blinded to the patients' clinical information were asked to count enhanced lesions and to divide them into supratentorial and infratentorial and thecal on four different T1-weighted sequences: 1mm sagittal 3D-fast field echo (FFE), 3-mm axial reformatted 3D FFE and fat-suppressed spin echo (FS SE), and 1 mm axial reformatted 3D FFE. Sequences were presented randomly. Statistical differences of the number of metastases detected on each T1-weighted sequence were evaluated using a Wilcoxon test (Bonferroni corrected p<0.008). Test of concordance Kappa was used to assess the interobserver agreement between the two neuroradiologists (<.05).

Results
1 mm axial reformatted 3D FFE was the sequence that scored best in identifying intraparenchymal (supra and infratentorial) metastases. 3 mm axial FS SE was the sequence that scored best in identifying thecal metastases and parenchymal metastasis from lung adenocarcinoma and the one that determined the greatest interobserver agreement (k=.951; p<.001).

Conclusions
At 3T, when you suspect brain metastases first look at 1 mm reformatted 3D FFE sequences. For thecal metastases priority should be given to FS sequences.

Response Assessment of Cerebral Metastases After High-Dose Stereotactic Radiation: Using Combined Diffusion and Perfusion MR Imaging

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Purpose
In the evaluation of cerebral metastases treated with radiation, accurate assessment of treatment response versus pseudoprogression or radiation necrosis can be challenging on conventional imaging. The purpose of this study was to assess whether multiparametric MR perfusion and diffusion biomarkers can predict response to radiation treatment in cerebral metastases.
Materials and Methods
Inclusion criteria for this retrospective study were: cerebral metastases that were treated with radiation, availability of multiparametric MRI including MR diffusion and dynamic susceptibility contrast (DSC) before the start of radiation and at least on two subsequent follow-up imaging studies. Image analysis was performed using FDA approved software (Olea Medical). Volumetric analysis of lesion volume was performed based on the signal intensity subsuming the entire region of enhancement on T1 postcontrast images. Dynamic susceptibility contrast studies were processed using Bayesian probabilistic method (1) to generate CBV maps. Using coregistered images, voxel-based ADC and rCBV values were obtained in the enhancing lesions. Disease progression was defined as an increase in lesion volume >40% over baseline pretreatment volume (2). Sequential follow-up rCBV and ADC values were scored to assess the fit with expected patterns of favorable response (rCBV: Steady decrease or increase followed by decrease; ADC: Increase or stable) or nonfavorable response (rCBV: Steady increase or decrease followed by increase; ADC: Decrease) (3). Pretreatment and follow-up values were assessed for significant differences using t-test and scores were assessed for diagnostic correlation using Fisher's exact test.

Results
Fifteen cerebral metastases were included with a total of 60 MRI scans evaluated in this longitudinal study. The mean follow up was 7.8 months after initial scan (range: 2.4 to 13.9). Twelve lesions (80%) remained stable or regressed after radiation as determined by lesion volume. The mean ± SD of imaging biomarkers in pretreatment scans versus sequential follow-up studies were: 1070 ± 325 versus 1227 ± 316 (10^-6 mm^2/s) for ADC (p=0.34); and 3.9 ± 5.1 versus 2.4 ± 2.0 for rCBV (p=0.37). Longitudinal follow-up MRI analysis demonstrated a progressive increase in ADC and a progressive decline in rCBV values compared to pretreatment scans (Figures 1 and 2). Using sequential ADC and rCBV scored values, expected response patterns matched volume-based response assessment in eleven (92%, p=0.37) and ten (83%, p=0.52) responding lesions, respectively. In subanalysis of the group with favorable biomarker response, five lesions (50%) showed an interesting trend of early rCBV increase followed by a gradual decline. It is plausible that the initial increase in perfusion can further accentuate the effect of radiation in this group.

Conclusions
Multiparametric MR diffusion and perfusion can be used in the characterization of postradiation changes in patients with cerebral metastases. Longitudinal analysis of combined rCBV and ADC can be used to predict postradiation treatment response independent of morphological changes on conventional imaging.
Figure 1. ADC values of lesions which responded to treatment. Follow-up values demonstrated an elevated ADC, which may signify an expected decrease in lesion cellularity.

Figure 2. rCBV values which responded to treatment. Follow-up values demonstrated a decrease in rCBV, signify an expected decrease in lesion vascularity.
The Role of Blood Volume Mapping in Treated Cerebral Metastases

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Purpose
While cerebral metastases are the most common malignancies in the CNS, they are less studied than primary brain tumors. Current therapies include surgery, focal high dose radiation, and newer chemotherapeutic approaches as well as immunotherapy. Treatment-related changes ranging from focal edema to extensive radiation necrosis often are present and can mimic tumor progression. Similar to high grade gliomas, differentiation of progression and pseudoprogression is becoming an issue in neuroradiology when solely standard anatomical imaging is used. The purpose of presenting this series of cases is to demonstrate the value of cerebral blood volume (CBV) mapping as an additional tool in the management of patients with cerebral metastatic disease.

Materials and Methods
Twenty-one patients with various metastatic diseases including lung, breast, melanoma, lymphoma and ovarian primary tumors underwent dynamic susceptibility contrast (DSC) imaging as part of the diagnostic MRI protocol or on imaging research protocol. Gadoteridol, or ferumoxytol was used as contrast agent. Cerebral blood volume maps were created using Nordic ICE, an FDA approved postprocessing software package. In some patients high resolution steady state CBV maps also were created using ferumoxytol.

Results
Perfusion sequences were different throughout the study. Scans optimized for tumor perfusion with higher spatial and lower temporal resolution were superior in the assessment of lesions. Steady state CBV helped assessing smaller enhancing areas, and the differentiation of vascular tumor hotspots from larger blood vessels were more obvious.

Conclusions
In this hypothesis generating study CBV mapping appeared a useful tool in patients with treated metastatic lesions to differentiate treatment-related changes from active tumor. Optimized CBV mapping as part of the treatment response criteria for metastatic disease may be considered.
Patient #1: melanoma metastasis post RTX
Low CBV – treatment related changes

Patient #2: melanoma metastasis post RTX
High CBV – tumor progression
Hemangiopericytoma from meningioma- Is diffusion weighted imaging useful in their differentiation?

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Purpose
Hemangiopericytoma and meningioma appear similar on routine diagnostic imaging and hence are difficult to distinguish. Diffusion-weighted images (DWI) has been used to characterize different types of tumors. The purpose of this study was to assess whether DWI can be used to differentiate hemangiopericytoma from meningioma on diagnostic imaging.

Materials and Methods
In a retrospective study, our tumor database was analyzed for diagnosis of hemangiopericytoma with DWI available at the time of diagnostic imaging. These patients then were matched based on location and size of the tumor in a ratio of one hemangiopericytoma versus two matched meningioma. The minimum and mean apparent diffusion coefficient (ADC) was measured in the tumor and the contralateral normal appearing white matter (NAWM). A normalized ADC (nADC) was calculated as the ratio of ADC in tumor with that in NAWM. The two tumors also were subjectively assessed for their heterogeneity.

Results
Out of the 14 patients with histopathological diagnosis of hemangiopericytoma, only seven had DWI for analysis. These were matched based on size and location with 14 patients out of the 209 meningioma patients screened. The age (p=0.076), gender (p=0.77), size (p=0.35) minimum ADC (p=0.081), mean NAWM (p=0.24) and normalized ADC (p=0.80) were not significantly different between the two groups. All primary meningioma were significantly homogeneous (p<0.001) in appearance compared to hemangiopericytomas. Hemangiopericytomas had a higher mean ADC compared to that of meningioma (p<0.001). Figure 1. A comparison between hemangiopericytoma (gray) and meningioma (black) using the mean ADC values measured from each case.

Conclusions
Hemangiopericytoma showed heterogeneity on DWI and significantly higher ADC compared to that of meningiomas in our small study. This needs to be confirmed in a study with a larger sample size.
Purpose
Metastasis is the most common cause of a parenchymal brain mass with lung and breast cancer being the first and second most common causes respectively. As patients with advanced stages of breast cancer are living longer, the incidence of brain metastasis from breast cancer is increasing. Standard of care for breast cancer involves evaluation of immunohistochemistry, which can guide therapy and alter prognosis. We aim to evaluate retrospectively magnetic resonance imaging (MRI) characteristics of breast cancer metastasis to the brain and assess whether imaging findings differ in tumors with different immunohistochemistry.

Materials and Methods
In this retrospective study, we identified 26 patients (mean age, 54.7 years; age range, 34-81
years) who underwent pretreatment MRI at our institution from January 2009 to June 2014 with pathologically proven metastatic breast cancer to the brain. Patients' primary breast cancer immunohistochemistry mutations (estrogen receptor, progesterone receptor, and HER2-neu receptor, etc.) were recorded. The exams were evaluated by two radiologists who were blinded to the pathology data.

Results
Twenty-nine females were identified with metastatic brain cancer, 15/29 were triple negative, 6/29 were triple positive (ER, PR, HER2), 4/29 were ER/PR positive and HER2 negative, 3/29 were only ER-positive and 1/29 were only PR-positive breast cancers. On noncontrast CT, 18/29 (62.1%) had evidence of a lesion, which were isodense to gray matter. Of these, 13/18 were triple negative, 4/18 were triple positive. On MRI, the lesions relative to gray matter were T1-hypointense in 27/29 (93.1%) of patients. Only 2/29 (6.9%) lesions were T1-isointense and both of these cases were triple negative. Twenty-four of 29 (82.8%) patients demonstrated T2 and FLAIR lesions were isointense to gray matter. Only 5/29 (17.2%) were hyperintense on T2 and FLAIR images, out of which four were triple negative. Twenty-one of 29 (72.4%) patients had heterogeneous postcontrast enhancement. Eight of 29 (27.6%) had homogenous postcontrast enhancement, out of which four were ER/PR positive and two were triple positive. The lesions varied in size ranging from 3.0 mm up to 4.7cm and average lesion size on postcontrast image was approximately 13.1cm. On DWI, 18/29 (62.1%) demonstrated restricted diffusion. Six of 11 patients without restricted diffusion were triple negative. On GRE sequence, 6/29 patients (20.6%) demonstrated susceptibility artifact and none demonstrated observable calcium on CT. Five of 6 of these patients were triple negative.

Conclusions
In patients with metastatic breast cancer to the brain, triple negative breast cancers are the most common subtype. Imaging characteristics of triple negative breast cancers include isodense (relative to gray matter) mass on CT. MR imaging characteristics of triple negative breast cancer reveals T1 hypointense, T2/FLAIR isointense mass with restricted diffusion and heterogeneous postcontrast enhancement. Also, in patients with history of breast cancer, presence of susceptibility artifact in a potential metastatic brain lesion is more likely to represent triple negative subtype.

O-509

Apparent Diffusion Coefficient Measurement of Chordoid Meningiomas in Comparison with Grade 1 and Grade 2 Atypical Meningiomas

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Purpose
Chordoid meningiomas are a rare variant of meningiomas with distinct histopathological features. Purpose of this study is to evaluate the imaging features of chordoid meningioma and to correlate the diffusion parameters with histopathological features, imaging and clinical follow up as compared with nonchordoid meningiomas.
Materials and Methods
We retrospectively evaluated the database of all chordoid meningiomas during the period from 2009 to 2014. There were eight patients with the sex ratio of M:F = 1:6 with average age of 53 years ranging from 23-78. Four had high red blood cell bandwidth distribution and one had microcytic anemia, which may be related to reported overproduction of interleukin-6 in patients with chordoid meningiomas. The majority was treated with a combination of surgery and radiation and during the average follow-up period of 2.29 years, there was no evidence of recurrence on imaging. We evaluated MRI findings in eight patients with chordoid meningioma and compared them with eight patients with WHO Grade 1 meningiomas and Grade 2 atypical meningiomas. Their lowest average apparent diffusion coefficient (ADC) values were calculated in the enhancing portion of the tumor and in the adjacent normal-appearing cerebral white matter. We used Student's t-tests for the statistical analysis between the groups.

Results
The conventional MR imaging features of chordoid meningiomas were similar to Grade 1 and Grade 2 meningiomas. However, the lowest average ADC value in the chordoid meningioma (1.025 x 10^-3mm^2/s, ranging from 0.849 to 1.349) was significantly higher than those in the normal white matter (0.749 x 10^-3mm^2/s, ranging from 0.688 to 0.758) (p<0.005), Grade 1 (0.814 x 10^-3mm^2/s, ranging from 0.644 to 0.924) (p<0.05), and Grade 2 meningiomas (0.762 x 10^-3mm^2/s, ranging from 0.680 to 0.842) (p<0.01). The high ADC values in chordoid meningiomas are due possibly to the abundant myxoid matrix seen in the pathology.

Conclusions
Chordoid meningiomas in our series had significantly higher ADC values than those in both WHO Grade 1 and Grade 2 atypical meningiomas. Although, chordoid meningiomas are believed to have a higher rate of recurrence, none of our patients has recurrent disease to date.

O-510
11:34AM - 11:42AM

Imaging Characteristics of Epidermal Growth Factor Positive Metastatic Lung Cancer to the Central Nervous System: A Retrospective Study

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Purpose
Central nervous system metastases considerably outnumber primary brain neoplasms and carry a dismal prognosis. Lung cancer is the leading cause of cancer-related mortality worldwide and the propensity for lung cancer to metastasize to the central nervous system (CNS) is one of the major causes of low survival rate in advanced stages of the disease. Recent studies have shown that in patients with nonsmall cell lung cancer (NSCLC), mutations in the Epidermal Growth Factor (EGFR) have increased propensity for brain metastasis and these patients carry worse prognosis. The aim of this study is to evaluate retrospectively imaging characteristics of lung cancer metastasis to the brain with EGFR mutation on computed tomography (CT) and MR imaging (MRI).
Materials and Methods
In this retrospective study, we identified 76 patients (46 females, 30 males; mean age, 70.1 years; age range, 48–91 years) who underwent pretreatment noncontrast CT and MRI at our institution from January 2009 to June 2014 with pathologically proven metastatic lung cancer to the brain. Patients’ primary lung cancer histologic subtype (adenocarcinoma, squamous cell carcinoma and small cell lung cancer) and receptor mutations (EGFR, ALK, KRAS, etc.) were recorded. The exams were evaluated by two radiologists who were blinded to the pathology data.

Results
Fifty-two patients [29 females (56%) and 23 males (44%)] were identified with gain of function mutation in the EGFR gene. Most of these patients had adenocarcinoma (47/52; 90.4%) and most of these patients (43/52; 82.7%) had multiple CNS lesions. On noncontrast CT, only 11/52 (21.1%) of the patients had evidence of a lesion, which were relatively isodense to gray matter. On MRI, the lesions relative to gray matter were hypointense (41/52, 78.8%) or isointense (11/52; 21.2%) on T1-weighted images and hyperintense (48/52; 92.3%) on T2 and FLAIR images and had heterogenous postcontrast enhancement (51/52; 98%). The lesions varied in size ranging from 4.0 mm up to 37.0 mm and average lesion size on postcontrast image was approximately 9.4 mm. Thirty-three of 52 patients (63.5%) demonstrated susceptibility artifact on gradient sequences and none of these lesions demonstrated observable calcium on CT. On diffusion-weighted imaging (DWI), only 5.8% (3/52) demonstrated restricted diffusion.

Conclusions
Our study shows that in patients with metastatic lung cancer, EGFR mutation is seen more commonly in females and most of these patients have more than one CNS lesion. The detection rate of metastasis on noncontrast CT exam is low (21%). MR imaging characteristics of EGFR positive metastases include T1 hypointense, T2/FLAIR hyperintense lesion without restricted diffusion and with evidence of susceptibility artifact and heterogeneous postcontrast enhancement.

O-511
11:42AM - 11:50AM

Comparison of systemic diffusion alterations in the normal appearing white matter of glioma and meningioma patients

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Purpose
Altered diffusion in normal-appearing white matter (NAWM) of glioma patients was described previously. The goal of the present study was to investigate if this diffusion alteration also was present in the NAWM of patients with well circumscribed tumors such as meningiomas, and to compare it to the diffusion alteration found in the NAWM of glioma patients.

Materials and Methods
Thirty patients with histologically verified glioma (grade II-IV), 25 patients with meningioma and two age- and sex-matched healthy control groups underwent diffusion-weighted imaging (b = 0, 500, 1000 s/mm²) on a 3T magnetic resonance system. All patients were examined before treatment. The entire NAWM in the hemisphere contralateral to the tumor was segmented. Then, mean ADC (mADC) in the NAWM was calculated. Comparisons between groups were
performed by Mann-Whitney U test or t test according to the statistical distribution of the data.

Relationship between mADC and glioma grade also was investigated.

Results
Mean ADC values of NAWM were significantly higher in both the glioma and the meningioma group compared to control subjects. Mean ADC was not significantly different between glioma and meningioma patients. Mean ADC in NAWM was related significantly to tumor grade in glioma cases.

Conclusions
The presence of altered diffusion in the NAWM of meningioma patients makes it less likely that, as suggested earlier, microedema due to infiltrating tumor cells is responsible for elevated mADC. The increased mADC in the NAWM of both patient groups might be the result of a compensating mechanism due to tumor compression.

O-512

Perilesional T1 Hyperintensity in Intra-axial Brain Masses: Not a Sign of Cavernoma

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Purpose
T1 shortening in perilesional vasogenic edema has been reported as a useful sign for differentiating cavernous angioma from other hemorrhagic intra-axial masses. In this study we reinvestigated the frequency of perilesional T1 hyperintensity in a variety of intra-axial hemorrhagic and nonhemorrhagic brain masses.

Materials and Methods
MR images of 158 patients with a total of 223 intra-axial brain masses with surrounding vasogenic edema [53 metastatic tumors, 38 grade III and IV glioma, 18 primary CNS lymphoma (PCNSL), 25 intracerebral hemorrhage, 24 cavernoma] were evaluated. The presence of T1 shortening in the perilesional vasogenic edema was evaluated qualitatively. In addition T1 signal intensity in the surrounding vasogenic edema was measured quantitatively and normalized to the contralateral white matter.

Results
T1 hyperintensity in perilesional vasogenic edema was found in 13 (11%) of 118 metastases (Figures A and B, arrows), five (21%) of 24 cavernous angiomas (Figure C, arrow), one (4%) of 25 intracerebral hemorrhages, and in none of the patients with high grade glioma or PCNSL. The normalized perilesional T1 hyperintensity in metastases, cavernomas, intracerebral hemorrhages, high grade gliomas, and PCNSL were 0.82, 0.95, 0.87, 0.71, and 0.68 respectively. Quantitative multigroup ANOVA analysis revealed that the normalized perilesional T1 hyperintensity was significantly different between the groups (p-value <0.0001), with post hoc analysis demonstrating significant mean differences for all but three pairwise group contrasts. Significant group differences also were observed for qualitative measures (p-value = 0.0216), although post hoc comparisons were not statistically significant after Bonferroni correction.

Conclusions
We observed T1 hyperintensity in perilesional vasogenic edema as expected in cavernomas but
also in multiple hemorrhagic metastases. This study contradicts the pre-existing literature that this finding is a reliable sign of cavernomas and caution imagers to consider malignancy when white matter hyperintensity is present. In addition, since T1 hyperintensity was not evident in PCNSL and gliomas, its presence may help distinguish single metastasis from primary brain tumors.

(Filename: TCT_O-512_T1hyper.jpg)

O-529

11:58AM - 12:06PM

T1-, T2- and Proton Density-Mapping of Peritumoral Edema in Malignant Gliomas

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Purpose
Damage to the blood-brain barrier with subsequent contrast enhancement is a hallmark of glioblastoma. Nonenhancing tumor invasion into the peritumoral edema, however, usually is not visible on conventional MRI. Quantitative MR sequences, such as diffusion-weighted images and perfusion MRI are used increasingly as an aid in the pre-operative evaluation of brain tumors (1), as well as postsurgically when treatment-related effects can occur in the brain (2). Furthermore, new quantitative techniques using relaxometry offer additional information about the tissue, compared to conventional imaging (3, 4). Recently a quantitative MR method (QMRI) (5), measuring relaxation times R1 (1/T1), R2 (1/T2) and proton density (PD) with a 6-minute scan-time has been developed. The aim of this study was to evaluate T1, T2 and PD in the peritumoral edema in a group of patients with malignant glioma before surgery.

Materials and Methods
In a prospective study, 15 patients with suspected malignant glioma were examined before surgery with a standard MRI protocol with the addition of QMRI before and after contrast agent injection. The diagnosis was confirmed after biopsy/surgery. The study was approved by the
regional institutional review board and informed written consent was obtained from all patients. Synthetic MR images were created from the QMRI scan. Delineation of the contrast-enhancing part of the tumor was done manually in the synthetic T1W Gd images (Figure 1) and regions of interest (ROIs) were placed in the peritumoral edema in the synthetic T2W images (Figure 2). Subsequently the images were coregistered and subtracted to avoid overlap. Quantitative values of R1, R2 and PD in the edema ROIs were obtained from the QMRI before contrast agent injection. Voxel-based statistical analysis was performed using mixed linear model.

Results
R1, R2 and PD in the peritumoral edema decreased with increasing distance from the contrast-enhancing portion of the tumor. R1 decreased with -0.0020 mm-1s-1 (SE 0.0001) (p<.0001) and R2 with -0.046 mm-1s-1 (SE 0.001) (p<.0001). Consequently T1 and T2 increased with increasing distance to the tumor, with relaxation time values indicating greater tissue heterogeneity closer to the tumor (Figures 3 and 4).

Conclusions
Quantitative analysis with relaxometry of peritumoral edema in malignant gliomas detects tissue changes not visualized by conventional MR images. The finding of shorter relaxation times closer to the tumor could reflect tumor invasion into the peritumoral edema. Quantification of tissue changes in the peritumoral region in patients with glioblastoma can be a support for the neuroradiologist assessing the tumor, and a decision support for the neurosurgeon planning the extent of tumor resection. It also may be of substantial value for radiation dose and treatment planning.
Thursday
10:30AM - 12:00PM
Sheraton Chicago Hotel & Towers, Erie (Level 2)

22H - PARALLEL SCIENTIFIC PAPER SESSION-INTERVENTIONAL: FLOW DIVERTERS
O-513

VasoCT and intravascular OCT for assessment of apposition after flow-diverter placement

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Purpose
Flow diverter (FD) stents provide a safe and effective technique for endovascular treatment of unruptured intracranial aneurysms (1-2). However, poor vessel wall apposition not only affects efficacy of the FD, but also may cause in-stent stenosis and late thrombosis, which increase the risks of stroke-related complications and may result in nonocclusion of the aneurysm due to so-called 'endoleak' (3). Here, high fidelity three-dimensional imaging strategies may enable improved assessment of apposition immediately following device deployment. We therefore explored the potential of high resolution contrast-enhanced cone-beam CT (VasoCT, Philips Healthcare) and intravascular optical coherence tomography (IVOCT) to quantitatively assess FD apposition in an experimental side-wall aneurysm model in canines.

Materials and Methods
Two sidewall aneurysms were created on each common carotid artery (CCA) in female canines by anastomosis of sections of the detached right external jugular vein (4). Under fluoroscopic guidance (Allura Xper FD20, Philips, Best, The Netherlands), FD stents (Pipeline Embolization Device, EV3-MTI, Irvine, CA) were placed and apposition was assessed bilaterally using VasoCT, and in the right CCA using IVOCT (C7 System/Dragonfly Catheter, St Jude Medical, Westford, MA). VasoCT images (617 unbinned projections, 20 s rotation) were reconstructed at 50% of the field-of-view volume at highest resolution (512³ isotropic voxels), yielding a 65 µm resolution. Raw IVOCT images (504 lines, 968 pixels/line, 10 mm field-of-view) were processed and analyzed using in-house developed software for slice-by-slice detection of the stent struts and vessel wall.

Results
Three-dimensional models of the vessel wall and FD stent surfaces were generated from slice-by-slice semi-automatic detection of the stent struts and vessel wall. To identify stent malapposition, point-wise distances between the stent and vessel wall surfaces were calculated and projected onto the surface models or on a flattened polar map. Figure A shows an example of a model fitted on IVOCT data, where the average distance between the FD and vessel wall measured 0.33 ± 0.13 mm. Manual delineation of the corresponding VasoCT image in a cross-sectional view showed that a similar distance of 0.42 mm could be detected (Figure 2), although lumen and stent struts are rendered more smoothly as compared to IVOCT.
Conclusions
VasoCT enables malapposition visualization in the order of 0.5 mm, but may be sensitive to arterial pulsation. Here we showed that IVOCT can provide a gold standard for the validation of VasoCT assessments of FD apposition as it provides superior resolution, with clearly visualized vessel wall and FD stent struts. However, neurovascular application of IVOCT currently is limited to the experimental setting.
Risk Factors for Spontaneous Intraparenchymal Hemorrhage Following Pipeline Embolization Device Treatment of Intracranial Aneurysms: Results from the IntrePED Study

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Purpose
Spontaneous intraparenchymal hemorrhage (IPH) is a rare and dreaded complication following flow diversion treatment of unknown etiology. Using a large, multicenter registry, we sought to determine the demographic, aneurysm, and procedural characteristics associated with IPH following pipeline embolization device (PED) treatment.

Materials and Methods
IntrePED registry patients with post-PED treatment IPH unrelated to index aneurysm rupture were identified. The rate of IPH was determined by baseline demographics, cardiovascular risk factors, aneurysm characteristics and procedure characteristics (including anticoagulation use, platelet testing, number of devices used, sheaths, catheters and guidewires). Categorical variables were compared with chi-squared testing and continuous variables were compared with Student's t-test.

Results
Of 793 patients with 906 treated aneurysms, 19 (2.4%) patients suffered IPH. Fourteen IPHs (74%) occurred within 30 days of the procedure (median=5 days, range=0-150 days). Six IPH patients (32%) died and 13 (68%) suffered major neurological morbidity. Intraparenchymal hemorrhage location was ipsilateral to the PED in 15 patients (83%) and contralateral in three patients (17%). Variables associated with higher odds of IPH included treatment of ruptured compared to unruptured aneurysms (OR=4.79, 95%CI=1.77-13.01, P=0.005), and use of three or more PEDs (OR=4.10, 95%CI=1.34-12.58, P=0.02). The use of a Shuttle Sheath (Cook Inc., Bloomington, IN) was not associated with IPH (OR=1.20, 95%CI=0.40-3.24, P=0.80). Age (P=0.16) and chronic hypertension (P=0.09) were not associated with IPH.

Conclusions
Spontaneous IPH following endovascular treatment of intracranial aneurysms with PED is a rare but devastating complication with 100% of patients suffering major morbidity or mortality. Variables associated with IPH include use of multiple PEDs and treatment of ruptured aneurysms. Intraparenchymal hemorrhages occurred within 6 months of the procedure suggesting that antiplatelet therapy may be a potential risk factor. The Shuttle, a device that was previously thought to be associated with IPH, was not associated with IPH in this study.

Peri- and postprocedural complications in the treatment of intracranial aneurysms and dissections with flow-diverters
Purpose
Flow diverters have become an important tool for the treatment of intracranial aneurysms. We retrospectively analyzed the peri- and postprocedural complications in a large single center series of intracranial aneurysms and dissections treated with two different types of flow diverters.

Materials and Methods
Initial and follow-up angiographic and clinical results of 531 procedures in 411 patients treated with either the Pipeline Embolization Device (Covidien) (n=232) or the p64 (phenox, Bochum, Germany) (n=299) between September 2009 and August 2014 were included. Results were dichotomized related to the type of flow diverter used. A multivariate analysis according to the shape (saccular, fusiform or dissection), the type of complication (ischemic, hemorrhagic or other) and the onset of complications (<24 hours, 1-30 days, >30 days) was performed.

Results
The overall complication rate in the PED group was 13% (n=31) compared to 10% (n=29) in the p64 group. Periprocedural complications occurred in 4% (n=9) in the PED group compared to 2% (n=6) in the p64 group. The general complication rate was significantly lower in saccular aneurysms compared to fusiform aneurysms or dissections (8%, n=23 versus 14%, n=22 or 13%, n=8). Hemorrhagic complications were observed more frequently in the acute phase compared to ischemic complications and vice versa.

Conclusions
The source of complications in the treatment of intracranial aneurysms and dissections with flow diverters is multifactorial. The type of target lesion seems to have a stronger impact on the occurrence of complications than the type of the flow diverter used.

O-516

Risk of Silent Ischemia in Pipeline Embolization Device Patients Receiving Long-Term Imaging Follow-Up with MRI

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Purpose
The rate of silent ischemia detected on MRI in the immediate and long term follow-up period following endovascular treatment of intracranial aneurysms with the Pipeline Embolization Device (PED) is not well established. The purpose of this study was to evaluate the occurrence rate of silent ischemia detected on MRI in patients undergoing treatment of intracranial aneurysms with PED.

Materials and Methods
We evaluated our institution's database of patients receiving PED treatment of intracranial aneurysms. Imaging records were searched to identify which patients received an MRI
postoperatively. Timing of MRI was divided into two time periods: 0 days-1 month and ≥6 months. MR images were obtained either as part of routine imaging follow up or evaluation of new neurological symptoms following PED treatment. MR images were reviewed for evidence of new infarction.

Results
Sixty-eight patients had MR imaging following aneurysm treatment with the PED. Mean (SD) follow-up time was 14.7 (14.2) months. Thirty-six had MRI 0-30 days following PED treatment, and 42 had MRI at ≥6 months following PED treatment. Of the patients with MRI at 0-30 days following PED treatment, 28/36 (77.8%) had new foci of restricted diffusion. Of these, 27 were ipsilateral to the treated vessel and one was contralateral. Only one patient (2.8%) had a symptomatic event. Of patients with MRI at ≥6 months following PED treatment, two of 42 (4.8%) had a new infarct. Of these, one had a lacunar infarct which was likely nonembolic and one patient had a punctate infarction in the contralateral centrum semiovale. None of these infarcts were symptomatic.

Conclusions
Approximately 80% of patients have MRI evidence of new foci of silent ischemia in the immediate postoperative period following PED treatment. The rate of silent ischemia identified on MRIs obtained in patients 6 months or more following PED treatment is low and not related to the device.

O-517

Factors Effecting Outcome in Cerebral Aneurysm Treatment With Flow Diverters

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Purpose
Safety and efficacy of flow diverters (FDs) in the treatment of intracranial aneurysms is well known. However factors related to complications, aneurysm occlusion rates and effect of adjunct endovascular techniques have not been studied thoroughly.

Materials and Methods
All the patients with intracranial aneurysms treated with Silk FD stent (Balt Extrusion, Montromercy, France) between October 2010 - November 2013 were reviewed retrospectively. All such patients were included regardless of the success of the procedure. Patient characteristics, aneurysm size and location, the experience of the primary operator (> 10 years versus < 5 years), adverse events, use of coils and aneurysm occlusion rates were evaluated.

Results
One hundred six patients with 127 aneurysms were treated. Technical success of the procedures was 96.5%. Adverse event rate during hospitalization was 11.2%. Among these adverse events, there were seven severe complications, four of which resulted with exitus. Adverse event rate was significantly lower in the second half of the procedures (11 complications in the first 58 procedures versus two complications in the second 58 procedures, p: 0.013). Likelihood of having unfavorable outcome for patients whose aneurysm sizes were greater than 13 mm was
9.63 times higher than that of patients whose aneurysms were smaller (p=0.004). Likelihood of total aneurysm occlusion for aneurysms greater than 13 mm was 3.15 times higher as compared to those smaller than 13 mm (p=0.040). Unfavorable outcome on follow up also was significantly higher in the aneurysms greater than 13 mm. The learning curve plot suggested that adverse event rate was stabilized at around 50 patients. Use of coils or experience of primary operator had no effect on clinical or angiographic outcome.

Conclusions
Use of FD is associated with a learning curve. Regardless of the operator experience, aneurysm size > 13 mm is associated with worse angiographic and clinical outcome.

O-518
11:10AM - 11:18AM

Surpass Flow Diverter for the Treatment of Intracranial Aneurysms Located in the Posterior Circulation


1Medical Centre - University of Freiburg, Freiburg, Germany, 2University Hospital Nijmegen, Nijmegen, Netherlands, 3ENERI - SAGRADA FAMILIA, Buenos Aires, Argentina, 4Besancon University Hospital, Besancon, France, 5National Institute of Neurosciences, Budapest, Hungary, 6Klinikum Kassel, Kassel, Germany, 7Kobe City Medical Center General Hospital, Kobe, Japan, 8Klinikum Hamburg Altona, Hamburg, Germany, 9Klinikum Hamburg Barmbek, Hamburg, Germany, 10University of South Florida College of Medicine, Tampa, FL, 11Medical Center - University of Freiburg, Freiburg, Germany, 12University of Massachusetts, Worcester, MA, 13Univ Of Massachusetts, Dept Of Radiology, Worcester, MA

Purpose
To clinically evaluate the safety and efficacy of flow diverter (FD) treatment of intracranial aneurysms located in the posterior circulation using a high mesh density FD (Surpass, Stryker Neurovascular).

Materials and Methods
This retrospective multicenter trial was conducted in 12 centers in Europe, Argentina, Japan, and the United States. Forty-six patients bearing both ruptured and unruptured aneurysms located in the posterior circulation were included. The primary safety end point was neurologic death and any stroke during follow up.

Results
Twenty-seven patients had fusiforme aneurysms, 19 presented with saccular aneurysms. Seven patients presented with ruptured aneurysms. Successful FD delivery was achieved in 45 patients. Flow diverters were placed in the vertebral artery in 19 patients, in the vertebro-basilar junction in seven, in the basilar artery in 15, and the posterior cerebral artery in four patients. Fourteen patients had additional aneurysm coiling. Periprocedural complications occurred in six patients with one fatality. Clinical follow up (mean: 8 months, range: 1-16) of 42 patients, showed that the primary safety end point occurred in 12 patients. Permanent neurologic morbidity and mortality were four of 42 and eight of 42, respectively. Five of 8 patients that died during follow up had fusiform aneurysms that included the basilar artery. Follow-up angiography was available in 32 patients. Intracranial aneurysms showed 100% occlusion in 22/32 patients (69%).
Conclusions
The Surpass FD may be used for the treatment of complex intracranial aneurysms located within the posterior circulation with acceptable angiographic outcome. Treatment of fusiform aneurysms that include the basilar artery were associated with an increased mortality rate.

O-519

Pipeline Embolization Device treatment of intracranial aneurysm, with parent artery measuring <2.5mm. Single institution experience

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¹University of Massachusetts, Worcester, MA, ²Nagoya University Graduate School of Medicine, Nagoya, Japan, ³University of South Florida College of Medicine, Tampa, FL, ⁴Stroke and Neurovascular center of Central California, Thousand Oaks, CA

Purpose
Flow diversion technology has become an established treatment option for embolization of large/giant, wide-necked and complex intracranial aneurysms, centered along the internal carotid artery, from the petrous to the superior hypophyseal segments. We present our experience with these devices in the treatment of circle of Willis distal aneurysms, with parent arteries smaller than 2.5 mm.

Materials and Methods
From June 2012 to August 2014, a total of seven intracranial aneurysms located along small branches of the anterior circulation were treated at our institution. Seven patients with a mean age of 65 years (range 51-71 years) underwent an endovascular treatment of a circle of Willis distal aneurysm with pipeline embolization device (PED). In four patients the aneurysms were found incidentally during cerebral angiogram, and three patients had history of prior subarachnoid hemorrhage (SAH) from the same aneurysm. Three patients had a positive family history of aneurysms. On admission six patients presented with a NIHSS and mRS of 0.

Aneurysms were located: two aneurysms along the pericallosal artery (1 left, 1 right) branch of the anterior cerebral artery (ACA), one aneurysm on the right angular artery, branch of the middle cerebral artery (MCA), two aneurysms at the anterior communicating artery (AComA), one at the ACom-right A2 ACA artery, and one in the lenticulostrate artery. Aneurysms ranged from 1 mm to 12 mm in diameter. The parent vessel size ranged from 1.5 mm to 2.3 mm (mean 2 mm). The technical feasibility of the procedure, procedure-related complications, postprocedural and follow-up angiographic results, and clinical outcome at discharge, 6 months, and 1 year were evaluated.

Results
All aneurysms were treated successfully with a single PED. No peri or postprocedural complications were observed. All patients were discharged with no change in NIHSS or mRS score. Angiographic follow up was available in six patients. In all follow-up cerebral angiography exams a complete aneurysm occlusion was demonstrated. In one patient, at 6-month follow up, a complete right angular artery aneurysm obliteration with mild in-PED intimal hyperplasia was noted. This was stable at the 12-month angiogram. No retreatment was
needed. Another patient showed mild intimal hyperplasia at 3-month follow-up angiogram. NIHSS and mRS remained unchanged (0) at follow-up time points for these patients.

Conclusions
Although the cohort of patients treated with PED for unruptured complex aneurysms centered along small vessel branches of the anterior circulation, is small, the procedure was noted to be a feasible, safe and effective method to obtain aneurysm occlusion with preserved patency of the parent arteries.

O-520

Flow Diverter Stenting for the Endovascular treatment of Intracranial Aneurysms located on small or Circle of Willis distal arteries.

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¹Besancon University Hospital, Besancon, France, ²Besancon University Hospital, Besancon, Vincennes

Purpose
The development of small (2 mm and 2.5 mm) flow diverter stents (FD) allows treating intracranial aneurysms located in small arteries also beyond the circle of Willis. These devices are characterized by higher radial force compared to larger FD stents. The purpose of our study was to report our experience using very small FD stents.

Materials and Methods
Twenty-four small FD stents (11 Surpass, 10 P64, 1 PED Flex and 2 Silk) were deployed for the treatment of 23 aneurysms in 22 patients (19 women and 3 men). Aneurysms were located in the MCA (n=10), in the Acom/A1-A2 ACA region (n=7), in the azygos/pericallosal artery (n=5) and in the P2 PCA artery (n=1). Long term (1 year) angiographic follow up was available in 13 aneurysms and midterm (3-6 months) FU in eight.

Results
Suboptimal deployment or positioning of the stents was observed in three cases needing balloon inflation in one case. A small asymptomatic parenchymal bleeding was observed in a patient. No permanent morbidity. One patient died due to a periprocedural bleeding. This complication will be detailed. Clinical and angiographic FU results will be discussed.

Conclusions
The use of small FD stents remains a difficult procedure. The indication must be evaluated carefully.

O-521

Flow Diversion in Middle Cerebral Artery Aneurysms: Is It an All-Purpose Treatment?

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¹Hacettepe University School of Medicine, ANKARA, Turkey, ²Cukurova University School of Medicine, ADANA, Turkey, ³Ufuk University School of Medicine, ANKARA, Turkey, ⁴Ankara Numune Education and Research Hospital, Ankara, Turkey, ⁵Essex Neuroscience Centre, Queens University Hospital, Essex, United Kingdom
Purpose
The outcomes of flow diversion (FLD) for bifurcation aneurysms, especially middle cerebral artery aneurysms (MCAAs) have not been defined clearly. We assessed our results of FLD in MCAAs selected for treatment based on aneurysm and middle cerebral artery morphology.

Materials and Methods
Patients with MCAAs were treated by FLD, either by flow diverters (FDs, Silk or Surpass devices) or telescopic stenting (Leo stents) if surgical or other endovascular treatment modalities had failed or were likely to fail. The anatomy of the aneurysm (saccular/lenticulostriate versus dissecting/fusiform) and the site of the aneurysm on the MCA (M1 or 'true bifurcation' or 'variant bifurcation' or M2) were criteria used for this selection.

Results
Treatment was attempted in 26 MCAAs. Technical failure rate was 3.8%. Of the 15 bifurcation aneurysms, eight were of variant type. The occlusion rates for saccular and fusiform aneurysms were 58.3% and 75.0% respectively, when lenticulostriate aneurysms were excluded, this rate dropped to 33.3%. In case of bifurcation aneurysms, MCAA occlusion was strongly associated with side branch occlusion (p<0.005). Overall procedure-related mortality/permanent morbidity was 3.8% (1/26).

Conclusions
Flow diverters appears to be the best available treatment in fusiform MCA aneurysms. Its unsatisfactory occlusion rate in bifurcation aneurysms likely results from residual filling of the aneurysm in cases where the jailed side branch remains patent. This outcome may be better tolerated in variant type bifurcation aneurysms since surgical or endovascular bail-out options are expected to have a lower risk.

O-522

Flow Competition as a Factor of Patency or Occlusion of Jailed Side Branches after Flow Diverting Stent Placement in Intracranial Arteries

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Purpose
Even though flow diverting stents are being used increasingly in intracranial aneurysm treatment, the fate of jailed side branches remains controversial. Our clinical experience leads to the hypothesis that terminal type of arterial supply regarding the covered branch may be a contributing factor to side branch patency.

Materials and Methods
A translational animal study in large White swine was conducted. Ten animals were randomly allocated in two groups of five. The animals of group A did not undergo vascular modifications, while those of group B underwent endovascular arterial branch occlusions, in order to obtain a terminal-type arterial circulation in the right ascending pharyngeal artery of each animal. They were all stented by flow diverting stents at the right common carotid artery, in a way to cover the
right ascending pharyngeal artery. A time-resolved 3D phase-contrast MRA protocol was employed in order to quantify flow rates, before and after stenting. The results were used as boundary conditions in order to produce realistic fluid dynamic simulations. After three months the covered ostia were observed by scanning electron microscopy (SEM).

Results
Mean flow rate at the right ascending pharyngeal artery poststenting was 0.19±0.06 ml/s for group A and 0.57±0.06 ml/s for group B. Mean circulating arterial ostium surface at 3 months was 268884±291368µm² for group A and 508641±333323µm² for group B. Increase in flow rates was observed after 3 months for group B, comparatively to group A. Statistically significant difference was found in correlation between flow rates poststenting and percentage of endothelium coverage of the ascending pharyngeal artery ostia at 3 months ( P<0.05), as well as between endothelial coverage and group A or B ( P<0.05).

Conclusions
Jailed branches retain higher flow rates poststenting and their ostia surfaces remain more patent in cases of terminal type circulation, comparatively to anastomotic type.

O-523

ENDOVASCULAR TREATMENT OF POSTERIOR COMMUNICATING ARTERY ANEURYSMS USING THE PIPELINE EMBOLIZATION DEVICE: SINGLE-CENTER EXPERIENCE OF SAFETY AND EFFICACY WITH SHORT TERM FOLLOW-UP RESULTS

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¹University of Massachusetts, Worcester, MA, ²Stroke and Neurovascular center of Central California, Thousand Oaks, CA, ³University of South Florida College of Medicine, Tampa, FL

Purpose
To determine the safety and efficacy of treating posterior communicating artery (Pcomm) aneurysms with the pipeline embolization device (PED, eV3/Covidien, Irvine, CA).

Materials and Methods
We retrospectively analyzed a consecutive series of patients, between February of 2013 and November of 2014, undergoing treatment of a Pcomm aneurysm with a PED. Patient clinical and angiographic data were collected. Pcomm arterial flow before and after PED placement was graded at postoperative angiography and follow-up angiography as completely patent, partially occluded, and completely occluded. Status of the aneurysm once PED treatment had taken place also was reviewed. Clinical outcomes in these patients also were analyzed.

Results
Ten patients with 11 aneurysms (one patient had a Pcomm aneurysm and a superior hypophyseal artery aneurysm) were included in this study. All patients analyzed had a normal origin (nonfetal) of the posterior cerebral artery ipsilateral to the Pcomm aneurysm. The treated Pcomm aneurysm in all patients demonstrated immediate blood flow stagnation within it following placement of the PED. In the immediate postintervention setting, seven (70%) patients had complete patency of the Pcomm and three patients (30 %) had partial occlusion with diminished flow rate. One patient had a 3-month follow-up angiogram which demonstrated proximal
migration of the device with incomplete coverage of the aneurysm neck; this required the placement of a second overlapping PED. Six patients have reached the 6-month follow-up angiogram and of these, four patients had their Pcomm artery still widely patent (66%); one had persistent partial occlusion (16.6%); and one progressed to complete occlusion (16.6%). Of these six patients who have reached the 6-month follow-up angiogram, three (50%) had complete resolution of the Pcomm aneurysm and three (50%) had residual filling of the aneurysm, but markedly decreased from pretreatment. Four patients also so far have reached the 12-month follow-up angiogram; regarding the patency of the Pcomm, two (50%) patients progressed from complete patency to partial occlusion, which remained stable at 18-month follow up; one (25%) patient had persistent yet unchanged partial occlusion of the Pcomm at 12-month follow up (no further follow up is yet available); and one (25%) patient had complete patency of the Pcomm (no further follow up is yet available). Of these four patients reaching the 12-month follow up, three had residual filling of the aneurysm, albeit progressively smaller, and one had complete resolution of the aneurysm. No patient suffered new neurologic symptoms on the periprocedural period or during follow up.

Conclusions
Flow diversion technology is a safe therapy for posterior communicating artery aneurysms. Treatment of Pcomm artery aneurysms with PED should be assessed on a case-by-case evaluation and an occlusion of the Pcom artery origin may be required for a complete early aneurysm occlusion.

Thursday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Sheraton Ballroom I-V (Level 4)

23A - SNIS: ANEURYSMS (AR) (SAM)
23A-1
1:15PM - 1:30PM
Computational Fluid Dynamics in Cerebral Aneurysms: What the Clinician Needs to Know

Gounis, M.
University of Massachusetts Medical School
Worcester, MA

23A-2
1:30PM - 1:45PM
Aneurysm Characteristics in the Prediction of Aneurysm Rupture

Patel, A.
Massachusetts General Hospital
Boston, MA

23A-3
Cutting Edge Aneurysm Treatment: Flow Diversion, New Coil Designs and Intravascular Devices

Fiorella, D.
Stonybrook Univ. Medical Center
Stonybrook, NY

23A-4

Follow-up of Coiled Aneurysms: When to Treat and How

Pukenas, B.
Hospital of the University of Pennsylvania
Philadelphia, PA

23A-5

Patient

23A-6

Questions and Answers

Thursday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom IX-X (Level 4)

23B - ASSR: ADVANCED IMAGING OF THE SPINAL CORD: ARE WE IN A CLOUD? (AR) (SAM)
23B-1

DTI of the Spinal Cord: The Naked Truth
Law, M.
University of Southern California, Keck School of Medicine
Los Angeles, CA

23B-2

MR Spectroscopy of the Spinal Cord: Are You Kidding?

Barker, P.
The Johns Hopkins University School of Medicine
Baltimore, MD

1:30PM - 1:45PM

23B-3

Is Functional MRI of the Spinal Cord Legit?

Stroman, P.
Queen's Univeristy
Kingston, ON

1:45PM - 2:00PM

23B-4

How CSF Fluid Dynamics Induces Cord Pathology

Haughton, V. · Mardal, K.
Univ. Of Wisconsin Hospitals and Clinics · Simula.no
Madison, WI · Lysaker

2:00PM - 2:15PM

23B-5

What is Possible with MR Neurography Plexus Imaging?

Carrino, J.
Johns Hopkins Hospital
Baltimore, MD

2:15PM - 2:30PM

23B-6

Questions and Answers

2:30PM - 2:45PM
The value of Prediction of Survival in Patients with Glioblastoma based on combination Analysis of Mammalian Target of Rapamycin (mTOR) - Epidermal Growth Factor Receptor (EGFR) Pathway and Dynamic Susceptibility Contrast (DSC)-MR Perfusion Imaging

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¹University of Rochester Medical Center, Rochester, NY, ²University of Rochester medical center, Rochester, NY

Purpose
Phosphatidyl-inositol-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 and epidermal growth factor receptor (EGFR), has emerged as a compelling molecular target in glioblastoma patients. However, the association between mTOR-EGFR pathway and hemodynamic changes in glioblastoma, and their prediction value of survival, are still unclear. The purpose of this study is to assess the association between mTOR-EGFR pathway and quantitative dynamic susceptibility contrast (DSC)-MR perfusion imaging derived indices, and evaluate their survival prediction value based on combination analysis.

Materials and Methods
Forty-one cases (mean age is 62±12 years) with new pathology-confirmed glioblastomas were enrolled in this study. Mean and maximal relative blood volume (rCBV) ratio, of the enhancing tumor (rCBVmean and rCBVmax), maximal rCBV ratio of peri-enhancing tumor area (rCBVperi-tumor) were measured as well as mean, maximal and minimal percentage of signal recovery (PSR) of the enhancing tumor. The analyses of Ki-67, IDH mutation, mTOR activation, and EGFR amplification were performed. The association between rCBVmean, rCBVmax, rCBVperi-tumor, mean PSR, maximal PSR and minimal PSR and mTOR and EGFR were assessed, the Cox regression was used to evaluate the implication of age, sex, operation method, DSC-MR PWI derived indices and genomic information on overall survival time (OS). The difference of above parameters between the patients who survived less than 12 months and more than 12 months was compared.

Results
The rCBVperi-tumor had significant correlation with mTOR, (p value was 0.016). The maximal PSR showed the trend to correlate with EGFR (p value was 0.054). The Cox regression analysis
showed that rCBVperi-tumor and mTOR were the two strongest predictors of OS. There were 21 patients who survived less than 12 months after initial diagnosis, and 20 patients survived more than 12 months. There was significant difference of rCBVperi-tumor between these two groups (mean rCBVperi-tumor value was 4.42±1.82 and 2.52±1.63 separately, p value was 0.001), rCBVperi-tumor and age had larger area under the curve (AUC) than other parameters in receiver operating characteristic (ROC) analysis, but combination of rCBVperi-tumor and mTOR had better prediction of survival time (Figures 1, 2).

Conclusions
Molecular signature of mTOR correlated with rCBVperi-tumor, which indicated that mTOR-EGFR pathway may moderate increase of neoplastic vasculature and infiltration in the peri-enhancing tumor area. The evaluation of mTOR-EGFR pathway not only provided additional genomic information, combination of rCBVperi-tumor and mTOR could improve prediction of survival time in patients with glioblastoma.

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O-525
1:23PM - 1:31PM
Survival Prediction in Glioblastoma Patients Using Multi-parametric MRI Biomarkers and Machine Learning Methods

H Akbari¹, L Macyszyn¹, J Pisapia¹, X Da¹, M Attiah¹, Y Bi², S Pal³, R Davuluri², L Rocco Grandi¹, N Dahmane¹, R Wolf³, M Bilello¹, D O'Rourke⁴, C Davatzikos¹
¹University of Pennsylvania, Philadelphia, PA, ²Northwestern University, Chicago, IL, ³Wistar Institute, Philadelphia, PA, ⁴Hospital of the University of Pennsylvania, Philadelphia, PA

Purpose
The goal of this study is to undertake an exploratory multiparametric MRI analysis to identify prognostic factors for survival in adult patients with glioblastoma, and to employ advanced computational methods for multiparametric imaging pattern analysis to extract distinctive
imaging biomarkers predictive of an individual patient's prognosis and which might assist in personalized treatment.

Materials and Methods
This research consists of a retrospective cohort of 105 de novo glioblastoma followed by a prospective study of 29 patients. Preoperative multiparametric MRI data (T1, T1-Gad, T2, T2-FLAIR, rCBV, DTI, and DSC-MRI) were employed to extract imaging biomarkers and to create a model to predict survival using a machine learning method in a cross-validated retrospective cohort study. Subsequently, this model was utilized in the prospective cohort study. Size of tumor and edema, diffusion time, location of tumor, and distribution of intensities of all modalities in each region were utilized through a feature selection method to build the model.

Results
This method predicted patients who survive less than 6 months with an accuracy of 88% and AUC of 0.87 and patients that survive more than 18 months with an accuracy of 89% and AUC of 0.91 in the retrospective study. In the prospective study, survival less than 6 months with accuracy of 83% and AUC of 0.85 and survival more than 18 months with accuracy of 83% and AUC of 0.84 were predicted. Kaplan-Meier survival curves for patients who survive less than 6 months, 6-18 months, or more than 18 months based on the method prediction resulted in hazard ratios of 18.91 (95% CI: 8.80-40.65) and 4.66 (95% CI: 2.49-8.73).

Conclusions
Multiparametric image analysis extracts subtle but informative biomarkers correlated to the survival of glioblastoma patients. The most accurate survival prediction can be obtained only through multiparametric imaging pattern analysis, while it would otherwise not be appreciated by examining individual features.
Magnetic Resonance Elastography of Intracranial Tumors

J Huston¹, A Arani¹, N Fattahi¹, K Glaser¹, A Manduca¹, J Hughes¹, K Pepin¹, F Meyer¹, J Van Gompel¹, M Link¹, G Lanzino¹, R Ehman¹
¹Mayo Clinic, Rochester, MN

Purpose
Magnetic resonance elastography (MRE) is a MRI technique capable of noninvasively and quantitatively measuring the viscoelastic characteristics of tissue. MR elastography has demonstrated generalized decreased brain stiffness in diffuse diseases such as MS and Alzheimer disease. The purpose of this study was to investigate the stiffness of brain tumors.

Materials and Methods
MR elastography is a three-step process beginning with the introduction of shear waves via an external vibration source. The shear waves then are imaged with a modified spin-echo echo planar imaging sequence with the following imaging parameters: 60 Hz vibration; TR/TE = 3600/62 ms; FOV = 24cm; 48 contiguous 3 mm thick axial slices; one 18.2 ms motion encoding gradient on each side of the refocusing RF pulse; x, y, and z motion encoding directions; and eight phase offsets spaced evenly over one period of motion. Finally, the shear wave images are inverted mathematically to calculate tissue stiffness. MR elastography was performed in a series of intracranial tumors including 28 meningiomas, 10 pituitary adenomas, eight vestibular schwannomas and 10 gliomas.

Results
MR elastography results strongly correlated with intra-operative surgical findings regarding all categories of tumors. Heterogeneous characteristics of larger meningiomas were demonstrated with higher spatial resolution techniques. All gliomas were softer than normal brain and demonstrated a trend of decreasing stiffness with increasing tumor grade.

Conclusions
MR elastography offers for the first time the ability to pre-operatively determine intracranial tumor stiffness. Knowledge of lesion stiffness can provide important information to influence surgical decision-making such as deciding between endoscopic or minimally invasive approaches to skull base lesions or potentially helping grade tumors prior to resection. MR elastography offers a novel new biomarker for the evaluation and treatment of both diffuse and focal neurologic diseases.

O-527

Tumor Infiltration in Enhancing and Non-Enhancing Parts of Glioblastoma: A correlation with Histopathology

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¹University of Heidelberg, Heidelberg, Germany, ²University of Heidelberg, Heidelberg, Heidelberg, ³University of Mannheim, Mannheim, Heidelberg, ⁴German Cancer Research Center, Heidelberg, Heidelberg
Purpose
To correlate histopathologic findings from biopsy specimens with their corresponding location within enhancing areas, nonenhancing areas and necrotic areas on contrast-enhanced T1-weighted MRI scans (cT1).

Materials and Methods
In 37 patients with newly diagnosed glioblastoma who underwent stereotactic biopsy, we obtained a correlation of 561 1mm³ biopsy specimens with their corresponding position on the intra-operative cT1 image at 1.5T. Biopsy points were categorized as enhancing (CE), nonenhancing (NE) or necrotic (NEC) on cT1 and tissue samples were categorized as viable tumor cells, blood or necrotic tissue (with or without cellular component). Cell counting was done semi-automatically (Figure 1c - red dots in cells indicate automatically counted cells).

Results
Nonenhancing had the highest content of viable tumor cells (89% versus 60% in CE and 30% NEC, respectively, p<.001). Besides, the average cell density for NE (3764±2893cells/mm²) was comparable to CE (3506±3116 cells/mm²), while NEC had a lower cell density with 2713±3239 cells/mm². If necrotic parts and bleeds were excluded, cell density in biopsies with "viable tumor tissue" decreased from the center of the tumor (NEC=5804±3480 cells/mm²) to CE (4495±3209 cells/mm²) and NE (4130±2817 cells/mm²).

Conclusions
The appearance of a glioblastoma on a cT1 image (circular enhancement, central necrosis, peritumoral edema) does not correspond to its diffuse histopathological composition. Cell density is elevated in both CE and NE parts (which do not differ significantly). Hence, our study suggests that NE contains considerable amounts of infiltrative tumor with a high cellularity which should be considered in resection planning.
Purpose
The aim of this study is to characterize the spatial distribution of glioblastoma by generating statistical atlases with respect to various clinical parameters.

Materials and Methods
Two hundred seven patients (117 men, 90 women, age 22-88 years, mean 62) with pathology-proven glioblastoma were included in this HIPAA-compliant, IRB-approved study. Of those, 65 subjects had pathology-proven recurrence. In addition, 113 subjects had molecular subtype, and 64 subjects had genetic information related to EGFR VIII expression, 49 negative and 15 positive. We used validated, locally developed software (1) to segment both enhancing and necrotic components of tumors in all patients. Next, we mapped the tumors from individual patients into a common template using deformable registration (1, 2), and superimposed them to create statistical maps that described the spatial location of tumors with respect to age, gender, molecular subtype, size of tumor, and EGFR VIII expression. We also created maps that describe the spatial location of recurrence. We applied a chi-square test to determine whether pattern differences were statistically significant.

Results
There were statistically significant differences when comparing patterns between men and women, younger and older patients, small and big tumors. The most frequent location for glioblastoma in all comers is the right temporal lobe. In women, there is strongly asymmetric involvement of the right temporal lobe. In younger patients, there is sparing of the anterior frontal lobes. There is asymmetric involvement of the temporal lobes, right greater than left by small tumors, whereas large tumors occur in the temporal lobes more symmetrically. The classical subtype tends to spare the frontal lobes, other subtypes do not. There is right temporal dominance for EFGR VIII negative tumors, whereas EFGR VIII positive ones tend to be more distributed. The center of recurrence usually occurs close and medial to the original tumors.

Conclusions
Our results are very intriguing as clear spatial localization seems to emerge. Propensity for specific regions may be related to the spatial distribution of stem cells, such as the subventricular zone, spatial distribution of receptors that mediate cell growth, and topology of blood supply. This preliminary work may eventually have significant clinical implications in terms of prognosis and treatment, e.g., in terms of guidelines for surgical resection and radiation therapy.
207 Patients with Glioblastoma

(Filename: TCT_O-528_graphics.jpg)

O-46

Imaging Spectrum of Carotid Space Nerve Sheath Tumors

N Le¹, B Hamilton², J Kaptuch³, R Wiggins³

¹Oregon Health and Science University, Beaverton, OR, ²Oregon Health & Science University, Portland, OR, ³University of Utah, Salt Lake City, UT
Purpose
To review the imaging findings of a series of 24 nerve sheath tumors of the carotid space, the largest collection in the literature.

Materials and Methods
Twenty-four patients with pathologically confirmed nerve sheath tumors were evaluated retrospectively according to the following variables: demographics (age, gender, clinical presentation), side of lesion, imaging characteristics (CT, MRI, enhancement, angiography), and surgical pathologic results (schwannoma, neurofibroma, other).

Results
The average age of all patients was 40, while patients with neurofibromas were younger on average (35) than those with schwannomas (41). Overall, males had more nerve sheath tumors (14/24), while there was a female predominance in neurofibromas (5/7) and male predominance in schwannomas (10/13). Clinically, five of seven patients with neurofibromas had known neurofibromatosis 1, while schwannomas showed no specific clinical pattern. Nine of 24 lesions were right sided, without predilection for either side in schwannomas or neurofibromas. Ten patients had CT with contrast, six had MRI with gadolinium, and four had angiography. Neurofibromas were low density and nonenhancing by CT, and variable intensity but gadolinium enhancing by MRI. Schwannomas enhanced by CT and MRI, had heterogeneous density and signal characteristics, and had variable angiographic patterns ranging from peripheral to central opacification. One schwannoma (1/7) was melanotic, malignant, and had T1 bright metastases. An outlying lesion was a malignant peripheral nerve sheath tumor (1/15) with low density and rim enhancement.

Conclusions
With attention to CT, MRI, and enhancement features, the histology of nerve sheath tumors of the carotid space can often be predicted. This presentation will focus on salient anatomy of the carotid space, imaging characteristics of lesions, and relevant clinical issues.

O-530 2:03PM - 2:11PM

**Modern diffusion MRI as a method of "non-invasive biopsy": Application in diagnosis of brain gliomas.**

A Tonoyan¹, I Pronin¹, V Kornienko¹

¹Burdenko Neurosurgery Institute, Moscow, Russia

Purpose
To assess the efficacy of diffusion kurtosis imaging in the diagnosis of glioma malignancy and proliferative activity.

Materials and Methods
Sixty-one patients with cerebral gliomas underwent 3T MR imaging. Diffusion kurtosis imaging was performed using b values of 0, 1000 and 2500 s/mm² and 60 gradient directions. Absolute and normalized values of mean diffusivity (MD), axial diffusivity (AD), radial diffusivity (RD), fractional anisotropy (FA), relative anisotropy (RA), mean kurtosis (MK), axial kurtosis (AK), radial kurtosis (RK), kurtosis anisotropy (KA) of tumors were compared in the most malignant solid parts of 21 Grade-I-II, 20 Grade-III and 20 Grade-IV gliomas (P<0.05 significance level,
Mann Whitney test). Pearson correlation coefficient was used to correlate between absolute values of diffusion kurtosis parameters and Ki-67 LI of gliomas.

Results
Absolute and normalized values of MK, AK, RK, KA, FA, RA were significantly higher in HGG (Grade III-IV) and absolute and normalized values of MD, AD, RD were significantly lower in HGG, compared with LGG (Grade I-II). Absolute and normalized values of MK, AK, RK, were significantly higher in Grade III gliomas and absolute and normalized values of MD, AD, RD were significantly lower in Grade III gliomas, compared with LGG (Grade I-II). Absolute and normalized values of MK, AK, RK, KA, were significantly higher in Grade IV gliomas and absolute and normalized values of MD, AD, RD were significantly lower in Grade IV gliomas, compared with Grade III gliomas. The normalized values of RK, MK, RD, AK and the absolute values of RK of gliomas were in a significant strong correlation with tumor Ki-76 LI (Spearmen correlation coefficients were 0.81, 0.8, -0.71, 0.71, 0.71 respectively).

Conclusions
Diffusion kurtosis imaging demonstrated a promising potential in the diagnosis of glioma malignancy and proliferative activity.

O-531

Comparison between Diagnostic Accuracy of MR Diffusion Tensor imaging and Diffusion Weighted Imaging for Preoperative Grading of Gliomas

T Nguyen1, N David1
1The Ottawa Hospital, Ottawa, Ontario

Purpose
Diffusion-weighted imaging (DWI) can provide an estimation of the apparent diffusion coefficient (ADC), which has been correlated with tumor cellularity. Recently, DWI has been reported to have higher diagnostic accuracy in glioma grading when using high b (3000s/mm2) value compared to standard b (1000s/mm2) value (1). In this study, we evaluated the diagnostic accuracy of ADC measurements obtained from diffusion-weighted imaging using multiple b values and from diffusion tensor imaging (DTI) using a standard b value in the preoperative grading of gliomas.

Materials and Methods
This prospective study included 40 patients with a new pathological diagnosis of an astrocytoma. A preoperative MRI was performed at 3T which included both DTI and DWI sequences. Diffusion tensor imaging parameters were: TR=3100ms, TE=106ms, 20 directions, b values (0, 1000s/mm2), slice thickness=2.5mm, matrix resolution 174x174. Diffusion-weighted imaging parameters were: TR=6300ms, TE=92ms, 3 directions, b values (0,500,1000,2000s/mm2), slice thickness=5mm, matrix resolution, 130x130. Apparent diffusion coefficient maps were calculated from DTI and DWI acquisitions. Using ImageJ, one large region of interest (ROI) was drawn over the solid component of the tumor taken from a slice where the tumor was the largest. Four smaller ROIs (35mm2) were drawn within the solid component of the tumor and the lowest value ("hot spot") among the ROIs was recorded. Correlation with glioma grade was evaluated using the Kruskal-Wallis test. Assessment of diagnostic accuracy for each parameter was done using receiver operating characteristic (ROC) curves.
Results
There were seven grade 2, nine grade 3 and 24 grade 4 gliomas. Apparent diffusion coefficient values obtained from hot spot analysis from DTI and DWI varied inversely with tumor grade (P=0.038). Apparent diffusion coefficient values obtained from large ROI in tumor did not show a statistically significant difference according to grade (P=0.09 for ADC from DTI and P=0.059 for ADC from DWI). Using ROC analysis, there was no statistical difference in the area-under-curve for hot spot ADC from DWI compared to ADC from DTI.

Conclusions
Hot spot ADC values from DTI and DWI vary inversely with glioma grade. There was no difference in diagnostic accuracy between ADC values from DTI and DWI in preoperative grading of glioma.

O-532
2:19PM - 2:27PM

Arterial spin labeling characteristics of biopsy-confirmed tumor progression after treatment for high grade glioma

B Shukri1, E Nyberg1, S Kreidler1, J Honce1, L Nagae1
1University of Colorado Hospital, Aurora, CO

Purpose
The differentiation between tumor progression and radionecrosis in patients with treated high grade gliomas (HGG) is a challenge for neuroradiologists and treating physicians (1). Arterial spin labeling (ASL) MR imaging can quantify cerebral blood flow (CBF) without the use of gadolinium-based contrast (2). Tumor progression in HGG is believed to demonstrate increased CBF on ASL, but present literature is limited by a lack of pathological confirmation of disease progression, with several studies reliant upon stability over time as evidence of lack of disease progression (3,4). The purpose of this study is to describe ASL perfusion characteristics of biopsy proven tumor progression and to compare ASL with conventional MR imaging.

Materials and Methods
IRB approval was obtained. We retrospectively reviewed the pathology reports and 3T MR imaging of patients with HGG treated at the University of Colorado Hospital from 2011 to 2014. Patients were included if they previously had been treated with chemoradiation and surgery according to standard of care, were later biopsied during follow up, and had ASL imaging prior to biopsy. Although all biopsies proved tumor progression, raters were blinded to this at the time of evaluation. Using both pre and postbiopsy imaging as reference, ROIs were placed on the prebiopsy ASL image in the region corresponding to the biopsy site. Second ROIs were placed on the mirror image contralateral side as a proxy for normal perfusion. Corresponding ADC values were obtained (5). Regions of interest were selected by three neuroradiologists (LN, EN, and JH) by consensus. Cerebral blood flow (CBF) and ADC values were recorded for each ROI. Disease also was assessed with contrast-enhanced T1-weighted (CE T1W) and T2-weighted FLAIR (FLAIR) images. Descriptive statistics were produced. Paired t-tests were used to compare CBF in tumor with CBF on the unaffected side. Arterial spin labeling was deemed positive for tumor progression if lesional CBF was increased relative to the contralateral side. We compared the sensitivity of this ASL-based criterion against clinical assessments on CE
T1W and FLAIR imaging, using separate McNemar's tests. A general linear model was used to test the association between ADC and lesional CBF.

Results
Twenty-two patients were included in the analysis. Mean age was 51.1 ± 11.7 years, and 10 (45%) were female. Median time between ASL imaging and biopsy was 16 days (range: 2 to 489 days). Cerebral blood flow was significantly higher (p<0.001) in tumor compared to unaffected tissue. The ratio of tumor CBF compared to the contralateral side was 3.2 ± 1.9. Arterial spin labeling was positive in 20 patients (sensitivity 91%). By comparison, sensitivity was 68% for CE T1W and 68% for FLAIR. Arterial spin labeling sensitivity did not differ significantly from CE T1W (p=0.13) or FLAIR (p=0.13) imaging assessments. Mean ADC was 976 ± 336 x 10^-6 mm2/sec. There was no significant association between CBF and ADC (p=0.56).

Conclusions
Cerebral blood flow on ASL was increased significantly in biopsy proven high grade glioma progression compared to the unaffected contralateral side (p<0.001). Arterial spin labeling may be more sensitive than CE T1W and FLAIR imaging for detection of tumor progression.

O-533

2:27PM - 2:35PM

Fully Automated Quantitative Scoring of VASARI Features Predicts Glioma Type and Survival

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1Columbia University Medical Center, New York, NY

Purpose
Magnetic resonance imaging is a powerful tool for glioma characterization. Recent studies have correlated expert annotated imaging features with glioma gene expression and survival (1-3). While these qualitative analyses have met some success, they are subjective and labor intensive (4). By contrast this study utilizes a novel, fully automated computer algorithm to rapidly and objectively assess Visually Accessible Rembrandt Images (VASARI) features that may correlate with glioma tumor type and survival.

Materials and Methods
The study was a retrospective review of The Cancer Imaging Archive (TCIA) database. Patient survival was obtained from the National Cancer Institute/REMBRANDT databases. A fully automated segmentation algorithm quantitatively and qualitatively scored the following VASARI features: enhancing quality; thickness of enhancing margin (quantitatively defined as a ratio of margin thickness to nonenhancing tumor radius); overall volume including enhancing, nonenhancing, necrotic and edema components. The previously unpublished algorithm, developed at our institution by the primary corresponding author, implements a multimodal approach to segmentation that incorporates a combination of level set edge detection, region growing and constrained clustering.

Results
In total, 32 patients were included (glioblastoma, n = 20; oligodendroglioma, n = 7; astrocytoma, n = 5). A nCET proportion >90% (or VASARI score > 7) correlated significantly with patient survival (13.2 versus 9.4 years, p = 0.038). Thickness of enhancing margin >0.86 (p = 0.068) and contrast-enhancing proportion >22% (p = 0.092) approached statistical significance in this small
sample set (Table 1). VASARI features correlated significantly in differentiating GBM from non-GBM (oligodendroglioma, astrocytoma) included: enhancement quality; proportion of enhancing and necrotic tumor; thickness of enhancing margin; and proportion of edema (Table 2). Overall these features were highly specific (92-100%), and slightly less sensitive (50-95%), for differentiation of GBM from other glioma types.

Conclusions
Fully automated quantitative description of glioma imaging features provides fast, reproducible, and objective data regarding tumor type and overall survival.
Figure 1. Fully Automated Segmentation and VASARI Feature Extraction: FLAIR edema (left) and contrast enhancing tumor/core (right)

Table 1. Quantitative and Qualitative VASARI Thresholds and Survival Correlation

<table>
<thead>
<tr>
<th>threshold (VASARI)</th>
<th>proportion enhancing (E5)</th>
<th>proportion nCEI (F6)</th>
<th>proportion necrosis (F7)</th>
<th>T1/FLAIR ratio (F10)</th>
<th>thickness of enhancing margin (F11)</th>
<th>proportion of edema (F14)</th>
<th>size (F29-30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malignant lesions</td>
<td>1.48</td>
<td>0.22</td>
<td>0.9</td>
<td>0.3</td>
<td>0.86</td>
<td>0.25</td>
<td>12 cm²</td>
</tr>
<tr>
<td>Survival, above (months)</td>
<td>10.5 (n=20)</td>
<td>8.7 (n=10)</td>
<td>13.2 (n=10)</td>
<td>9.5 (n=12)</td>
<td>11 (n=11)</td>
<td>9 (n=14)</td>
<td>10.8 (n=15)</td>
</tr>
<tr>
<td>Survival, below (months)</td>
<td>11.6 (n=12)</td>
<td>12.6 (n=22)</td>
<td>9.4 (n=22)</td>
<td>11.8 (n=20)</td>
<td>10.2 (n=21)</td>
<td>12.5 (n=18)</td>
<td>11.3 (n=17)</td>
</tr>
<tr>
<td>p-value</td>
<td>0.591</td>
<td>0.092</td>
<td>0.038</td>
<td>0.252</td>
<td>0.981</td>
<td>0.061</td>
<td>0.864</td>
</tr>
</tbody>
</table>

* defined as a ratio between normalized pre-contrast and post-contrast T1W1 intensity
† defined as a ratio between size of pre-contrast T1 abnormality and FLAIR abnormality
‡ defined as a ratio of margin thickness to nonenhancing tumor radius

Table 2. VASARI Thresholds and Glioma Tumor Type Correlation

<table>
<thead>
<tr>
<th>tumor type</th>
<th>enhancement quality (F4)</th>
<th>proportion enhancing (E5)</th>
<th>proportion nCEI (F6)</th>
<th>proportion necrosis (F7)</th>
<th>T1/FLAIR ratio (F10)</th>
<th>thickness of enhancing margin (F11)</th>
<th>proportion of edema (F14)</th>
<th>size (F29-30)</th>
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<tr>
<td>GBM</td>
<td>19</td>
<td>10</td>
<td>1</td>
<td>16</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>non-GBM</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>OLIGO</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>ASTRO</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>below threshold</td>
<td>11</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>GBM</td>
<td>11</td>
<td>12</td>
<td>3</td>
<td>11</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>non-GBM</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>OLIGO</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>p-value</td>
<td>&lt;0.001</td>
<td>0.014</td>
<td>0.006</td>
<td>0.008</td>
<td>0.009</td>
<td>0.001</td>
<td>0.001</td>
<td>0.657</td>
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<tr>
<td>sens (GBM)</td>
<td>0.95</td>
<td>0.50</td>
<td>0.95</td>
<td>0.80</td>
<td>0.50</td>
<td>0.70</td>
<td>0.70</td>
<td>0.65</td>
</tr>
<tr>
<td>spec (GBM)</td>
<td>0.92</td>
<td>1.00</td>
<td>0.75</td>
<td>0.92</td>
<td>0.92</td>
<td>1.00</td>
<td>0.92</td>
<td>0.58</td>
</tr>
</tbody>
</table>
Diagnostic Performance of Texture Analysis on MRI in Grading Cerebral Gliomas.

K Skogen¹, A Schulz¹, E Helseth¹, J Dormagen¹, A SERVER-ALONSO¹
¹Oslo University Hospitals, Oslo, Norway

Purpose
To retrospectively determine the diagnostic accuracy of grading cerebral gliomas by assessing the tumor heterogeneity using texture analysis on magnetic resonance imaging (MRI).

Materials and Methods
Ninety-five patients with histologically diagnosed glioma were included. Of these, 68 were high grade gliomas (HGG) (Grade IV = 34 and Grade III = 34) and 27 low grade gliomas (LGG), all grade II. MR imaging examinations were performed on a 3T scanner and texture analysis was done on preoperative contrast-enhanced T1-weighted images. The texture analysis was assessed using a commercialized software program (TexRAD) that selectively filters and extracts textures at different anatomical scales between filter values 2-6 (2 = fine features and 6 = coarse features), Figure 1. The parameters, standard deviation (SD) and mean positive pixels (MPP), retrieved by the software were used for characterizing tumor heterogeneity. Receiver operating characteristics was performed on parameters, found to be significant by the Mann-Whitney test, to assess sensitivity and specificity for differentiating between the different grades and calculating a threshold value to quantify the heterogeneity.

Results
Filter value 2 for both MPP and SD was best at discriminating HGG versus LGG with a sensitivity and specificity of 82%/93% (AUC 0.925 p>0.0001) and 81%/93% (AUC 0.910 p>0.0001) respectively, Graph 1. It is slightly more difficult differentiating between the different grades separately, but still significant. Differentiating grade IV versus grade III with SD and grade III versus grade II with MPP had a sensitivity and specificity of 97%/44% and 71%/89%, respectively.

Conclusions
Measuring heterogeneity in gliomas to discriminate HGG versus LGG and to a certain extent between different histological grades using texture analysis can be useful. Texture analysis maximizes the information already obtained from current standard MRI sequences and can augment the diagnostic accuracy in grading cerebral gliomas.
Figure 1 Example how texture analysis is performed.

Graph 1 Scatterplot showing MPP-values for glioma patients, highlighting the threshold value

<table>
<thead>
<tr>
<th>MPP for filtervalue 2</th>
</tr>
</thead>
</table>

Sensitivity = 82%
Specificity = 93%
AUC = 0.925
p < 0.0001
Thursday  
1:15PM - 2:45PM  
Sheraton Chicago Hotel & Towers, Chicago Ballroom VII (Level 4)  

**23D - NEURO-NUCLEAR IMMERSION: THE MERGING OF ANATOMIC AND FUNCTIONAL IMAGING: ONCOLOGIC IMAGING PART III: ONCOLOGIC APPLICATIONS**  

**23D-1**  
1:15PM - 1:40PM  
Thyroid Cancer Scintigraphy and Radioiodine Ablation  
Appelbaum, D.  
The University of Chicago  
Chicago, IL  

**23D-2**  
1:40PM - 2:05PM  
Pitfalls of PET-CT in Evaluating Head and Neck Cancer  
Singh, J.  
Rush University  
Chicago, IL  

**23D-3**  
2:05PM - 2:30PM  
PET Imaging of Brain Tumors  
Fink, J.  
Univ Of Washington  
Seattle, WA  

**23D-4**  
2:30PM - 2:45PM  
Questions and Answers
Thursday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Chicago Ballroom VIII (Level 4)

23E - CSI: POST PROCESSING BASICS; SHORT CIRCUITS

23E-1
Taking Your Images to the Next Step

Peterson, R.
Emory University Hospital
Atlanta, GA

23E-2
Perfusion and Permeability Software

Shiroishi, M.
USC Keck School of Medicine, of University of Southern California
Los Angeles, CA

23E-3
DTI Software

Khan, R. · Collins, J.
University of Arizona Medical Center · The University of Chicago
Tucson, AZ · Chicago, IL

23E-4
New Horizons/Creating a Post Processing Lab

Quigley, E.
University of Utah
Salt Lake City, UT

Thursday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Michigan AB (Level 2)
Predicting High-Flow Spinal Cerebrospinal Fluid (CSF) Leaks in Spontaneous Intracranial Hypotension: Have We Reduced Repeat CT Myelograms (CTM)?

J Verdoorn¹, P Luetmer¹, C Carr¹, J Lane¹, V Lehman¹, J Morris¹, K Thielen¹, J Wald¹, F Diehn¹
¹Mayo Clinic, Rochester, MN

Purpose
Extradural fluid on spine MRI has been reported to predict fast cerebrospinal fluid (CSF) leaks (1). In January 2011, we adopted an imaging algorithm using spinal MRI to direct the use of dynamic CT myelograms (CTM) whenever extradural fluid was present and conventional CTM when absent. Our purpose was to evaluate algorithm compliance and impact on repeat CTM for leak localization which had averaged 21% in the prior 8 years (1).

Materials and Methods
After IRB approval, we identified 181 patients referred to CTM for CSF leaks between January 2011 and September 2014. Patients with iatrogenic leaks (12), traumatic brachial plexus injuries (3), or a prior CTM within 2 years (35) were excluded. Leaks were recorded as absent, slow or fast (defined as requiring dynamic CTM to localize). The completion and results of pre-CTM spinal MRI, CTM technique and need for repeat CTM for localization or unnecessary dynamic CTM were recorded.

Results
The algorithm was adhered to in 104 (79%) of 131 patients. No extradural fluid was present in 75 patients (73%), of whom 70 (93%) had no leak, four (5%) had slow leaks and one (1%) had a fast leak requiring repeat CTM. Extradural fluid was present in 29 patients (28%), of whom 25 (86%) had fast leaks, two (7%) had slow leaks and two (7%) had no leak identified. When the algorithm was followed, only one (1%) required repeat CTM and four (4%) had an unnecessary dynamic CTM. The algorithm was not adhered to in 27 patients (21%). Algorithm breaches included no pre-CTM spinal MRI in 12 (44%), one with a fast leak; performing a conventional CTM when extradural fluid was present in 12 (44%), six with fast leaks; and performing a dynamic CTM when no extradural fluid was present in three (11%), all three with no leak. Algorithm breaches resulted in seven (26%) repeat CTM and three (11%) unnecessary dynamic CTM which were significantly higher proportions than in patients in whom the algorithm was followed (p<0.001, two-tailed Fisher's exact test). Breaches were most prevalent in the first year (37%).

Conclusions
Use of spinal MRI to direct CTM has resulted in a significant reduction in repeat CTM to localize fast leaks with a small number of unnecessary dynamic CTM.

BMI Correlates with CSF Opening Pressure in Patients with Idiopathic Intracranial Hypertension
Purpose
Idiopathic intracranial hypertension (IIH) primarily affects young obese females and is characterized by signs and symptoms of raised intracranial pressure in the absence of a space occupying lesion or other identifiable cause. The currently accepted upper limit of normal cerebrospinal fluid (CSF) opening pressure is between 18 and 20 cm H2O. The influence of body mass index (BMI) on CSF opening pressure in the general population remains controversial. The purpose of the study is to determine if BMI correlates with lumbar puncture opening pressure in patients with a history of IIH when compared to a control group of patients.

Materials and Methods
Twenty-two patients with a history of IIH and 32 controls underwent a lumbar puncture. The medical records were evaluated to determine the patient's BMI and opening pressure. Control patients had no history of IIH or any risk factor for raised intracranial pressure. All punctures were performed with 22g Quincke needles under fluoroscopic guidance, and the opening pressure was measured with a plastic manometer. Continuous variables were compared with an unpaired t-test. A Pearson's correlation coefficient reflecting the correlation between BMI and opening pressure was calculated for both groups.

Results
Body mass index was higher in patients with IIH (mean 37, range 25-54) compared to controls (mean 30, range 21-46). Opening pressure was higher in patients with IIH (mean 30.7, range 13.0-63.0 cm H2O) compared to controls (mean 22.1, range 14.0-32.0 cm H2O). Both of these differences were statistically significant (p<0.05). In patients with IIH opening pressure significantly correlated with BMI (r value=0.445, p=0.04). In the control group opening pressure had a no correlation with BMI (r value=0.185, p=0.31).

Conclusions
In patients with IIH, lumbar puncture opening pressure correlates significantly with BMI. This finding is not observed in the general population, suggesting a different susceptibility to the effects of BMI on intracranial pressure in the IIH population.
underwent MRI of the brain on the same admission. All MRIs were evaluated for brainstem distortion, ponto-mammillary crowding, tonsillar ectopia, pachymeningeal thickening, and pituitary enlargement. A chart review was performed to determine which patients met diagnostic criteria (2) for CSF leak.

Results
Twelve out of 116 patients demonstrated findings of intracranial hypotension on brain MRI. Of these, 10 subsequently were confirmed to have CSF leaks by imaging and clinical criteria. Three additional patients had no signs of intracranial hypotension on presenting MRI; however, subsequently were found to have CSF leaks. In patients presenting with subdural hemorrhage, the sensitivity and specificity of MRI for identifying the subset of patients with CSF leak is 77% and 98%, respectively.

Conclusions
The majority of patients with subdural hemorrhage and MR findings of intracranial hypotension have CSF leak. Intracranial hematoma alone rarely causes brainstem distortion which would mimic intracranial hypotension. As a result, patients who present with subdural hemorrhage and MRI signs associated with intracranial hypotension should undergo workup for CSF leak.

O-539
1:47PM - 1:55PM

Spectrum of CSF Pressures in Patients with Spontaneous Intracranial Hypotension and Correlation with Brain MR Imaging Findings

T Tanpitukpongse¹, L Gray¹, P Kranz¹
¹Duke University Medical Center, Durham, NC

Purpose
It commonly is believed that cerebrospinal fluid (CSF) pressure is low in the majority of patients with spontaneous intracranial hypotension (SIH), and that brain imaging findings are a reflection of this low pressure. This study's purpose was to determine the range of CSF pressures in patients with SIH, and to examine the correlation between CSF pressure and specific brain imaging signs.

Materials and Methods
Subjects were considered to have SIH if they met criteria based on those previously proposed by Schievink, including headaches clinically suggestive of SIH, and at least one of the following: positive brain MRI findings, opening pressure ≤6 cm H2O, or CSF leakage on myelography. Cerebrospinal fluid opening pressure (OP) was measured at the time of initial presentation in all patients. Procedural records and MRI data were reviewed. Correlations between CSF pressure and MRI signs (dural enhancement, brain sagging, and the venous distention sign) were compared using the Mann-Whitney U test. P-values of <0.05 were considered significant.

Results
We identified 124 patients with SIH. The mean OP (±SD) was 9.2±5.8 cm H2O (range 0-23.5). Thirty percent of patients had an OP of ≤6 cm H2O, while 30% had an OP of ≥12 cm H2O. No difference in OP was seen between patients who demonstrated or did not demonstrate dural enhancement (p=0.12) or brain sagging (p=0.074). There was a significant difference in OP in patients who demonstrated a venous distention sign compared with those who did not (p = 0.0097).
Conclusions
Patients with SIH commonly have CSF pressures in the normal range, and in some cases pressure may be >20 cm H2O. Presence of the venous distension sign was correlated with CSF pressure, however dural enhancement and brain sagging were not, suggesting other contributing mechanisms for the physiologic changes seen on brain imaging in patients with SIH.

![CSF opening pressure in SIH patients](TCT_O-539_Table1_ASNR.jpg)

Molecular Neurography as an Imaging Biomarker for the Detection of Diabetic Neuropathy

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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 non-fasting mice received multiple doses of Streptozotocin (STZ) at 55 mg/kg body weight for 5 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 3 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 Tc-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 Tc over 60 minutes, with 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 in experimental animals became elevated from baseline consistent with
induction of diabetes from the first week onwards (two-tailed T-test p<0.0001). The mean
Radiance of TTc imaging (selected values in photons/s/cm2/steradian) were
2.67E+08±1.77E+07 and 2.69E+08±3.68E+07 before treatment, and 2.89E+08±2.94E+07 and
1.97E+08±5.31E+07 at 7th week and 1.04E+08±2.44E+07 and 6.72E+07±2.01E+07 at 18th
week for control and diabetic animals respectively. 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 selected Von Frey values were 2.90±0.34 and 3.35±0.49 at 7th week, and 3.98±0.00
and 4.29±0.16 at 18th week for control and diabetic animals and showed statistically significant
differences from 9th week onward (p=0.0003, 0.0002, <0.001, 0.0025, 0.0134). Histological
differences also were significant.

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
correlated well.

O-541

2:03PM - 2:11PM

Neurographic Imaging as a Biomarker for Detecting Radiation Injury to the Spinal Cord

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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 2 days
after radiation. Transport was decreased significantly by 16 d 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 d and developed posterior paralysis by 45 d.
Pathologic changes of radiation damage could be seen in radiated cords after 30 d 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
biomarker to assess radiation-induced cord injury and monitor therapeutic interventions aimed at preventing such injury.

**O-542**

**Quantitative MR-Neurographic Parameters Can Determine and Specify Lower Limb Nerve Injury in Amyloid Related Polyneuropathy**

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**Purpose**

Hereditary transthyretin familial amyloid-polynuepathy (TTR-FAP) usually manifests with a rapidly progressive, distally-symmetric polyneuropathy (1, 2). Recently, we were able to show that nerve injury in TTR-FAP is detectable in vivo by applying high resolution MR neurography and evaluating nerve T2-signal and nerve caliber. In the current study we further quantified nerve lesions at thigh level where nerve injury has been shown to be strongest, and determined the ability of two quantitative parameters to clearly differentiate between symptomatic TTR-FAP, asymptomatic gene carriers and healthy volunteers.

**Materials and Methods**

Twenty patients with a confirmed TTR gene mutation (13 symptomatic TTR-FAP, 7 asymptomatic gene carriers), and 40 age/gender-matched healthy volunteers were classified prospectively according to neurological and electrophysiological findings. MR neurography with high structural resolution was performed on a 3T MR scanner (Magnetom/TIM-TRIO/Siemens): 1) T2-TSE-fs (TR/TE 5970/55ms, voxel size 0.4x0.3x3.5mm³); 2) Dual-echo-TSE-fs (TR 5210ms, TE1/TE2 12/73ms, voxel size 0.4x0.3x3.5mm³). Manual voxel-wise segmentation of the sciatic/tibial/peroneal nerve with subsequent fully automatic classification as nerve lesion voxels was performed on each axial imaging slice (280/subject). The apparent T2-relaxation time (T2app) and proton spin density (p) as distinct and quantifiable parameters that measure microstructural nerve tissue composition in vivo (3) then were calculated for all nerve lesion voxels.

**Results**

One-way ANOVA and post-hoc comparisons showed that proton spin density was highest in symptomatic TTR-FAP (549.97±35.78), decreased significantly in asymptomatic gene carriers (406.09±28.22;p=0.002), and further decreased significantly in controls (286.56±10.04;p<0.001 versus symptomatic TTR-FAP and versus asymptomatic gene carriers (p=0.004; see Figure). Post-hoc comparisons showed that T2app was increased significantly only in symptomatic TTR-FAP (103.92ms±6.4) versus asymptomatic gene carriers (79.14ms±1.8;p=0.012) and versus controls (84.08ms±2.54;p=0.003), but not between asymptomatic gene carriers and controls (p=0.783; see Figure).

**Conclusions**

For the first time, we were able to prove that alterations of the evaluated quantitative markers were highly specific: Asymptomatic carrier status and symptomatic disease both were associated closely with a strong increase of proton spin density, while a significant increase of the T2-relaxation time was found only in symptomatic TTR-FAP, but not in asymptomatic carriers.
These findings suggest that proton spin density is more sensitive for the detection of early or even subclinical nerve lesions, while T2app may serve to specifically differentiate increasing disease severity in already symptomatic TTR-FAP.

MR-Neurography of the Sural Nerve in Patients with Hereditary Amyloidosis: Can Imaging Compete with Sural Nerve Biopsy?
Purpose
Sural nerve biopsies often were performed in order to detect the underlying disease in patients suffering from unclear polyneuropathic symptoms. In transthyretin familial amyloid polyneuropathy (TTR-FAP) the diagnostic value of invasive sural nerve biopsies is discussed controversially as it often lacks to detect amyloid deposits (1). As we reported recently, amyloid-related nerve injury in TTR-FAP can be unambiguously determined in large caliber nerves (sciatic/tibial/common peroneal nerve) by applying high resolution MR neurography (2). However, the diagnostic yield of MR neurography of the small caliber sural nerve, representing the target nerve specimen for biopsies, is still unclear and was subject to this investigation.

Materials and Methods
We prospectively enrolled 25 patients with manifest TTR-FAP, 10 asymptomatic gene carriers with confirmed mutations in the TTR gene, and 40 age/gender-matched healthy volunteers. Besides detailed neurological and electrophysiological examinations in all patients and gene carriers, a sural nerve biopsy was obtained in 12/25 manifest TTR-FAP patients. All participants underwent the following high resolution MR neurography protocol (3T/Magnetom/TIM-TRIO/Siemens): 1) axial 2D-T2-TSE-fs (TR/TE 5970/55ms, voxel size 0.4x0.3x3.5mm³); 2) axial 2D-dual-echo-TSE-fs (TR 5210ms, TE1/TE2 12/73ms, voxel size 0.4x0.3x3.5 mm³). On each axial imaging slice the sural nerve was identified and segmented manually. After signal normalization (histogram-based, comparison with control population), nerve voxels were classified statistically as nerve lesion voxels by operator independent, threshold-based segmentation. The apparent T2 relaxation time and proton spin density were calculated for all nerve lesion voxels.

Results
Sural nerve lesion voxels were found to be significantly higher in manifest TTR-FAP versus controls (p<0.0001), in asymptomatic gene carriers versus controls (p<0.0001) and in manifest TTR-FAP versus asymptomatic carriers (p=0.0035). Wilcoxon rank sum test revealed with high statistical significance that proton spin density was higher in severely affected TTR-FAP patients (p<0.0001), in moderate TTR-FAP (p<0.0001) and also in asymptomatic gene carriers (p=0.0003) compared to healthy controls. The apparent T2-relaxation time was increased significantly in symptomatic TTR-FAP (p<0.05) but not in asymptomatic gene carriers (p=0.4286) compared to controls.

Conclusions
MR neurography of the sura nerve is a new, noninvasive and highly sensitive diagnostic tool, which can clearly differentiate between symptomatic TTR-FAP, asymptomatic gene carrier status and healthy controls by evaluating nerve lesion voxels and proton spin density. Additional analyses of the apparent-T2 relaxation time can further confirm symptomatic disease. Results of this evaluation may have a strong impact for a better diagnostic interpretation of negative sural nerve biopsies.
Diagnostic benefits of brachial plexus high-resolution MR neurography

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Purpose
High resolution magnetic resonance neurography (MRN) is an imaging technique which enables focused multiplanar imaging of peripheral nerves, as well as diagnosis and localization of entrapment and nonentrapment peripheral neuropathies related to etiologies, such as inflammation, tumor and trauma. Brachial plexus MRN is used in our institute when referral suspects a brachial plexus injury. Our purposed is to examine the diagnostic benefits of the brachial plexus MRN.

Materials and Methods
Our MRN protocol utilizes 3D-T1 with FS, 3D-T2 with FS, 3D STIR and 3D PD for the detection of nerve signal, contour and size changes for the assessment of the peripheral nerve, as well as conventional sequences (T1 with and without contrast and T2) examining anatomy and nerve enhancement. We collected all cases of brachial plexus studies with the brachial plexus MRN protocol from Jan 2012 to April 2014. Pathological studies were noted. For each MRN pathological study, the conventional sequences were read retrospectively. Whether the findings can be seen in the conventional sequences was noted.

Results
There were 47 brachial plexus MRN examinations, 15 male, 32 female (mean age 52 years ± 18 std.). Fourteen were pathological (29%). Retrospectively, tumors (n=3, 6%) could be seen on conventional sequences, yet their extent would have been underestimated. Traumatic injury (n=2, 4%) was correlated retrospectively in conventional scans, but prospective diagnosis was considered doubtful without MRN. Degenerative (n=1, 2%) or inflammatory nerve changes (n=7, 15%) were not seen on conventional scans. Distal denervation (n=1, 2%) secondary changes were seen on conventional scans. Thus for traumatic, degenerative and inflammatory injury MRN was essential. For tumor studies, MRN was additive.

Conclusions
Magnetic resonance neurography was essential for diagnosis in 71% (10 of 14) and additive for 21% ( 3 out of 14) of pathological studies.

Thursday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Superior AB (Level 2)

23G - PARALLEL SCIENTIFIC PAPER SESSION-SPINE VASCULAR DISEASE AND DEGENERATION
O-545

Comparison of First-Pass Contrast Enhanced MR Angiography and Multiphase Time Resolved MR Angiography in Evaluation of Spinal Dural Arteriovenous Fistulas
Purpose
To compare the accuracy and utility of first-pass contrast-enhanced MR angiography (CE MRA) and multiphase time resolved MR angiography (TR MRA) in evaluation of spinal dural arteriovenous fistulas (SDAVF) and to highlight the differences in radiological appearances of these lesions on these techniques.

Materials and Methods
A retrospective review of patients referred to two institutions with data from the last 10 years identified 52 patients with clinical suspicion of SDAVF who underwent consecutive conventional MR imaging, first-pass CE MRA or TR MRA, and digital subtraction angiography (DSA). The presence/absence of SDAVF, vertebral level and side, localizing signs in addition to presence/absence of T2-weighted hyperintensity, signal abnormality in conus, serpentine flow voids and cord enhancement were noted on MRI studies. MR imaging findings were compared with findings on DSA which was used as the reference standard.

Results
Of the 52 cases, 40 were evaluated using CE MRA and 12 using TR MRA; 30 had SDAVF on DSA. Sensitivity, specificity and accuracy of CE MRA were found to be 96%, 46% and 81% respectively, and for TR MRA these were 100%, 60% and 82% respectively. The level and side of SDAVF was diagnosed correctly in 62% versus 82% and in 72% versus 82% using CE MRA and TR MRA respectively. Specific radiological localizing signs (tuft of vessels along dura, draining radicular vein entry site, enlarged segmental artery, early appearance of radicular vein) were compared for both techniques. The average age of patients with SDAVF was 63 years (range: 39 to 89 years) with male predominance (M:F = 3.6:1). On MRI, serpentine flow voids and signal abnormality in conus were associated significantly with SDAVF (p<0.01).

Conclusions
First-pass CE MRA and multiphase TR MRA are comparable in detection of SDAVF, although localization is better with TR MRA. Both techniques are useful noninvasive screening for SDAVF, and facilitate but do not replace DSA for confirmation and acquisition of all details needed before treatment.

O-546
1:23PM - 1:31PM

First-Pass Contrast Enhanced MR Angiography in Evaluation of Treated Spinal Dural Arteriovenous Fistulas: Is Catheter Angiography Necessary?

Purpose
To determine the accuracy and utility of first-pass contrast-enhanced MR angiography (CE...
MRA) in post-treatment evaluation of spinal dural arteriovenous fistulas (SDAVF) compared to postoperative catheter angiography.

Materials and Methods
A retrospective review of data from the last 10 years at a single institution identified 19 SDAVF patients who underwent conventional MR imaging, first-pass CE MRA, and digital subtraction angiography (DSA) after surgical or endovascular treatment of SDAVF. The presence/absence of recurrent/residual disease on MRA, vertebral level and side in addition to presence/absence of T2-weighted hyperintensity, signal abnormality in conus, serpentine flow voids and cord enhancement were noted on MRI studies. MR imaging findings were compared with findings on DSA which was used as the reference standard.

Results
A total of 21 observations were performed on 19 postop SDAVF patients, out of which four were positive for recurrent/residual disease. Contrast-enhanced MRA correctly identified all positive cases with one false positive reading; sensitivity, specificity and accuracy of CE MRA were found to be 100%, 94% and 95% respectively. The level and side of residual/recurrent SDAVF was diagnosed correctly in all cases using CE MRA. Specific radiologic localizing signs including tuft of vessels along dura and enlarged segmental artery are highlighted. On MRI, serpentine flow voids on T2 were associated significantly with recurrent/residual SDAVF (p<0.01).

Conclusions
First-pass CE MRA is useful noninvasive test to evaluate treated SDAVFs. In this study all residual/recurrent SDAVFs were detected with MRA, although the numbers were small. False positive occurred in one out of four cases. This study suggests that in appropriate clinical setting, postdisconnection CE MRA has the potential to replace catheter angiography.

O-547

Angiography of spinal cord ischemia and stroke

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Purpose
It often is assumed that the role of modern spinal digital subtraction angiography (SpDSA) is limited to the diagnosis and treatment of spinal vascular malformations. The purpose of this abstract is to describe the contribution of SpDSA in the management of patients with a suspected vascular myelopathy.

Materials and Methods
This work is illustrated with angiographic findings obtained in 30 patients presenting with an acute or subacute myelopathy of unclear etiology and diagnosed with spinal cord ischemic disease.

Results
Angiographic signs consistent with spinal cord ischemia or stroke were found in association with the following conditions: i) atheromatous ostial stenoses or occlusions (n=5), ii) anterior or posterior intervertebral disk herniations (n=6), iii) the diaphragmatic crus syndrome (n=6) (Figure), iv) the endothoraic fascia compression syndrome (n=5), v) anterior spinal artery
thromboembolic disease (n=2), vi) spinal cord steal syndrome (n=3), and vii) vertebral artery dissection (n=3).

Conclusions
Spinal digital subtraction DSA can play a significant role in the management of myelopathies of undetermined etiology. In some situations, SpDSA may identify underlying pathologies that warrant a specific therapy (e.g., diaphragmatic crus syndrome or ostial stenoses). In many patients, establishing a positive diagnosis of spinal cord ischemia with SpDSA either prevents the introduction or allows discontinuing inappropriate, costly, and at times deleterious treatment options (e.g., long term immunosuppression or plasma exchange therapy). Figure legend. Left - T2-weighted MRI documenting abnormal signal at the level of the conus medullaris (large black arrow); Middle - SpDSA, right L2 injection, showing nonostial occlusion of the intersegmental artery by the crus of the diaphragm (large white arrow); Right - SpDSA, right L3 injection, revealing collateral supply to right L2 and to the artery of Adamkiewicz (small white arrows).
O-548

Safety and Efficacy of Intraoperative Spinal Angiography
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Purpose
This study evaluates the safety and efficacy of intra-operative spinal angiography (ISpA).

Materials and Methods
Demographics: Twelve patients (10 men and 2 women, average age 55.2 years, range 19 to 76 years) underwent a total of 18 ISpAs between 2008 and 2014, either immediately prior to surgery for localization purpose (n=5) and/or after (n=13) to confirm the intervention's efficacy. The pathologies included seven spinal dural or epidural arteriovenous fistulas (AVF) (58.4%), three perimedullary AVFs (25%), one spinal arteriovenous malformation (8.3%), and one case of diaphragmatic crus syndrome (8.3%). Technique: Intra-operative spinal angiography was performed in the operating room in the prone position using a C-arm. Vascular access was obtained under general anesthesia in the supine position. A 5-French 55-cm long femoral sheath was inserted and secured to the access site, with the hub positioned on the lateral surface of the thigh to enable catheter maneuvering with the patient in the prone position.

Results
Complications: No peri or postprocedural complications were noted. Impact on surgery: All the targeted intersegmental arteries (ISA) were catheterized successfully. Intra-operative spinal angiography changed the course of surgery in three patients (25%). In one case, ISpA revealed spontaneous resolution of an epidural AVF, preventing unnecessary surgical exploration. In another case, three ISpAs were necessary before all the feeding branches of an epidural AVF were addressed successfully. Finally, in a patient undergoing surgery for anterior spinal artery (ASA) compression by the diaphragmatic crus, ISpA showed thrombosis of the ISA and nonvisualization of the ASA. Full recanalization was obtained by immediate intra-operative intra-arterial thrombolysis, without postoperative clinical consequences.

Conclusions
Intra-operative spinal angiography is a safe and useful adjunct to surgical treatment for spinal vascular conditions. Intra-operative spinal angiography changed the surgical strategy in three patients (25%), and provided a positive intra-operative confirmation of the treatment success in all cases (100%).
Diagnosis of Spinal Arteriovenous Fistulae using 3D T2-Weighted MRI Technique

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Purpose
The purpose of this study was to determine the sensitivity, specificity, and interobserver agreement for diagnosis of spinal arteriovenous fistulae (sAVF) from spinal MRIs using 3D T2-W compared to 2D T2-W techniques.

Materials and Methods
A retrospective case-control study was conducted from Jan 2001 - Dec 2014 of all patients with spinal DSA performed at Indiana University Health - Methodist Hospital. Patients with known tumor and/or tumor embolization procedures were excluded; patients with type II and type III sAVMs were excluded; patients without spinal MRI were excluded. Two blinded neuroradiologists reviewed spinal MRIs which were performed with either a sagittal T2-W turbo spin echo (TSE) (2D group) or sagittal 3D T2-W SPACE (3D group), and documented presence or absence of a sAVF. Using spinal DSA diagnosis as a gold standard, the sensitivity, specificity, and interobserver agreement for the 2D group and 3D group MRI diagnosis were calculated.

Results
A total of 24 patients were identified. The 2D group consisted of 11 patients and the 3D group consisted of 13 patients. The 2D group demonstrated a sensitivity of 100% [radiologist A, 95%(CI) 58.93-100%] and 85% [radiologist B, 95%(CI) 42.23-97.63%]; specificity of 100% [radiologist A, 95%(CI) 40.23-100%] and 100% [radiologist B, 95%(CI) 40.23-100%].

Interobserver agreement in the 2D group was k=0.814. The 3D group demonstrated sensitivity of 67% [radiologist A, 95%(CI) 11.55-94.53%] and 67% [radiologist B, 95%(CI) 11.55-94.53%]; specificity of 90% [radiologist A, 95%(CI) 55.46-98.34%] and 80% [radiologist B, 95%(CI) 44.43-96.89%]. Interobserver agreement in the 3D group was k=0.806.
Conclusions
The use of 3D T2-W techniques may result in reduced sensitivity and specificity for detection of sAVF compared to 2D MRI techniques.

O-550
1:55PM - 2:03PM

Transmedullary venous anastomoses - Anatomy and angiographic visualization using FPCA

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Purpose
Flat-panel catheter angiotomography (FPCA), a recently developed modality based on conventional catheter angiography, finally offers a spinal equivalent to the venous phase routinely obtained during cerebral angiography. This improvement in imaging ability has created the need for a more intricate knowledge of the anatomy of the spinal venous system (1-3). The purpose of this work is to discuss the angiographic appearance of a type of venous structure until now principally known through the analysis of cadaveric material, the transmedullary venous anastomoses (TMVAs) (4, 5).

Materials and Methods
This presentation is illustrated with FPCA images obtained during routine diagnostic spinal angiograms performed in eight patients. The acquisition protocols consisted of 20-second nonsubtracted rotational angiograms obtained either during the selective injection of intersegmental arteries providing significant radiculomedullary branches (n=4) or the selective injection of subclavian branches (n=4).

Results
The morphology of several types of TMVAs linking the anterior and posterior longitudinal spinal venous systems is discussed. The illustrated configurations include centrodorsolateral, median anteroposterior, median anteroposterior with duplicated origin, and combined centrodorsolateral/median anteroposterior TMVAs, while a pathological case documents the potential role of TMVAs as collateral venous pathways.

Conclusions
Transmedullary venous anastomoses are normal venous structures that need to be differentiated from spinal cord anomalies such as intramedullary vascular malformations. Two of the TMVA configurations described in this report have not been documented previously. Figures: 1. FPCA, left L1 injection, axial reconstruction; example of a median anteroposterior TMVA (white arrows). 2. Anatomical illustration of a median anteroposterior TMVA. Anterior median spinal vein = AMSV, posterior-median spinal vein = PMSV. 3. FPCA, right vertebral injection, axial reconstruction; example of a TMVA with combined median anteroposterior (white arrows) and centrodorsolateral (black arrows) characteristics. 4. Anatomical illustration of a centrodorsolateral TMVA. Posterior-lateral spinal vein = PLSV
En-bloc vertebrectomies and ligature of segmental arteries: what is the interest of preoperative spinal arteries localization?

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Purpose
To assess neurologic function after ligature of segmental arteries giving radiculomedullary arteries (RMA) in en-bloc spondylectomy and to discuss the interest of pre-operative spinal arteries localization.

Materials and Methods
Between January 2013 and June 2014, eleven en-bloc spondylectomies with pre-operative spinal arteriography in 11 patients were performed. Pre-operative embolization was performed if the lesion was hypervascular and no RMA present.

Results
In seven patients (3 females, mean age 38.8 years), a RMA was visible at the level of the segmental artery occluded during spondylectomy. The number of levels of vertebrectomy was one (n=4), two (n=1) or three (n=3). Lesions were breast metastase (n=1), colon metastase (n=1), chordoma (n=2), angiomatous histiocytosarcoma (n=1), chondroblastoma (n=1), and osteosarcoma (n=1). In four patients, a great radiculomedullary artery was concerned by the occlusion. No patient presented neurologic deficit after spondylectomy.

Conclusions
The absence of neurologic deficit after ligature of segmental arteries giving RMA emphasizes the importance of the spinal collateral network. Pre-operative arteriography still presents the interest to inform the surgeon about medullary vasculature and also to perform embolization if no RMA is present.

MR diffusivity is a strong indicator of the loss of disc structural integrity as well as its mechanical competence

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Purpose
This study investigated the association between T2, T1\rho, and mean diffusivity (MD) and the viscoelastic response of intact human discs and the effect of loading condition [simulating bed rest (200N) versus standing (700N)] on these associations.

Materials and Methods
Six lumbar L2-L3 discs from donors age 49-70 years were imaged using the following MR protocols. T2 relaxation: MSME sequence (TR=5000ms, TE= 7..186ms, 11.6ms spacing),
matrix=256^2, Slice=1mm. Diffusion: four equally spaced b-values (100-1000)mm^2/s with D14ms, d=8ms, Matrix=128^2, Slice=1mm. T1r: Fast spin-echo sequence (Spin Lock(SL): Time:=0/40/80/120)ms; power =300Hz, ETL= 8, BW= 31.25 kHz; (TR/TE=5000/12)ms, matrix=256^2, Slice=1mm. Disc viscoelastic response was measured in stress-relaxation. T2, T1r and MD values were analyzed (MRmapper, BIDMC), Figure 1. General linear models (JMP 8.0, SAS, NC) tested for association of MR parameters with disc degeneration and viscoelastic response.

Results
gher disc degeneration (Pfirrmann) was associated with the decrement in the disc viscoelastic parameters (E1, E2, n1) p>0.05. T2 relaxation correlated with viscoelastic response (E2, n1: p<0.05) in the disc, whilst showing tissue dependent association (NP: E1 (p<0.01); E2 (p<0.01); AF: E2 (p<0.05). T1r significantly correlated with the short (E1: p<0.01) and long term (E2: p<0.001) viscoelastic parameters. MD strongly correlated with viscoelastic parameters at the disc level (E1: p<0.001, E2: p<0.001 and damping (n1): p<0.001) and the tissue level, [(NP: E1: p<0.001, E2: p<0.001, n1: p<0.001), (AF: E1: p<0.01, E2: p<0.05, n1: p<0.05)]. Under load (200 versus 700)N, only diffusivity measures maintained significant association with the viscoelastic parameters.

Conclusions
The tissue-based differences in MR parameters reflect the dissimilarity in composition, hydration and structure between the AF and NP tissues. Although each MR parameter demonstrated both disc- and tissue-based association with the viscoelastic parameters of the disc, MR diffusivity appears to be a strong indicator of the loss of disc structural integrity as well as its mechanical competence.
Figure 1: Grade III disc T2 weighted relaxation, T1ρ, and MD maps at 9.

Vertebral Level-Wide Changes in Diffusion Tensor Imaging Metrics in Cervical Spondylotic Myelopathy
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Purpose
Prior studies evaluating the cervical spinal cord in patients with cervical spondylotic myelopathy (CSM) using diffusion tensor imaging (DTI) commonly assess for pathologic changes at the intervertebral disc level of maximal compression (LMC). However, most significant changes in DTI metrics may not occur at the LMC (1). Changes at regions distant from the site of injury are well described in studies of traumatic spinal cord injury (2). This study was conducted to compare DTI metrics of the cervical spinal cord in patients with CSM to those measured in healthy volunteers across all cervical intervertebral disc levels.

Materials and Methods
Magnetic resonance (MR) imaging of the cervical spinal cord was performed in four symptomatic patients with CSM and in five healthy volunteers with imaging protocol consisting of a sagittal T1-weighted, sagittal T2-weighted and sagittal and axial DTI sequences. Fractional anisotropy (FA) and mean diffusivity (MD) values were calculated on sagittal DTI acquisitions with regions of interest (ROIs) encompassing the entire cross-sectional area of the cord. Fractional anisotropy and MD values also were calculated on axial imaging with ROI placement in the anterior, lateral, and posterior regions of the spinal cord to approximate the locations of the anterior gray matter, corticospinal tract, and dorsal column, respectively. Measurements were obtained at all cervical intervertebral disc levels in patients and controls. Nonparametrical statistical analysis was used to compare patients and controls within each ROI on a level-by-level basis.

Results
Conventional MR imaging revealed that patients' LMC ranged from C4-C5 to C6-C7 intervertebral disc levels. Mean diffusivity values were significantly higher in anterior ROIs in patients compared to controls at intervertebral disc levels C2-C3 (p=0.025), C4-C5 (p=0.014), and C6-C7 (p=0.050). Mean diffusivity values also were significantly higher in sagittal cord ROIs in patients compared to controls at intervertebral disc levels C5-C6 (p=0.050) and C6-C7 (p=0.050). In the posterior ROIs, MD values were significantly higher in patients compared to controls at all intervertebral disc levels except C7-T1.

Conclusions
Diffusion tensor imaging metrics in patients with CSM may demonstrate changes that are remote from the site of maximal compression. Evaluation of DTI metrics across all cervical intervertebral disc levels may more accurately reflect disease severity in CSM patients.

O-554

The value of simultaneous 18F-FDG-PET/MRI for the detection of spondylodiscitis: a feasibility study
Purpose
The diagnosis of infectious spondylodiscitis often is challenging. Alterations seen in MRI are quite sensitive, but lack specificity, and the distinction from osteochondrosis often is difficult. The aim of the present study was to assess the diagnostic value of simultaneous 18F-FDG-PET/MRI in cases of suspected spondylodiscitis.

Materials and Methods
In a prospective study, 15 patients with symptoms of a possible spondylodiscitis were enrolled. All patients underwent simultaneous whole spine 18F-FDG-PET/MRI scanning including standard MRI sequences with/without contrast enhancement. The image datasets were independently and finally in consensus session evaluated by two radiologic and one nuclear imaging expert. For all suspected spinal discs as well as one adjacent healthy disc per patient, SUVmean and SUVmax were determined. The diagnostic certainty of the MRI data was evaluated on a five-point Likert Scale. The consensus decision was dichotomized and compared with histology.

Results
The interrater agreement between the two radiologists in regard to the MRI scans was moderate with a weighted $\kappa=0.67$ and an absolute diagnostic certainty in just 10%. With addition of the PET data, the agreement between the radiologists rose to $\kappa=0.95$, and the absolute diagnostic certainty to 50%. In one case, the imaging diagnosis changed due to the additional PET data. The final histological analysis was identical in all cases with the PET/MRI diagnosis. There was a strong correlation between the SUVmax ratio of healthy/sick disc and the 5-point MRI rating with a $R^2=0.52; p<0.001$. Applying a ROC analysis-derived SUVmax ratio threshold of 2.89 resulted in a 100% specificity and sensitivity for the PET data. Neither the level of CRP nor the leukocyte count were significantly correlated with the spondylodiscitis diagnosis.

Conclusions
The use of a simultaneous 18F-FDG-PET/MRI significantly increases the diagnostic certainty in the detection of infectious spondylodiscitis, especially in cases with ambiguous findings in MRI alone.

Thursday
1:15PM - 2:45PM
Sheraton Chicago Hotel & Towers, Erie (Level 2)

23H - PARALLEL SCIENTIFIC PAPER SESSION-EPILEPSY AND DEGENERATIVE DISEASES

O-555

1:15PM - 1:23PM

Low Functional Robustness in Mesial Temporal Lobe Epilepsy: A Graph Theory Study

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Purpose
Brain functional topology was investigated in mesial temporal lobe epilepsy (mTLE) patients by means of graph theory measures. Measures of segregation, integration, and centrality were explored.

Materials and Methods
Eleven subjects with left mTLE (36.5 ± 10.9 years) and 15 age- and gender-matched healthy controls (HC) participated in this study. Functional integrity was investigated with two differentially defined graphs: one using anatomically segmented nodes and another using nodes defined from putative functional networks (1). Network segregation was studied by obtaining local clustering coefficient, transitivity, modularity, and network integration by calculating harmonic mean. Modularity was investigated considering only non-zero degree nodes as a way to identify how many of the defined nodes actually contribute to community structure in patients and controls. Node degree and participation coefficient also were calculated to investigate network hubs. Measures were investigated in a range of low to medium cost.

Results
Both groups presented complex network architecture by having small-world property, in which the patient group was significantly higher than HC at each level of sparsity. Patients also presented lower local and global segregation than HC while having higher integration. We found that patients were using more nodes to get less or similar number of modules than controls. Hubs in the network of patients did not include PCC/Precuneus complex but included bilateral cerebellar regions contrary to controls (Figure 1).

Conclusions
The use of two differentially defined graphs synergistically contributed to findings. Patients failed to engage the PCC/Precuneus complex or default mode network which is widely engaged in diverse processes and therefore may lead to a variety of deficits while engaging cerebellar regions as major hubs, which could represent possible network compensation. Overall subjects with mTLE presented lower specialization or higher integration along with weaker connections than controls, which could translate into a less robust network and more prone to disruption.
Language function is organized in specific networks. Recently fMRI-based connectome analysis was used to visualize these networks in vivo (1). As left hemispheric temporal lobe epilepsy (lTLE) patients frequently show atypical language representations (2), the aim of this study was to identify alterations of the language connectome (LC) in lTLE patients.

Materials and Methods
The LC was calculated on the basis of a fMRI verbgeneration task (3T, TE=35ms, TR=3000ms,
slice thickness: 4mm, 32 slices, 96x96 matrix, 2.4x2.4x4mm, 100 dynamics, verb generation task, FreeSurfer, FSL). A reference LC was established based on 13 healthy controls (median age 38) and compared to the connectome of eight patients with nonlesional ITLE (median age 35) and 12 ITLE patients with hippocampal sclerosis (HS) (median age 42). Differences in the functional connectome analysis were quantified using the network-based statistics (NBS) approach.

Results
Compared to healthy controls, nonlesional ITLE patients and HS patients showed significantly increased interhemispheric connectivity (p<0.001) (Figure). Both, nonlesional ITLE and HS patients showed an increased node degree in the Broca region. Controls showed stronger connectivity in default mode network.

Conclusions
Task-based NBS analysis reveals widespread alterations in the language connectome of ITLE patients. Structural alterations of the temporal lobe and/or seizure activity may relate to the recruitment of interhemispheric connections. These observations refine existing theories of language reorganization in TLE (3).
64-Channel Phased Array Coil Hippocampal 3T MR Imaging

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Purpose
Improved brain 3T image quality has been achieved through the use of phased array (PA) coils and motion resistant BLADE pulse sequences. High coil element density PAs are limited by signal loss as a function of distance from the receiver coil and resultant heterogeneity of the images, a challenge for temporal lobe epilepsy imaging. We report our experience optimizing a commercially available 64-channel PA coil imaging of the brain, and the complementary benefit of BLADE sequences.

Materials and Methods
Protocol development was performed with a commercial 64-channel receive-only PA coil on a 3T Prisma, with qualitative and quantitative assessment of gray-white contrast and SNR. Base protocol parameters were TR 3900, TE 128, 1 average, 150% coverage, ETL 16, 3 mm slice thickness, interleaved, 0.4 mm pixels, 360 Hz/pixel bandwidth, accel 2, 8:44. Comparison was made to conventional TSE sequences of varying duration. Blade sequences are enabled for iPat factors of 2 or 3, though there is no scan time advantage at 3. Scans therefore were performed at 2. Higher iPat factors are not enabled for blade at this time and the speed advantages may be limited by noise amplification for clinical imaging.

Results
Motion reduction and high contrast and SNR resulted from the blade acquisition. Signal-to-noise gains at the superficial cortex also are demonstrated in the hippocampus and are improved due to the additional scan time and without motion artifacts typical of longer scans times. Figure: A) blade full FOV, B) conventional acquisition with motion artifacts at the midbrain, and C) blade demonstrating excellent contrast, higher signal, and motion mitigation.

Conclusions
High spatial and contrast resolution are critical in the detection of subtle hippocampal dysmorphologies. The promise of better image quality with higher coil density is limited by distance factors for deeper structures. Use of the blade sequence facilitates oversampling of central k-space for excellent contrast resolution and motion artifact reduction. Long sequence times are better tolerated with blade due to reduced artifacts due to inherent bulk patient and physiologic motion.
Regional Cerebral Hypoperfusion on Interictal Arterial Spin Labeling MRI Correlates with EEG Lateralization in Patients with Epilepsy

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Purpose
We hypothesize that arterial spin labeling (ASL) can provide supplemental information in addition to routine MRI that can help localize an epileptic focus.

Materials and Methods
We retrospectively reviewed 42 patients who had EEG monitoring and interictal brain MRI with ASL. Brain MRI was performed on a 3.0T clinical scanner using an 8-channel head coil. Cerebral blood flow (CBF) (ml/100g/min) was estimated using pseudocontinuous ASL (pCASL). The EEGs were recorded using the international 10/20 system of scalp electrode placement. The EEGs were reviewed by a single epileptologist who was blinded to patients' imaging and previous EEG reports. MR imaging, including ASL data, was reviewed by a single neuroradiologist who was similarly blinded. Evaluation of ASL was performed by visual interpretation of color and gray scale cerebral blood flow (CBF) maps as well as symmetric placement of uniform regions of interest in the frontal, parietal, and temporal lobar cortical regions. Significant lobar hypoperfusion was defined by >10 ml/min/100 g of tissue or 20% relative difference from the contralateral region. This threshold was based on a prior voxel-level reproducibility study at our institution that demonstrated a standard deviation of 9.8 ± 1.9 ml/min/100 g of tissue or 23 ± 4% relative difference in gray matter. Regional hypoperfusion from interictal ASL also was compared to regional hypometabolism from interictal FDG PET when available.

Results
Of the 42 patients that had both EEG and ASL, 25/42 had lateralized hypoperfusion on ASL, of which 14/25 had corresponding lateralization on EEG, 4/25 had conflicting lateralization on EEG, and 7/25 had normal or global changes on EEG. In the 17/42 that had normal or global changes on ASL, 7/17 had corresponding normal EEG and 10/17 had lateralized EEG findings. With respect to EEG findings, 28/42 had lateralized EEG findings, of which 14/28 had corresponding lateralization on ASL, 4/28 had conflicting lateralization on ASL, and 10/28 had normal or global changes on ASL. In the 14/42 that had normal or global changes on EEG, 7/14 had corresponding normal or global changes on ASL and 7/14 had lateralized EEG changes. In 10/42 who had identifiable structural lesions, 8/10 had corresponding lateralization to both ASL and EEG, 1/10 lateralized with ASL but not with EEG, and 1/10 lateralized with EEG but not with ASL. In 10/42 who also had FDG PET, regional hypoperfusion on ASL lateralized to regional hypometabolism on PET, but the regions did not necessarily overlap one-to-one.

Conclusions
In this study, we showed that epilepsy patients with lateralized findings on both ASL and EEG, 14 (78%) had corresponding lateralization as opposed to four (22%) with conflicting lateralization. Only 10 (24%) patients had identifiable structural lesions, which when present,
80% had corresponding lateralization to both ASL and EEG. The addition of ASL to routine brain MRI provides supplementary information that is helpful in the evaluation of epilepsy.

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O-559

1:47PM - 1:55PM

Diffusion Tensor Imaging and Tractography of the Superior Longitudinal Fasciculus: Anatomical Substrate for Language Impairment in Patients with Polymicrogyria

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Purpose

Polymicrogyria (PMG) is a malformation of cortical development (MCD) commonly manifested with epilepsy and language disorders (1). Magnetic resonance imaging (MRI) exhibits abnormal overfolding of too many small gyri that produce an irregular cortical surface. Diffusion tensor imaging (DTI) may advance further to characterize the associated abnormalities in the underlying parenchyma, providing information on white matter (WM) microstructure. The superior longitudinal fasciculus (SLF) is a major tract involved in human language processing, as it connects the Broca's area in the frontal lobe (speech production) with Wernicke's area in the temporal lobe (speech comprehension) (2). Our purpose is to evaluate the integrity of the SLF.
with tractography in a series of patients with PMG. Correlations with neuropsychological evaluation of language skills and naming abilities also will be held.

Materials and Methods
Twelve patients with PMG and 12 matched controls were enrolled (patients: mean age±SD=29.9±6.1 years, range = 21–42; controls: 30.3±7.4 years, range = 19–38, p-value = 0.88; both: 6F/6M). All subjects were evaluated prospectively with MRI at 3.0T. Six patients had bilateral PMG while six had unilateral lesions. Whole-brain tractography was obtained automatically with a brute-force approach with ExploreDTI. The SLF was dissected virtually with a deterministic streamline approach (Figure). The fiber assignment by continuous tracking algorithm was applied with a fractional anisotropy (FA) threshold of 0.25 and maximal angle of 60 degrees (3). Diffusion tensor imaging metrics included FA, mean diffusivity (MD), axial diffusivity (AD) and radial diffusivity (RD). Tracts with less than five streamlines or spurious fibers were excluded from the quantitative analyses. A smaller subset of patients (n=4) was further clinically evaluated to assess language skills with an adapted version of the Montreal Communication Evaluation Battery (MAC) (4), as well as naming abilities with the Boston Naming Test (BNT) (5).

Results
In three patients with bilateral PMG, the SLF was not delineated on both hemispheres. The SLF was not depicted in the right side in other three patients and on the left side in one. Patients exhibited significant decrease of FA (patients: mean±SD=0.43±0.01; controls: 0.45±0.02, p-value=0.003) and increase of RD (patients: mean±SD=0.58±0.02; controls: 0.55±0.02, p-value=0.03) in the right SLF. There was significant increase of MD in the left SLF in comparison to controls (patients: mean±SD=0.76±0.02; controls: 0.74±0.02, p-value=0.04). All four patients with neuropsychological evaluation had suboptimal performance on lexical-semantic and prosodic components of the MAC battery. Two patients with the worst scores also exhibited severe disruption of the SLF, that was not tracked on both sides in one patient, and on the right side in another. On the other hand, naming abilities assessed with the BNT were not compromised.

Conclusions
Diffusion tensor imaging and tractography suggest that the SLF is severely disrupted in patients with PMG, providing an anatomical "in vivo" substrate for the language disorders commonly associated with these cortical malformations.
(A) Coronal view of an FA colormap in a normal control. The SLF is identified as a triangle (arrow) lateral to the CST (blue). (B) Lateral view of a dissected colormap and T1-weighted images in the coronal plane of a patient with aphasia and language impairment. The SLF is not well delineated on the left side.
Characteristic MR findings in seizures associated with nonketotic hyperglycemia (NKH): diagnostic value of contrast enhanced FLAIR imaging (CE-FLAIR)

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Purpose
Nonketotic hyperglycemia (NKH) have been reported to induce seizures, and may cause transient signal changes on magnetic resonance imaging (MRI). The aim of our study was to describe the characteristic MRI abnormalities in patients with NKH complicated with seizures and to evaluate the diagnostic value of contrast-enhanced FLAIR imaging (CE FLAIR). We also attempt to characterize the pathogenesis of this unusual finding.

Materials and Methods
We retrospectively studied MRI abnormalities in 10 patients with seizures associated with NKH. All patients underwent brain MRI within 2 days of seizure onset. The clinical manifestations, laboratory findings, MR findings, and clinical outcome in each patient were analyzed.

Results
All patients except one patient presented with focal seizures, either simple or complex partial seizures or negative motor seizures. All patients had long-standing uncontrolled diabetes mellitus. The MRI abnormalities observed acutely were focal subcortical hypointensities on T2-WI and FLAIR imaging in all patients with overlying cortical gyral hyperintensities in two patients. Focal overlying cortical or leptomeningeal enhancement on CE T1-WI or CE FLAIR was observed in all patients. And CE FLAIR was superior to CE T1-WI for detecting characteristic leptomeningeal enhancement. Diffusion-weighted imaging showed mild restricted diffusion in two patients with cortical gyral T2 hyperintensities. The parietal and occipital lobes were involved most commonly. On clinical recovery, the subcortical T2 hypointensities, leptomeningeal enhancement and overlying cortical hyperintensities reversed.

Conclusions
Patients with seizures in NKH may have transient MRI abnormalities that are characterized by subcortical T2 hypointensity with overlying cortical or leptomeningeal enhancement in additional to cortical T2 hyperintensity. Contrast-enhanced FLAIR is superior to CE T1-WI for detecting the breakdown of the blood-brain barrier (BBB) in these diseases. Although these MRI abnormalities pose a broad differential diagnosis, recognition of these radiologic abnormalities in NKH is important in restricting unwarranted investigations and to institute early therapy.
A novel electrocorticography grid using conductive nanoparticles in a polymer thick film on an organic substrate improves CT and MR imaging

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Purpose
Electrocorticography (ECoG) grids are implanted routinely over brain cortex for cortical mapping prior to epilepsy surgery. Such grids are prone to produce extensive metal artifacts at CT and MR imaging (1). This study compares CT and MR artifacts from conventional ECoG grids with those from a new grid developed by deposition of conductive nanoparticles in a polymer thick film on an organic substrate (PTFOS).

Materials and Methods
A 64-contact ECoG grid was developed in a PTFOS construct via deposition of silver nanoparticles on top of denaturized collagen (2). We compared the susceptibility artifacts at MR imaging, both in the field strengths of 3T and 7T, between the PTFOS grid and a platinum grid. We also compared metal streak artifacts at CT imaging between the PTFOS grid and a stainless steel grid. Platinum and stainless steel grids were used in MR and CT, respectively, as these materials tend to produce fewer artifacts in these respective modalities (1). All imaging was performed on a cadaveric human head specimen that was repeatedly imaged without and with different ECoG grids both in CT and MR scanners (Figure 1).
Results
The PTFOS grid produced essentially no artifacts in MR and CT images (Figure 2 and Figure 3); the quality of the images with the PTFOS grid was comparable to images without any grid. Platinum and stainless steel grids, on the other hand, produced extensive and expected artifacts in the vicinity of the grid electrodes that severely degraded the quality of MR and CT images.

Conclusions
Polymer thick film on an organic substrate technology can be used to suppress imaging artifacts from ECoG grids in both CT and MR imaging.
Figure 1. The human cadaveric specimen used for imaging. The specimen with grid (A) and with three different grids: stainless steel (B), platinum (C), and (Filename: TCT_O-561_PTFOS1.jpg)
Figure 2. *CT images.* 140 kVp images of the head specimen without any grid (A), with the stainless steel grid (B), and with the PTFOS grid (C).

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Figure 3. $T2W$ images of the specimen, from a 3T scanner, without any grid, a platinum grid, and with the PTFOS grid. The platinum grid electrodes produce more signal loss (arrowheads) that are not seen with the PTFOS grid.

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Quantitative T2 Shortening in the Deep Gray Matter Structures Associated with Gadolinium-Based MR Contrast Agents

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Purpose
The purpose of this study was to quantitatively assess changes in T2 relaxation time between prior gadolinium-based contrast administrations in the dentate nucleus, pons, globus pallidus, and thalamus on MRI.

Materials and Methods
Following IRB approval, 57 patients who underwent brain MRI between July 2014 and December 2014 on a 1.5T scanner with a dual spin echo PD/T2-weighted imaging were evaluated retrospectively. History and number of prior gadolinium-based contrast administration was recorded. Regions of interest (ROIs) were placed in globus pallidus (GP), thalamus, dentate nucleus (DN) bilaterally, and centrally within the pons. Using an in-house developed MathCAD program the T2-relaxation times in each structure was calculated which was correlated with prior gadolinium administrations. Patients with a history of cirrhosis, iron-deposition disease, and hemodialysis were excluded.

Results
The study cohort was comprised of 12 patients with no prior gadolinium administration, 10 patients with prior MultiHance® (Gadobenate Dimeglumine) but no Magnevist® (Gadopentetate Dimeglumine) administration, and 35 patients with prior Magnevist® administration. Significant differences were seen in T2-relaxation times in patients with prior Magnevist® administration compared to patients without prior Magnevist® in the DN (P<0.0001), thalamus (P=0.0015), and GP (P=0.035). In patients with three or more Magnevist® injections (range 3-15) strong correlations were seen between the number of injections and T2 relaxation times of the DN (r=-0.67) and moderate correlations were seen in the thalamus (r=-0.36) and GP (r=-0.37). No significant differences in relaxation times were seen in the pons (P=0.17). Patients with prior MultiHance® administration, but not Magnevist® did not demonstrate a significant difference in relaxation times (DN P=0.19, thalamus P=0.91, GP P=0.061).

Conclusions
Decreases in T2 relaxation times were seen in select areas of brain parenchyma potentially associated with the number of prior Magnevist® administration. No significant T2 shortening was seen in patients with prior MultiHance® administration.

Optimized, Minimal SAR MRI for High-resolution Imaging in Patients With Implanted Deep Brain Stimulation Electrodes

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Purpose
Deep brain stimulation (DBS) is an effective treatment for neurological disorders such as Parkinson disease. Stereotactic high resolution MRI is the imaging modality of choice in patients undergoing DBS. At our institution, leads commonly are placed in staged unilateral procedures for reasons of patient safety. Due to the precision required for stereotaxis, immediate pre-operative scanning is the standard of care, necessitating imaging with DBS electrodes in place for surgical mapping for placement of the second electrode. Additionally, in cases where the clinical outcome is suboptimal, MR imaging may be requested to assess lead placement. Manufacturer guidelines for performing MRI with DBS in situ (SAR<0.1W/kg) do not allow for diagnostic quality presurgical imaging. Though there is anecdotal experience, the main safety concern is heating due to energy deposition and complications have been reported. We describe our experience performing high resolution pre-operative MR in patients with DBS electrodes at minimal SAR at 1.5T.

Materials and Methods
Protocol optimization was done minimizing SAR whilst providing image quality necessary for adequate presurgical planning for second electrode placement. The protocol was approved by the institutional MRI safety committee. We reviewed patients evaluated for DBS electrode placement between 2/2012-12/2014. Inclusion criteria included age>18 years with MR performed with DBS electrode in situ. Images were reviewed by neuroradiologist (YWL) and neurosurgeon performing the procedure (AM). Image quality was graded qualitatively and presence of artifacts were noted. Deviations from established MR protocol were noted as well as clinical complications from MR scanning.

Results
Protocol consists of a high resolution axial T2WI (FOV 260, slice thickness 2.5, TR 250, TE 83, n=4) applying 0.3 W/kg SAR to the head and axial GRE T1 MPRAGE (FOV 260, slice thickness 1.5, TR 1870, TE 4.03, n=1) kept within the 0.1 W/kg SAR limit. All sequences remained within 20 T/s dB/dT gradient limit. Protocol was adopted on a clinical 1.5T, horizontal bore magnet using a transmit-receive head coil. Twenty-five patients (21 Parkinson disease, four cervical dystonia) had Medtronic (Minneapolis, MN) neuromodulation implants in situ. There were 22 subthalamic and three globus pallidus implants; six patients had bilateral electrodes. Devices were inspected immediately prior to and following MRI by trained neuromodulation staff. No adverse effects occurred. Mild device-related local susceptibility artifact was present in all studies which did not affect overall image quality. Minimal aliasing artifact was seen in seven and moderate motion in four cases on T1WI only though all studies were judged adequate for guidance.

Conclusions
Implanted devices present potential MRI safety concerns; however, imaging is possible in certain situations and attention must be paid to minimize patient risk. Using an optimized MRI protocol with minimal SAR it is possible to obtain pre-operative images for surgical guidance safely in patients with DBS electrodes.
Is the Swallow Tail Sign on Susceptibility Weighted Imaging as Sensitive a Finding in Patients with Parkinson Disease as Previously Suggested?

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Purpose
The "Swallow Tail" sign (STS) demonstrates the healthy appearance of Nigrosome 1 on susceptibility-weighted imaging (SWI). Loss of the STS has been shown to be highly sensitive for the diagnosis of Parkinson disease (PD) at 3T (1). The purpose of this study is to evaluate our ability to reproduce the reported sensitivity of loss of the STS for the diagnosis of PD on clinical strength magnets.

Materials and Methods
This was a blinded, retrospective study including 26 patients with a clinical diagnosis of PD who also had SWI as part of their workup. Fourteen age-matched healthy controls also were selected who underwent SWI. Susceptibility-weighted images were reviewed for the presence or absence of the STS. In cases where there was no initial interobserver agreement, the reviewers reached a
consensus together. Statistical comparison was performed with the Chi-Square test and sensitivity values were calculated.

Results
There was high interobserver agreement in rating the presence or absence of the STS (37/40 patients, 92.5%). Notably, the only disagreements occurred on images obtained using a 1.5T magnet. The STS was rated as present in 11/14 (78.6%) of the healthy controls. In the PD group, the STS was rated as absent in 19/25 (76.0%, p < 0.001) patients. The sensitivity for loss of the STS in PD patients was 0.760 (95% confidence interval 0.549 – 0.906).

Conclusions
Loss of the STS may be helpful to distinguish PD patients from normal patients, although the calculated sensitivity is lower than currently published data.

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Can Loss of the Swallow Tail Sign on Susceptibility Weighted Imaging be Seen in Patients with Parkinson-Plus Syndromes?

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Purpose
The "Swallow Tail" sign (STS) demonstrates the healthy appearance of Nigrosome 1 on susceptibility-weighted imaging (SWI). Previously published research has suggested that loss of the STS on SWI is highly sensitive for the diagnosis of Parkinson disease (PD), although no other movement disorder patients, such as the Parkinson-Plus syndromes, were included in that study (1). We seek to evaluate the STS in patients with Parkinson-Plus syndromes.

Materials and Methods
This was a blinded, retrospective study which included 10 patients with a clinical diagnosis of corticobasal syndrome (CBS) or progressive supranuclear palsy (PSP) and 11 patients with a clinical diagnosis of multisystem atrophy with Parkinsonism (MSA-P) who underwent SWI of the brain as part of their workup. Fourteen age-matched healthy controls also were reviewed who underwent SWI. Images were reviewed for the presence or absence of the STS. In cases where there was no initial inter-observer agreement, the reviewers reached a consensus together. Statistical comparison was performed with the Chi-Square test.

Results
There was high interobserver agreement in the rating of the presence or absence of the STS (31/33 patients, 93.9%). Notably, the only disagreements occurred on images obtained using a 1.5T magnet. The STS was present in 11/14 (78.6%) of the healthy controls. The STS was absent in 10/11 (90.9%, p < 0.001) of the patients with MSA-P and 10/10 (100.0%, p < 0.001) of the patients with CBS/PSP.

Conclusions
Similar to PD, the STS very often is absent in patients with Parkinson-Plus syndromes. These results suggest that the STS may be a nonspecific indicator of the presence of a movement disorder.